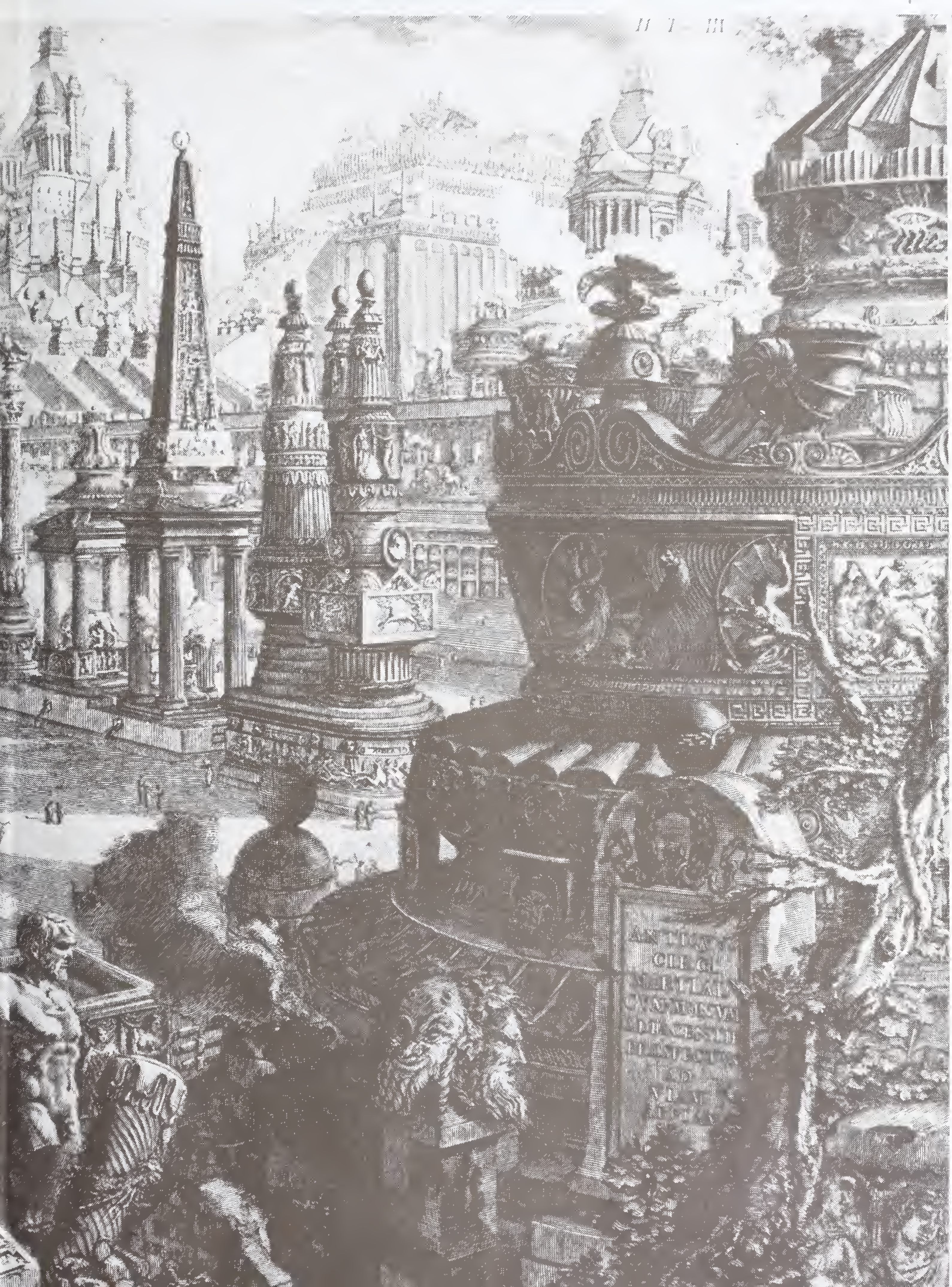
THE MAGIC OF OBELISKS

BY PETER TOMPKINS

Author of Secrets of the Great Pyramid and Mysteries of the Mexican Pyramids



THE MAGIC OF OBELISKS

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PETER TOMPKINS

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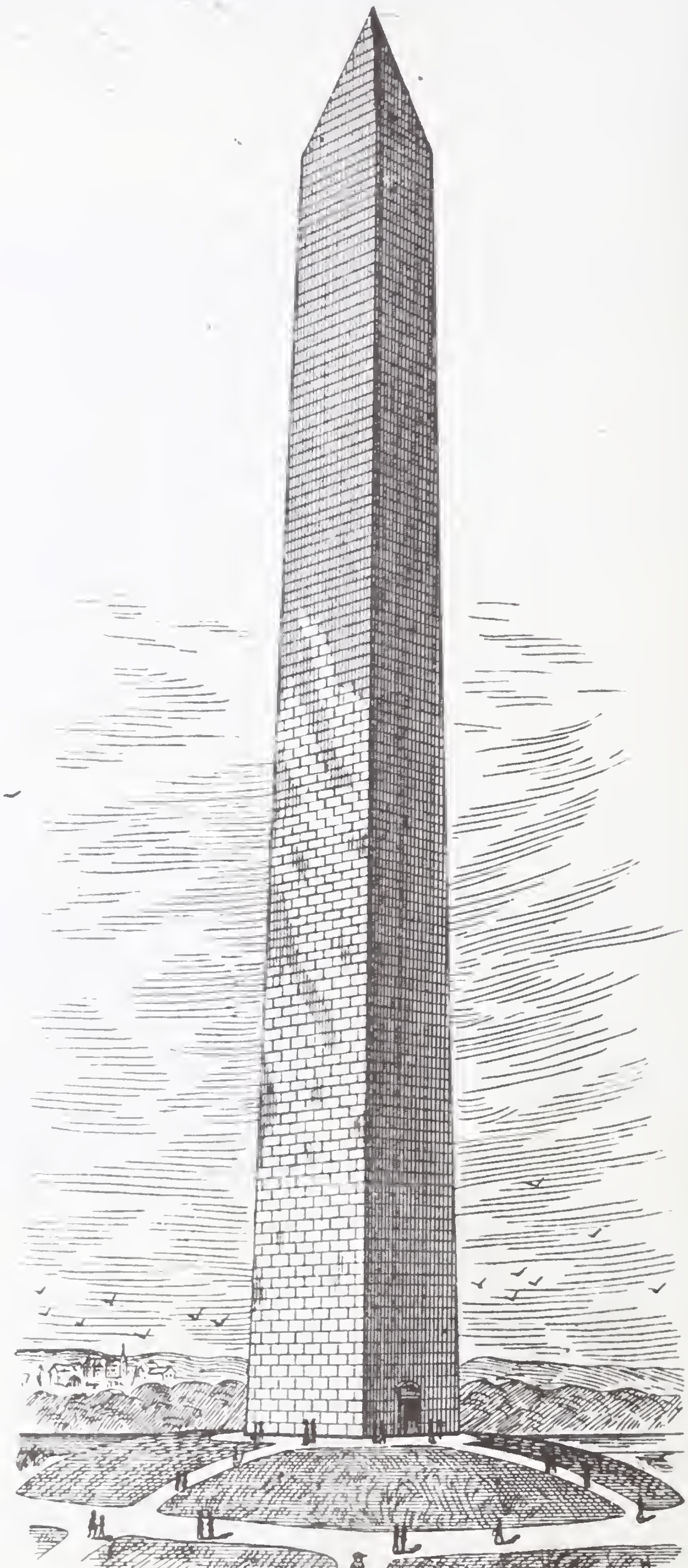


Washington National Monument

1. HISTORICAL BACKGROUND

The most stunning and prestigious monument in the capital of the United States is an enormous obelisk, named for the founder of the country, George Washington, a thirty-third-degree Mason. It is the tallest such monument in the world, 555 feet high, though not truly an obelisk, because it is not quarried from a single piece but put together from 36,000 separate blocks of granite faced with marble.

New York has a true obelisk, brought there from Egypt in 1880 at the substantial cost at that time of $100,000 to stand in Central Park near the Metropolitan Museum of Art. European capitals such as London, Paris, Rome, and Constantinople have their obelisks, also brought from Egypt, the apparent source of the fashion at least five thousand years ago, though where the Egyptians got the notion is a matter of conjecture.

In ancient Egypt there were a great many obelisks. The pharaoh Seti I, son of Ramses I and father of Ramses II, who reigned in the second half of the second millennium B.C., boasted that he alone fairly "filled Heliopolis with obelisks." This city of the sun, as it was called by the Greeks—the On of the Old Testament and the modern El Mataria, near Cairo—must have been an extraordinary sight standing on a rocky plateau in Lower Egypt, with its forest of slender gilded obelisks reflecting sunlight into the bright clear air of the wide Nile Delta.

Obelisks had already been raised at Memphis and Thebes by Thothmes III, named after Thoth, the Egyptian god of learning and science. Thothmes, whose reign is dated from the beginning of the sixteenth century B.C., is considered by many Egyptologists to have been the greatest pharaoh in the country's history. One of his more beautiful obelisks is now in New York. Another is in London. Thothmes brought the tallest standing obelisk in Egypt, 106 feet high, to Karnak, which already had at least thirteen such monoliths. It now stands in the square of Saint John Lateran in Rome. Thothmes's stepmother, Queen Hatshepsut, who was also his rival, raised four more (slightly smaller) obelisks in Karnak.

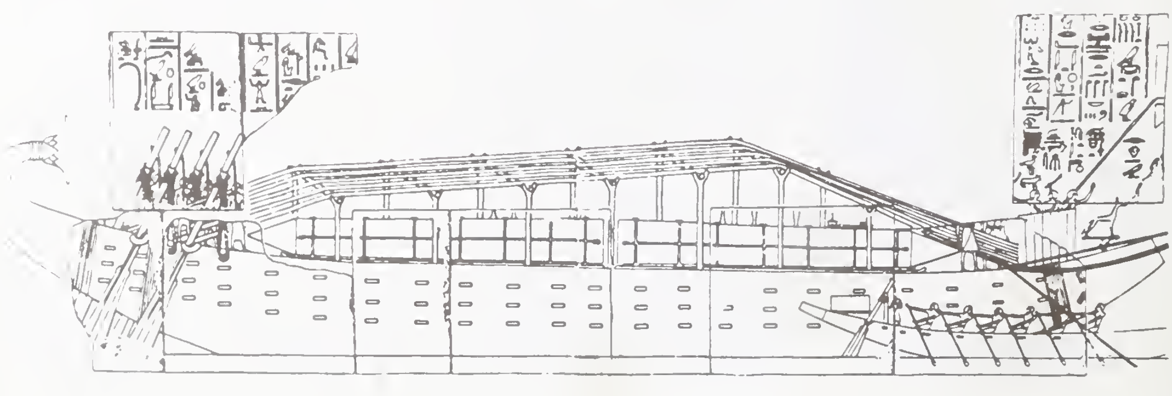
The next great name in Egyptian conquerors and obelisk raisers was Ramses II. This Nineteenth Dynasty king, who is said to have reigned for most of the thirteenth century B.C., is credited with having raised fourteen obelisks at

Obelisk reraised in Constantinople by the emperor Theodosius In A.D. 390. Originally more than 100 feet tall, it was reduced to half that size in transit from Egypt, where it had been originally raised in Karnak by Thothmes III.

Tanis alone; but his most renowned examples are the two he placed outside the Temple of Luxor in Thebes, one of which is now in Paris's Place de la Concorde.

The Roman historian Pliny the Elder, who died in the eruption of Vesuvius in A.D. 79, tells how Ramses, with the help of 100,000 workers, brought down to Heliopolis a great obelisk, all of 162 feet high. To prevent the workers from being careless with the dangerous machinery needed to raise such a monster, he had his son tied to the top of the obelisk. To save the one, workers must save the other—and thus their heads. Not that Ramses II ran much risk of losing an only heir: he is reputed to have fathered several dozen sons. The task was successfully accomplished; though what became of the obelisk, nobody knows.

Three of the most eminent historians of the ancient world, Herodotus, Diodorus Siculus, and Pliny, all tell the story of another pharaoh who raised two great obelisks at On. While crossing the Nile, this monarch is said to have been caught in a terrible storm, so menacing that the turbulent waters became a threat to his life. Outraged, the pharaoh is described as having seized a lance and hurled it into the seething river. The Nile, so the story goes, was offended, and struck the pharaoh blind. Nor could anyone cure him, though he tried a variety of doctors. Then an oracle informed the king of a remedy: he must bathe his eyes in the urine of a married woman who had slept *only* with her husband. With the help of his beautiful queen, the pharaoh daily bathed his eyes in the manner prescribed; but he still remained blind. In despair, he experimented with several more women until at last he found one who cured him. Those who had failed, he collected into a city called Zolla Rossa, and had them burned—women and city. The faithful lady with the successful remedy, he married. And so happy was this monarch, say the historians, that he raised all kinds of monuments in Egypt, including two huge obelisks, each reputedly 100 cubits



Two of Queen Hatshepsut's obelisks being floated down to Thebes from Aswan. Pliny tells how Ptolemy Philadelphus later brought Nectabis' obelisk to Alexandria. From the Nile he dug a canal to where the monolith lay. He then filled two flat-bottomed barges with granite blocks equalling twice the weight of the obelisk, and floated the barges under the needle. As the barges were unloaded they rose to accept the obelisk and float it away.

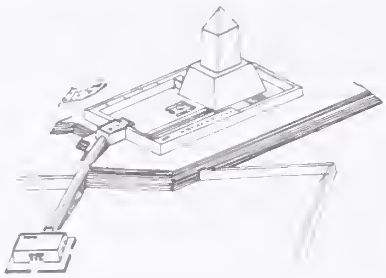
Dragging Constantine's obelisk to be raised in the Byzantine Hippodrome

high—which would be 165 feet—dedicated to the sanctuary of the sun. What happened to these, nobody knows; and if one had to rely on "classical" Greek and Roman authors to find out how such great obelisks were raised or what their real purpose may have been, one would be left ill informed.

There are other records—some more, some less plausible—of very ancient obelisks farther up the Nile, as far as Philae and Elephantine, by the first cataract, and even as far south as Soleb in Nubia. Available records of obelisks extend back to the Old Kingdom, with its first four dynasties, dated by Egyptologists to the third millenium B.C., whose pharaohs are credited with having built the Great Pyramids on the Giza plateau. But no obelisk of this era is known to exist. The records tell that Sahure, and other pharaohs of the Fifth Dynasty, built magnificent temples, such as the Temple of Neurine at Absia, adorned with obelisks, only parts of which survived. The earliest example of a complete needle appears to be that of King Senusret I of the Twelfth Dynasty, found at Heliopolis.

The obelisk of Teti, the earliest known true obelisk

Fragments of earlier obelisks, attributed to King Entef of the Eleventh Dynasty, date back to the end of the third millennium B.C. Though broken, their hieroglyphs have been well preserved, thanks to the protective coating of sand under which they were buried. Only no one yet knows what these particular hieroglyphs mean. Recent excavations show that these obelisks differ from later, more familiar ones, being shorter and squatter, and having taller masonry bases, sometimes as long as one-third of their shaft. According to Egyptologists, the longer bases were re-



Pharaohs of the Fifth Dynasty added to their pyramid complexes vast solar temples built around a huge benben. But these early needles, rather than true monoliths, were obeliscoid structures composed of separate blocks raised high on a truncated pyramid.

quired to raise these sacred "pryamidions," or *benben* as the Egyptians called them, nearer to the sun. In fact, there may have been other reasons, both occult and scientific.

Of the hundreds of obelisks that once stood in Egypt, only nine still stand; ten more lie broken, victims of infuriated conquerors, or of the religious fanaticism of competing cults. The rest are buried or have been carried away to foreign lands to dwell in dumb mimicry of Egyptian grandeur.

The first conquerer to remove an Egyptian obelisk was the Assyrian monarch Assurbanipal, better known by his Greek name of Sardanapalus, who ravaged Thebes in 664 B.C. and carried away two obelisks to his palace at Nineveh, presumably floating them down the Red Sea, across the Indian Ocean, up the Persian Gulf to the Tigris, and thence to Nineveh, some 1,600 miles away.

Sardanapalus in his harem

The next foreign conqueror, seeking to undo humiliation suffered at the hands of both Thothmes III and Ramses II, was the Persian leader Cambyses (or Kembathet), who defeated the Egyptian pharaoh Psametic III near Pelusium in a battle in which the Persians killed fifty thousand Egyptians. With the help of the battle fleet of the Phoenicians, who had also suffered repeatedly at the hands of pharaohs, the Persians swept the Egyptian navy from the seas, and made themselves masters of Egypt. Marching his army through the delta, Cambyses desolated the land with fire and sword till he came to the great city of On, which he took by storm and set on fire. In the holocaust that followed, the great Temple of the Sun was destroyed. Obelisks were dragged to the ground and mutilated, the

Constantine I, known as the Great (A.D. 280–337), bastard son of emperor Constantius I, became the first Christian emperor after defeating Maxentius at the gates of Rome.

most hated specimens being those that bore the inscriptions of the cruel deeds Thothmes III and Ramses II had performed against the Persians. Only when fire reached the base of one magnificent obelisk over 100 feet tall, did Cambyses, apparently out of admiration for its size (or so we are told by Pliny), relent and make his followers extinguish the flames.

Later conquerors of Egypt removed one or more obelisks as souvenirs. After the Macedonian generals of Alexander the Great had subdued Egypt and established a Ptolemaic line of Egyptianized Greek pharaohs, who ruled for three centuries, the Romans in 30 B.C. reduced the once proud kingdom to a province of Imperial Rome. It was their turn to loot Egypt of its obelisks. But first, in commemoration of their conquest, they built in Alexandria a great temple known as the Caesarium, or Palace of the Caesars. Started by Cleopatra after the birth of Cesarion, her son by Julius Caesar, the palace grew into the tallest and most impressive building in the city, surrounded by a sacred grove, embellished by porticoes, complete with library and works of art. As sentinels to guard its grand water-gate entrance, Julius Caesar's adoptive son Augustus, as Rome's first emperor, brought from Heliopolis, where they had stood for a millennium and a half, two great obelisks which came to be known as Cleopatra's needles. One is now in London, the other in New York.

Transporting and raising obelisks was no easy task, even for such expert engineers as the Romans. Although the records of Roman operations with obelisks are almost as incomplete as those of the Egyptians, Vitruvius, architect and military engineer to Augustus—claimed by modern Freemasons as one of their own—writes that the motive power for raising such enormous weights came from men working in a squirrel cage, thereby gaining a wheel-and-axle mechanical advantage. Vitruvius also describes a large two-legged shears for supporting tackle with which to raise an obelisk and set it on its base. But just how the job was really done remains a mystery.

Somehow, the Egyptians had developed a means of placing these huge blocks of granite directly onto a cubical pedestal which had to be absolutely level in order to have the apex of the obelisk truly vertical over its base—no easy task. The Romans, either because they could not match this expertise or because their obelisks had been injured at the base—by Persians or in transport—came up with a system of wedging astragals, or metal footings, to a column, between the base of the obelisk and the top of the pedestal. For this purpose the

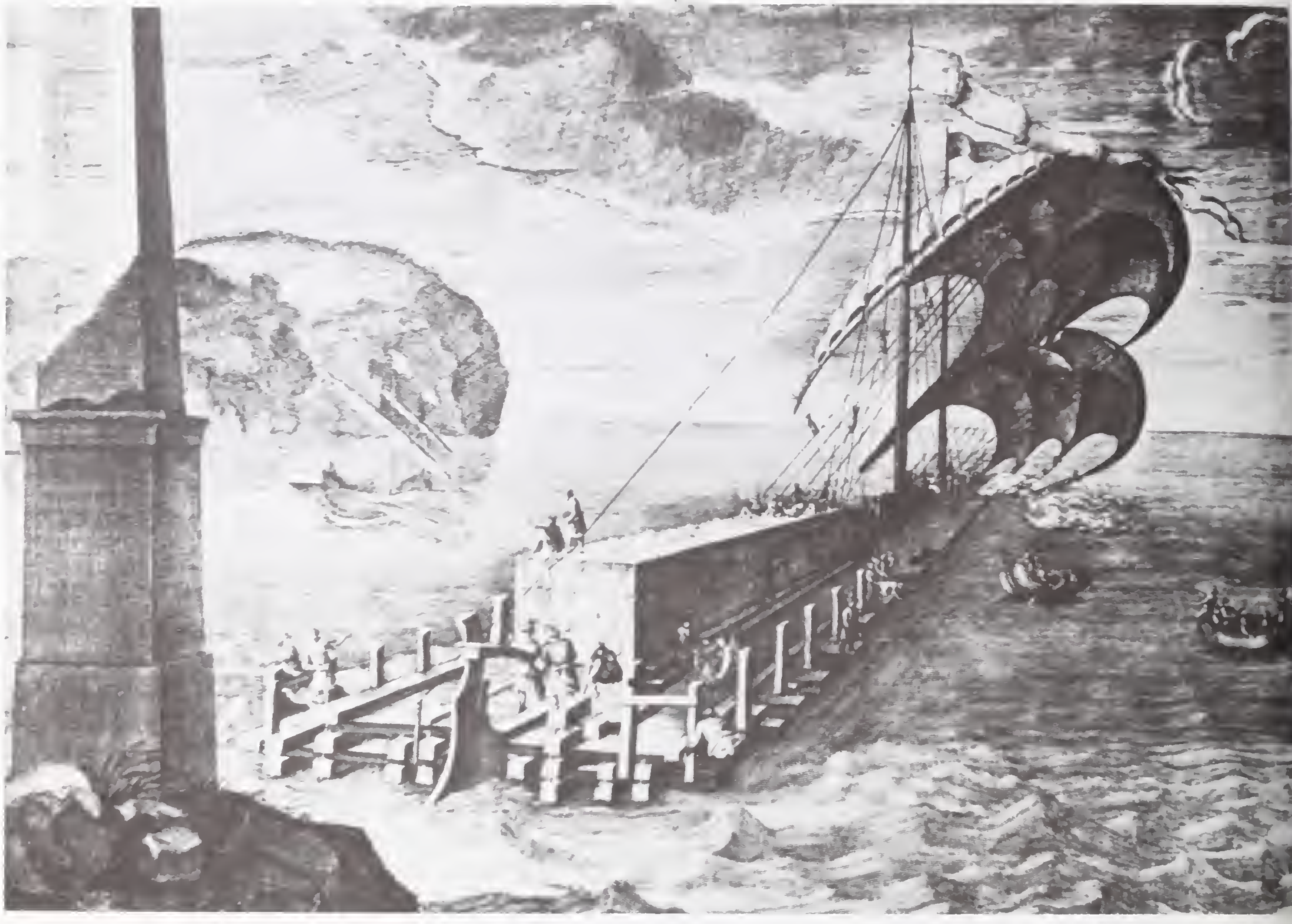
The standing obelisk at Heliopolis is the oldest known surviving needle in Egypt. Twenty meters high, it weighs 121 tons. From the inscription on it, Egyptologists have deduced it was raised on the jubilee of pharaoh Sesostris I in 1942 B.C. Heliopolis, with its Temple to the Sun, "its 13,000 priests chanting before a huge mirror of burnished gold, the sacred hawk in the golden cage, the pyramidal ben-ben, and the sacred calf Mnevis on its purple bed," was the greatest theological center in ancient Egypt. There the pyramid texts, the largest single collection of religious compositions yet recovered from early Egypt, were mostly composed by Heliopolitan priests. Of the ancient city, with its scores of obelisks, nothing remains but this lone example.

Reconstruction of an Egyptian temple with its standing obelisks

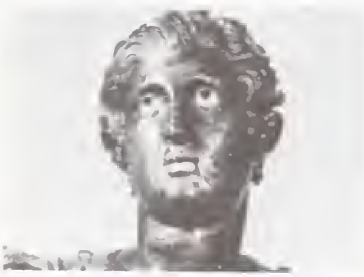
Romans cast bronze crabs, each about 16 inches in diameter, with shanks made to fit downward into the pedestal and upward into the shaft of the obelisk. As each monolith was settled onto its four crabs, hot lead was poured around dovetailed shanks so that future vandals could not so easily remove them—though they did, repeatedly. Crabs are said to have been chosen by the Romans as appropriate symbols to sustain obelisks dedicated to the Egyptian sun god because the Romans somehow considered the crab a symbol for their own sun god, Apollo.

Not content with moving two obelisks within Egypt, Augustus decided to transport another great needle all the way to Rome to be raised along the spine of the chariot-racing course of the oldest Roman circus, the Maximus, which had been laid out by Tarquin between the Palatine and Aventine hills. Augustus had no trouble choosing his obelisk. According to Pliny, the 75-foot porphyry needle he selected had been carved with hieroglyphs on order of the pharaoh whom Pliny calls Psemetnepserphreo and modern Egyptologists call Psammetikos, "during whose reign Pythagoras went to Egypt." This would have been in the sixth century B.C., though it is clear that the obelisk had been quarried many centuries earlier.

The main difficulty in transporting an obelisk consisted in being able to build a ship large enough to carry the enormous weight of 200 tons or more. To accommodate his obelisk, Augustus ordered a ship to be built at least 100 feet long. When the journey was successfully completed, the emperor exhibited the vessel in the naval yard of Pozzuoli, outside Naples, so that it could be admired by the people. After the obelisk was raised in the Circus



Painting in the Vatican of a Roman ship designed to bear an Egyptian obelisk to Rome. One such vessel could accommodate 1,200 passengers besides a cargo of niter, papyrus, and 400,000 bushels of wheat.



The emperor Gaius (A.D. 12-41), generally known as Caligula. A slave to his wild compulsions, he eventually went insane.

Maximus, Augustus decided he liked it so much he had another one brought from Egypt to be erected in the Campus Martius, or Field of Mars, where the Roman armies had once exercised, and where the censor G. Flaminius had built a circus in 220 B.C. This second obelisk was 9 feet shorter than the first but was covered with beautifully carved hieroglyphs, incomprehensible to the natives, though Pliny, with his intuitive ear for worthwhile lore, reported the glyphs to be "interpretations of natural phenomena according to the philosophy of the Egyptians."

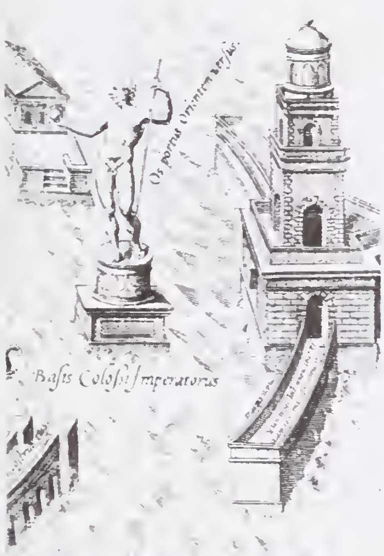
The next Roman emperor to bring an obelisk to Rome was Caligula, contemptuously described by the historian Suetonius as a singer, dancer, gladiator, and chariot driver—a job normally reserved for slaves—who brought an even taller one to adorn the Vatican Circus, which he built to entertain himself with chariot racing. To import his obelisk, along with the five enormous pieces of numidian

Roman chariot race around a central obelisk. These races date from the founding of Rome in the eighth century B.C. and were dedicated to the seasonal revitalizing of nature by the sun—symbolized by the central obelisk, pillar of life, and axis of the solar system. The racecourse was likened to the path of the planets around the ecliptic, with altars to each planet along the spine. Smaller obelisks marked the equinoctial and solstitial limits of the course. The charioteers bore different colors attributed to the various planets. Such festivals were worldwide. In Nineveh chariots with planetary colors raced around the city's crenellated walls; and in Yucatán the ballcourts similarly represent the concourse of planets wheeling around the vivifying sun in a narrow circuit of 7° north and south of the celestial equator.

granite designed to sustain it, Caligula constructed an even longer ship than Augustus's. The obelisk, taken from Heliopolis, had no inscriptions on its faces, and its ancient history could not be easily determined. It is believed to have been cut at Syene, the Arab Aswan, far up the Nile near the Tropic of Cancer, in the thirteenth century B.C. According to Pliny this may have been the obelisk set up by the pharaoh he calls Noncoreo, who raised it in gratitude for his restored eyesight. What is certain, says Pliny, is that nothing like the ship which bore it, with its three hundred oarsmen, had ever been seen before. To bolster the obelisk, and keep it from moving when the ship rolled, more than 1,000 tons of lentils in sacks were stuffed around its shaft. If the obelisk weighed 330 tons, as reported by Pliny, the base 174 tons, and the lentils 1,000 tons, the ship would have sailed with a minimum displacement of more than 1,500 tons, no small undertaking for those days.

Once the obelisk was safely at the mouth of the Tiber, Caligula ordered the ship tied up in Ostia harbor as a museum piece. In A.D. 40, just before Caligula was murdered, the obelisk was set in place in his Vatican Circus by means of a heavy framework of timber. Claudius, who succeeded Caligula, had the ship filled with the ubiquitous Roman mortar, *pozzulana*, and sunk to make a bigger harbor, with three docks "as tall as towers." During recent excavations for Rome's international airport at Fiumicino, the outlines of Caligula's ship were found, and it was seen to have been all of 240 feet long.

Nero, who succeeded Claudius, and, like Caligula, enjoyed driving a *quadriga,* or four-horse chariot, had the Vatican Circus protected by a wall all around so he could practice without being seen (or laughed at) by the people. Once he considered himself sufficiently proficient, he had the plebes called in to "raise their applause to the skies."



Towered docks at Rome's harbor, built by the emperor Claudius

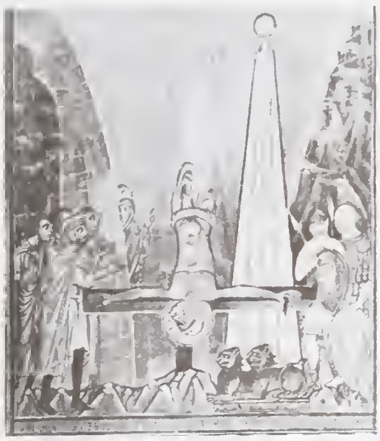
The obelisk as it was raised on the Pincian Hill, in 1820

When Nero put the blame on the early Christians for burning Rome—orders for which he had given—many of them were martyred in the Vatican Circus, among them Simon, called Peter, who is supposed to have met his death somewhere near the foot of the great obelisk.

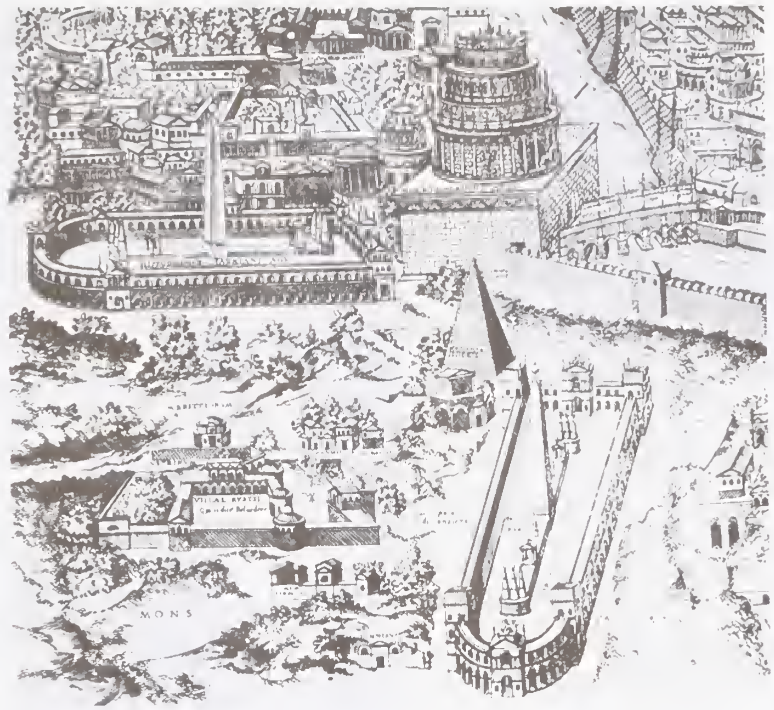
The emperor Hadrian, pained by the drowning in the Nile of his favorite boyfriend, the beautiful Antinoüs, decreed the building of a city on the banks of that river, to be called after him, and ordered an obelisk raised in Rome as a monument on which they said was writ in hieroglyphs the sad tale of the sacrifice made by this youth to serve his master. For many centuries no one knew quite where this obelisk had been raised. It was believed the self-castrated emperor Heliogabolus had taken it as a phallic ornament for his own small circus, but eventually it turned up near the present Basilica of Santa Croce in Gerusalemme in 1770 and was reraised in the Villa Borghese by Pious VII fifty years later.

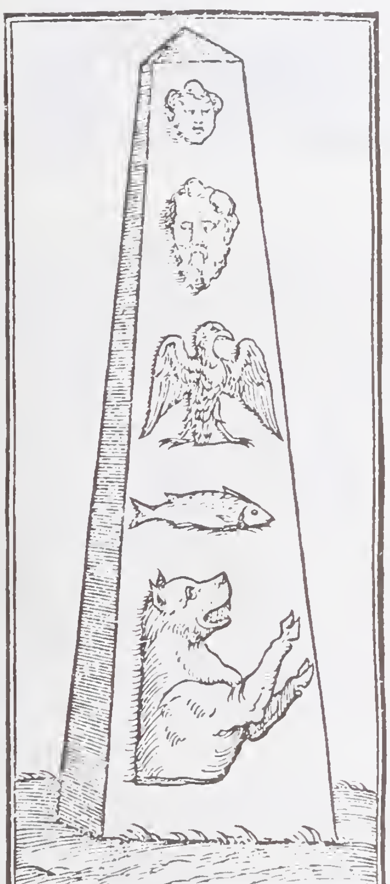
The only non-emperor in ancient Rome to have had an obelisk on his property was Julius Caesar's friend Caius

Giambattista Piranesi's etching of the Basilica of Santa Maria in Gerusalemme, where Hadrian's obelisk dedicated to Antinoüs was found. Its glyphs, honoring Hadrian, were carved in Rome, in imitation of Egyptian originals.



The supposed crucifixion of Saint Peter beside Caligula's obelisk in Nero's Vatican Circus, from a thirteenth-century fresco reproduced by Cesare d'Onofrio





Sallustius Crispus, who managed to accumulate such a fortune in Africa—without too much scruple—that he could afford to have a palace with baths, forum, tribune, and obelisk on a large estate that ran between the Quirinal Hill and the Pincio (and part of which is now the French Academy in the Villa Medici). Though this obelisk came from Egypt, its hieroglyphs were carved in Rome, copied from the obelisk of Augustus in the Circus Maximus. The work was so poorly done that some of the glyphs are backwards.

At the beginning of the fourth century A.D., when the Roman Empire began to split, and the emperor Constantine founded a new capital in Constantinople, he too had to have an obelisk. For "New Rome" on the Bosporus, he chose the tallest obelisk yet tackled by any Roman emperor, the great monolith which Thothmes III had brought from Syene to the Temple of Amon at Karnak before he died, and which his grandson Thothmes IV had raised some years later. Augustus had seen this colossus, and had thought of bringing it to Rome, but had not dared to do so because it was dedicated to Amon, of whom he stood in awe. Constantine, with fewer qualms, had the monolith dragged and floated to Alexandria in 330. But there it lay prostrate, as Constantine lay dying. In the ensuing insurrections, the Caesarium, with its extraordinary remnants of the great Library of Alexandria—wherein may have lain an explanation of the purpose of the great obelisks—also suffered its first destruction.

The Karnak obelisk of Queen Hatshepsut. "First of noble women," so named at the age of 13 after a mysterous ceremony, this queen is described as a sensuous, mystical creature who considered herself an incarnate goddess (born by theogamy) divinely ordained to rule Egypt. She was depicted wearing the traditional artificial beard of a pharaoh, and was referred to as "he." The daughter of Thothmes I, she married her half brother Thothmes II and ruled jointly with him. Her father, as third king of the Eighteenth Dynasty, was responsible for erecting the first pair of red granite obelisks at Thebes, each weighing close to 150 tons, for which he had a boat 180 feet long and 60 feet wide built to transport to Karnak. One of the obelisks still stands between the third and fourth pylons. Each face bears his name, but Ramses IV added his own, as did Ramses VI. Hatshepsut raised four other obelisks at Karnak, one of which still stands. Another lies broken beside it. On the occasion of her jubilee, she had another pair of obelisks quarried by the Aswan cataract and floated to Thebes, where they were raised in the Temple of Amon-Ra at Karnak. They were a hundred feet tall and weighed 232 tons, and their pyramidions were sheathed with electrum to reflect the sun. A text of thirty-two lines on the base describes the events. One of Hatshepsut's engineer-architects, Senenmut, is reputed to have controlled the clergy, as a state within the state, a secret society of architects and masons, devoted to the mother

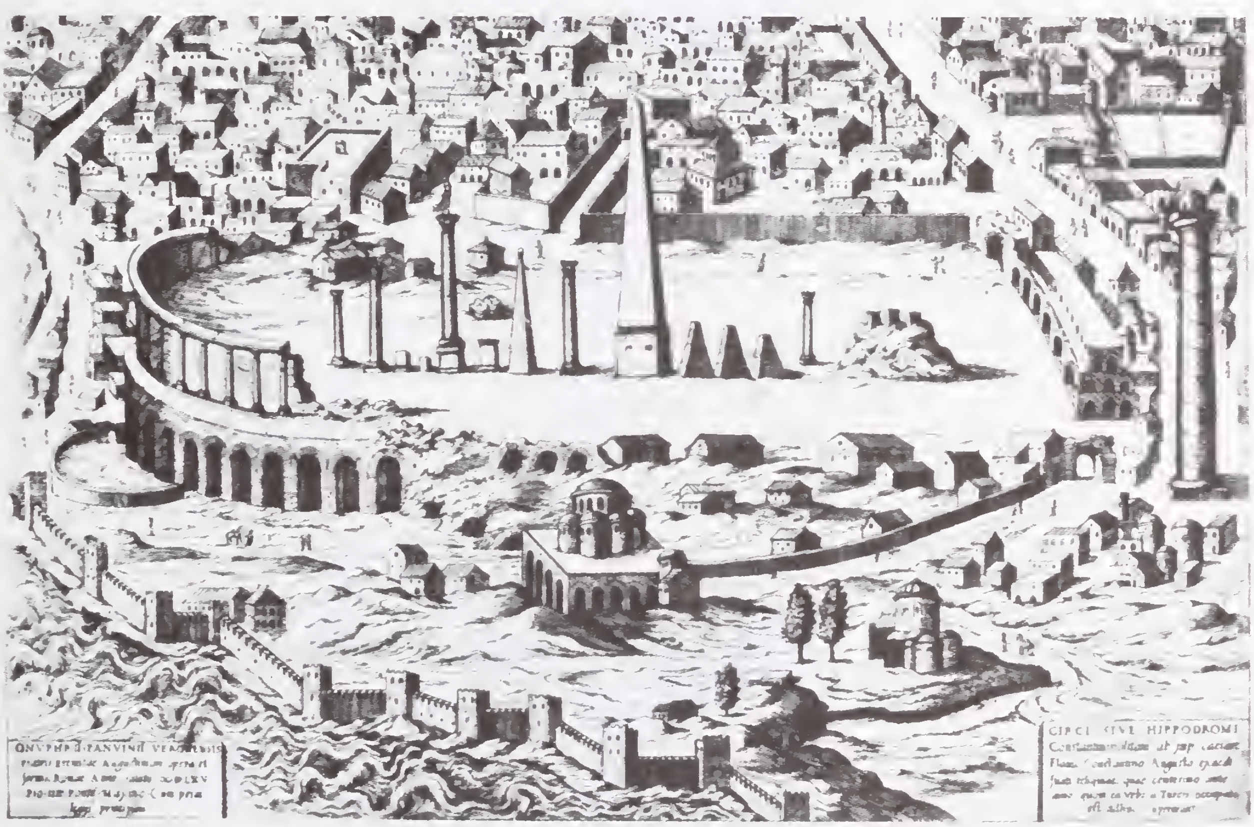
When Constantine's son and successor, Constantius, traveled to Old Rome, then governed by his brother Constans, he was so impressed by the grandeur of its monuments he decided to tie his own name to the eternal city by having the tallest of all known obelisks brought there from Alexandria. It took another enormous ship with three hundred oarsmen to ferry the red granite monolith, carved from the hills of Aswan, safely to the port of Ostia. From there it was floated up the Tiber on a huge raft as far as the Ostiense docks, where it was thrown into a side street, because the tyrant Magnentius had just slain Constantius's brother and occupied Rome.

Only when Magnentius conveniently committed suicide in Lyons in 353 was Constantius able to resume the job of dragging the obelisk along the present Aventine avenue to the center of the Circus Maximus. Ammianus Marcellinus, the Greek historian who wrote about Rome and was alive at the time, says that to raise it in the year 357 thousands of men were employed to pull on huge ropes, and that so many timbers were required the circus looked like a forest. He adds that as the needle finally stood erect, many more thousands of spectators were dumbfounded to see that it dwarfed the obelisk of Augustus, about 50 goddess, spread among the temples to survey "strict observance" of the rule. After her death, the images and names on Hatshepsut's monuments were removed. Her successor, Thothmes III, raised seven obelisks in Karnak and Heliopolis.

meters away, which had dominated the area for 367 years.

Meanwhile the inhabitants of Constantinople obtained another obelisk from Karnak, one believed to have been raised there by the pharaoh Menkherra-sonb. It too had been dragged to Alexandria on orders of Constantine, but had lain neglected since his death. Constantius's cousin, Julian, who succeeded him as emperor, got it moving again by urging the people of Alexandria to forward the old shaft to New Rome, in return for a colossal statue of himself. The ship which bore the obelisk from Alexandria was driven ashore in a storm near Athens, whence the shaft was at last brought to Constantinople by Theodosius I, who came to the throne twenty years after Julian.

Along with the fifteen authentic Egyptian obelisks which the Romans ferried across the inland sea to adorn their streets, forums, and circuses, they also raised a forest of imitations, many with hieroglyphs carved in the style of the Egyptian originals, which no one could any longer read or understand. Decay was at hand. Within a few centuries of the decline and fall of Rome came the decline and fall of its obelisks. With but one exception, all were knocked down and badly damaged by fire, especially around the bases, as if with the deliberate intent that they never be raised again.

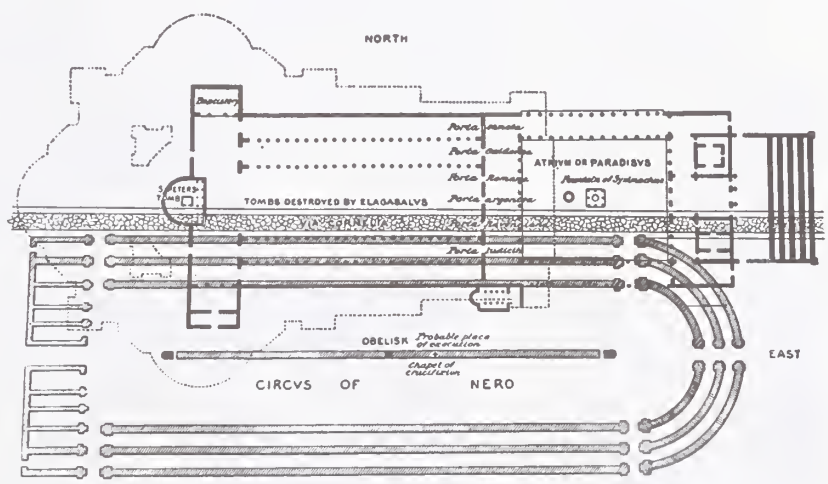


The circus at Constantinople, with its obelisks along the spine, where the ancient festivals gradually lost their meaning in the course of the decadent Byzantine millennium

For a long time this vandalizing was attributed to the various barbarous invaders who succeeded each other in waves. Later writers, beginning in the Renaissance, concluded that the obelisks had been disposed of not by barbarians, envious of such imposing monuments, but by bigoted Christians who hated or feared all that was pagan. Rodolfo Lanciani, the Italian-born historian and antiquarian, pointed out at the turn of the century that obelisks were not the only pagan monuments to be destroyed, desecrated, and broken up to make new buildings. In his *The Ruins and Excavations of Ancient Rome* he flatly absolves the barbarians: "We can discard the current opinion that attributes to barbarians the disappearance of Rome's monuments." According to Lanciani, whereas the scourge of invaders passed over the massive constructions of the Roman Republic and the Roman Empire, leaving what he calls hardly a trace of damage, the real harm was done by Christianized Romans of the Middle Ages and of the early Renaissance. "Can one," Lanciani asks, "really see the barbarians pulverizing the 65 kilometers of marble around the Circus Maximus?"

Ruins of ancient Rome with a fallen obelisk—and incomprehensible glyphs—depicted by Piranesi

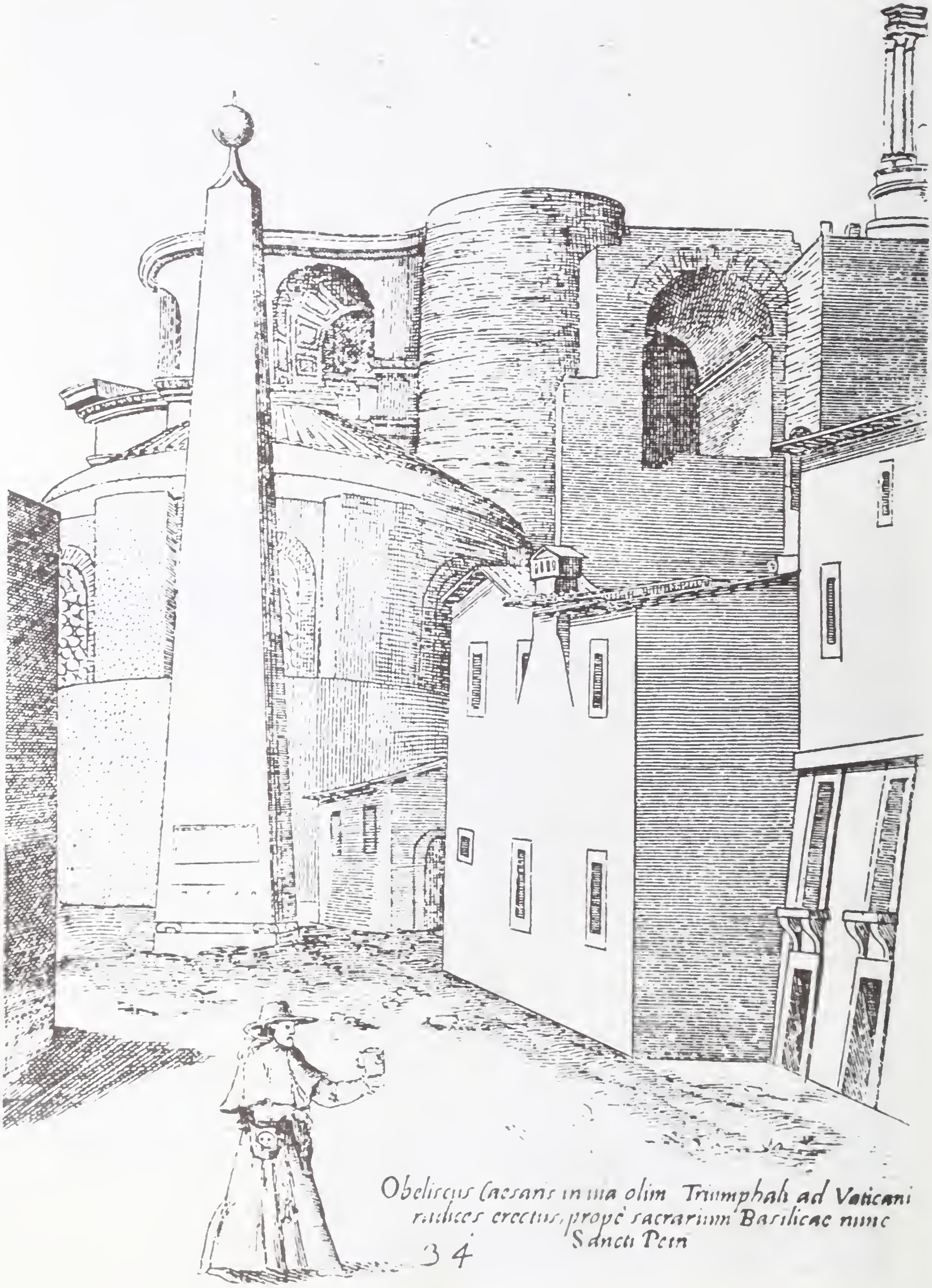
The demolition and retrogression perpetrated by Christians lasted for a thousand years. As the great city slowly decayed, grass grew in the marketplaces and the forums; carefully laid stones were toppled, one after the other, till wolves roamed the empty spaces. Of the great obelisks, with one exception—that brought by Caligula—not a trace was left. They were buried, lost, forgotten. Even the sole standing example was up to its navel in refuse and dirt, its pedestal and bronze astragals completely buried. It still stood only because of the Christian basilica of Saint Peter, founded by Constantine, whose walls it almost touched. Any attempt to knock down the obelisk would have risked destroying this most holy of Christian churches, deliberately built on the spot in Caligula's Vatican Circus where Saint Peter was said to have been martyred.



Plan of Saint Peter's Basilica as it was built over the remains of Nero's circus beside Caligula's still-standing obelisk

If the Goths and Vandals had been interested in destroying obelisks, they would hardly have spared this example for that reason. More likely, the early pontiffs, exponents of an antipagan religion, wished to supplant once and for all these erect symbols of a pantheistic way of life and, as they did in the case of so many ancient pagan sites, turn this sole remaining obelisk into a Christianized place of worship, granting indulgences to pilgrims who would crawl about its base, praying to Saint Peter.

But such is the karmic wheel of life that it was to be the succeeding pontiffs in later rounds of history who would do their damnedest to raise again the old obelisks to their former grandeur, like so many phoenixes rising from their ashes to proclaim the very wisdom which the Church had wished to silence.


Obeliscus Caesaris in via olim Triumphali ad Vaticani
radices erectus, propè sacrarium Basilicae nunc
Sancti Petri
34

2. RESURRECTION OF THE OBELISKS

Ball atop Caligula's obelisk, close by the Vatican Basilica, said to contain the ashes of Julius Caesar. From a sixteenth-century print reproduced by Cesare d'Onofrio

An English prelate who traveled to Rome at the beginning of the fourteenth century, Master Gregorius, found the last obelisk still standing up against the walls of Saint Peter's Basilica, in a dark alley flanked by crumbling old houses. As its shaft was covered with dirt and weeds, well above the sign of any base, Master Gregorius had no way of telling the length of the obelisk, and conjectured it might be as long as 250 feet. More interested in the pagan antiquities of Rome than its Christian churches, Gregorius was captivated by the tradition that the bronze ball on top of the obelisk contained the ashes of Julius Caesar. In letters to his English parishioners, in which he cheerfully admitted that "he read much but understood little," Gregorius passed on the story that the obelisk had been raised on the exact spot where Caesar, on the way to the Capitol, had been accosted by an astrologer who warned him he would be killed on the ides of March.

The assassination of Julius Caesar

The antiquarian and historian Cesare d'Onofrio, in his *Gli Obelischi di Roma,* attributes the belief partly to the fact that the words *Julius* and *Caesar* appear four times in the Latin inscription below the obelisk, and partly to a misunderstood passage in Suetonius, "one of those cases of false etymology," says d'Onofrio, "so common among the learned when they try to explain away something they cannot understand." Suetonius, in his *Lives of the Caesars,* relates that right after the dictator's remains were

Nicholas V replaced the antipope Felix V, a duke of Savoy—not even a priest—elected when the Council of Basel in 1439 deposed Eugenius IV as a heretic.

With the end of the schism of the Church, Nicholas V reestablished Rome as the seat of the papacy, and to celebrate this triumph proclaimed a jubilee whose participants he milked to embellish Rome.

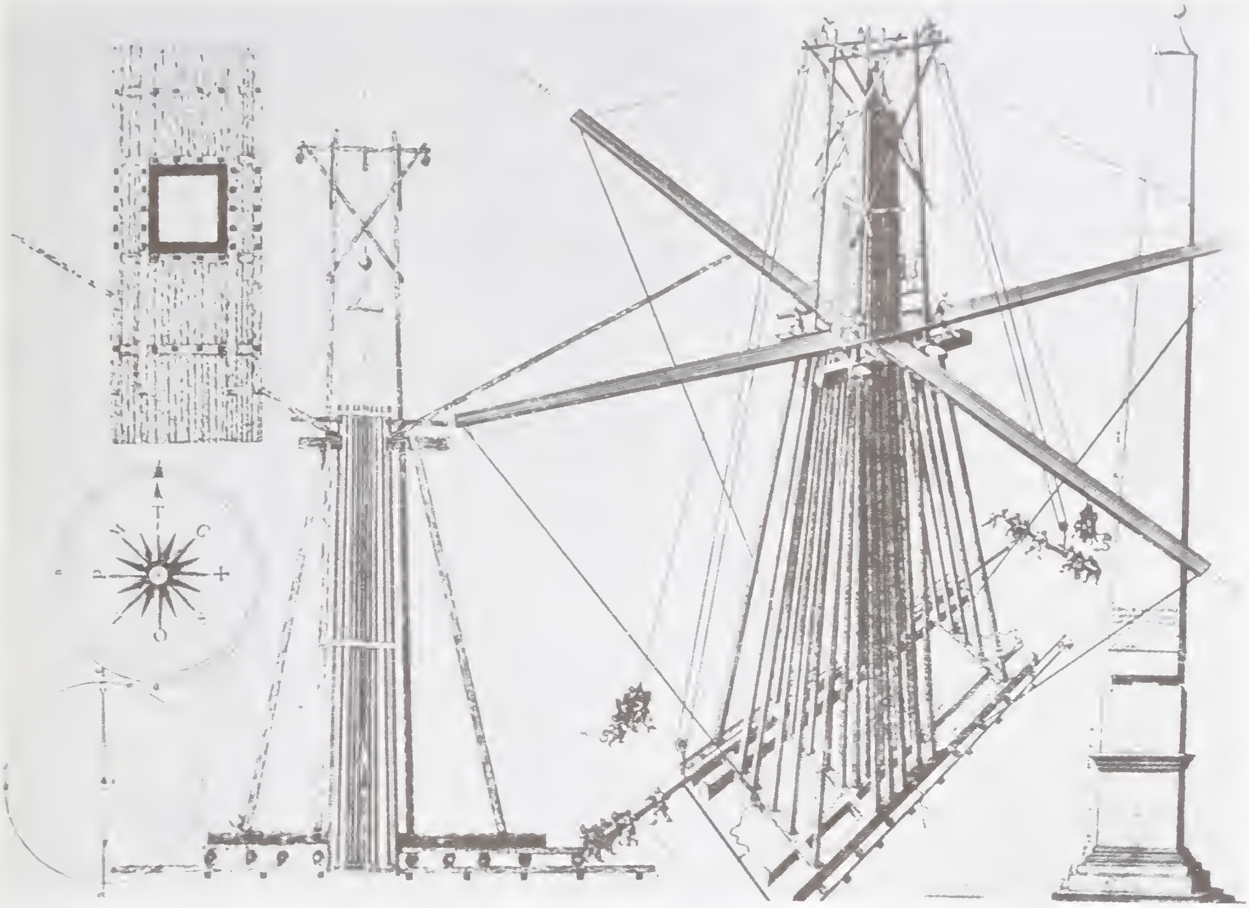
Antonio Sangallo

burned, the populace erected in the Forum a solid column of numidian stone, 20 feet high, dedicated to the Father of His Country.

The first serious attention paid to this last of the standing obelisks came in the Renaissance from Tommaso Parentucelli, Pope Nicholas V (1447-55), a humanist of considerable erudition, of whom his secretary—later Pope Pius II—reported that "what he does not know is outside the range of human knowledge." Part of Nicholas's grandiose scheme of rebuilding Rome into a stunning capital of Christendom was to have Caligula's Vatican obelisk moved from its dark hiding place to the center of Saint Peter's Square, there to be raised on four life-sized bronze statues of the Evangelists. By placing atop the obelisk a huge bronze Jesus with a golden cross in his hand, Nicholas declared, his wish was "to strengthen the weak faith of the people by the greatness of that which it sees." The night before the job was to be assigned to his favorite architect, a Bolognese engineer named Ridolfo Fioravante degli Alberti, better known by the nickname of "Aristotle," the old pope died, reputedly of a broken heart because Constantinople had fallen to the Turks.

Fifteen years later, when the Franciscan general Francesco della Rovere, who had spent his life as a mendicant friar, came to the papacy as Sixtus IV (1471-84), his secretary was to say of him "he was so exempt from avarice he could not endure the sight of money." Result: he depleted the papal treasury, waging war against the Florentines, the Venetians, and the Neapolitans, sending a battle fleet to its doom against the Turks, and spending a great deal of money beautifying Rome with such lavish constructions as the Sistine Chapel. Among his grander projects was a revival of the idea of moving Caligula's obelisk. But the project failed; this time because his architect, the same Aristotle whom Nicholas V had befriended, was caught minting his own coin and was locked up in Castel Sant'Angelo, from where he defected to Russia to build churches in the Kremlin.

A generation later, after Antonio da Sangallo had presented plans for a basilica of Saint Peter's in which Michelangelo was to become involved, Pope Paul III (Alessandro Farnese, 1534-49) became determined to have Caligula's obelisk raised in Saint Peter's Square. On several occasions he discussed the matter with Michelangelo, whom he knew had invented special equipment for raising heavy stones, but Michelangelo would not go along with the idea. When asked by friends why he, who was such an ingenious fellow, and had invented such good



Paul III, a great lover of luxury and a phenomenal nepotist, by means of which he alienated great fiefs of papal land to his bastard children. This pope introduced the Inquisition into Italy in 1542. He also approved the foundation of the Society of Jesus as an army to combat heresy. And it was he who established rigorous censorship and an index of forbidden books.

equipment, would not give the pope the pleasure of moving the obelisk, Michelangelo is reported to have replied: "What if it breaks?" More likely, Michelangelo disagreed with the motive behind the scheme—the raising of a mighty symbol to reinforce the suppression of heresy—and when commissioned by Paul III to paint the Last Judgment in the Sistine Chapel, made a point of painting a pope in hell.

It remained for a poor swineherd from the Adriatic coast near Ancona, another mendicant Franciscan friar, who came to the papal throne as Sixtus V (1585-90), to raise sufficient money to fell and reerect the obelisk. Born in poverty as Felice Peretti, the son of a chambermaid and a farmhand, this new pope turned out to be even more extravagant in his expenditures of public funds than had been Sixtus IV. But unlike his predecessor, Peretti managed rapidly to accumulate an enormous fortune through the imposition of heavy taxes and the sale of offices. Romans quipped that the only remaining commodity untaxed by Sixtus was the heat of the sun. In the short five years during which he was pope, Sixtus V got the reputation of having "built five bridges, watered five fountains, erected five obelisks, and left five millions in the treasury."

Sixtus V (1585–1590). Crafty and malignant, this new pope announced: "I come not to bring peace but the sword!" In all parts of the Papal States stakes were erected, on each of which stood the head of an "outlaw." With the sale of offices Sixtus refilled the papal coffers, raising the price for becoming treasurer from 15,000 to 50,000 scudi. He then placed a heavy burden on the poor by taxing such indispensable articles as firewood. With the vast wealth he accumulated in Castel Sant'Angelo, Sixtus created a battle fleet to fight the Ottomans and was the first to draft an army of his own people in the hope of seizing the Kingdom of Naples from Philip II of Spain. A compulsive "moralist," Sixtus ordered courtesans whipped naked for trafficking with married men, and was dissuaded by the governor of Rome from confining all the prostitutes in a ghetto only because there were too many. The ancient ruins of Rome Sixtus considered "festering sores" of an ugly pagan civilization riddled by superstition, to be obliterated; and the destruction of the Colosseum was only avoided by his sudden death, accredited by *vox populi* to a dose of poison administered by the Jesuits.

Domenico Fontana

Most of this was accomplished with the help of a Swiss-Italian architect from Lugano in the Ticino, Domenico Fontana, whom Peretti had hired when he was still Cardinal di Montalto, to construct for him several imposing edifices, including the mausoleum for Pope Nicholas IV. At that time, the incumbent pope, Gregory XIII, disapproving of such ostentatious shows of magnificence from a mere cardinal, had suspended Montalto's income. But Fontana, at his own expense, had kept right on architecting his patron's extravagant projects, a gesture which was to pay off handsomely two years later when Peretti became Pope. Not only was Fontana reimbursed from the papal treasury, he was given the job of completing the construction of the dome of Saint Peter's, which Michelangelo had left unfinished on his death twenty years earlier in 1564.

Three months later, he was given an even bigger task, one which would make his fame and fortune.

A tough reactionary, whom later historians were to dub "the Fascist Pope," Sixtus quickly cleaned up the papal states with a ferocious campaign against "outlaws and bandits," so as to be able to concentrate his efforts against all forms of heresy, of which Protestantism was the most rampant. More severed heads appeared on pikes outside the gates of Castel Sant'Angelo "than melons for sale in the market at Campo de' Fiori." Blasphemers had a hole burned in their tongues. Bandits had their guts ripped out and their quartered limbs hung on spikes. Death was meted out for adultery; and mothers who prostituted their daughters were condemned to the gibbet while the daughters were obliged to witness the execution. Pederasts were burned alive, as was a baker, for baking inferior bread. When several cardinals begged Sixtus to reprieve an innocent teen-ager, condemned for some peccadillo, the pope replied he would ennoble the boy's death by witnessing the execution.

While still a cardinal, Montalto had been inquisitor general for the extirpation of heresy in Venice, but he had been so high-handed in the conduct of his duties that he was forced to leave that island republic. So intransigent was he considered that on his election to the papacy one Roman wit seen leaving the city in a hurry explained he didn't believe Sixtus would even forgive Jesus His sins. With the excuse that he wished to "quench the detestable memories of idolatry" and "extirpate the idols exalted by pagans, such as pyramids, obelisks, and columns," Sixtus V decided to move Caligula's obelisk, and raise above it a Christian symbol to "enhance the spirit of the Counter-Reformation" and "exalt the mysteries of the Catholic religion."

On August 24, 1585, Sixtus V appointed a special commission to study the problem and to make a recommendation for the transport of the obelisk. Among those chosen were four cardinals, a bishop, a senator from Rome, and three conservators. But, as d'Onofrio notes, not a single technician was included. Having endowed the commission with sufficient funds and authority to ensure results, the pope specified that the learned gentlemen define the precise spot where the obelisk could be reerected, as a symbol of the conquest of Church over paganism and Protestantism. More important, they were to determine how such a fragile shaft of granite weighing 334 tons was to be dismantled, transported over a distance of almost 300 yards, and reerected without being broken.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Unanimously the commission invited anyone with a suggestion, no matter how farfetched, to step forward. Within less than a month, five hundred candidates presented themselves from all over Italy and from as far afield as Rhodes and Greece, including several engineers and a smattering of adventurous monks. Each came with his own suggestions and specially devised equipment. Most of the applicants brought plans, sketches, or models. The majority considered it essential that the obelisk be transported upright, believing it to be too difficult a task to lower and then raise it again. Others grandly proposed carrying both obelisk and base simultaneously in an upright position. Still others suggested carrying the obelisk at an angle of 45°. One architect, Francesco Masini, wanted to build a canal and float the obelisk to its new location.

Fontana, more conservative, brought a model in wood of a mechanism designed to handle the job, with ropes and pulleys all to scale, and a 2-foot obelisk made of lead. To the assembled congregation he demonstrated with words and motions how he could lower, transport, and reraise the full-scale obelisk without any problem. The commission appeared impressed by the plan, model, and presentation, as well as the fact that Fontana was the pope's protégé. Nevertheless, the commission hesitated to give such responsibility to a man of only forty-two. As a compromise, they appointed Fontana engineer-in-chief, placing over him, as supervisor, the seventy-four-year-old Florentine mannerist architect and sculptor, Bartolommeo Ammanati, who contributed nothing to the job, was ignored by Fontana, and is remembered mostly for having designed the Pitti Palace in Florence.

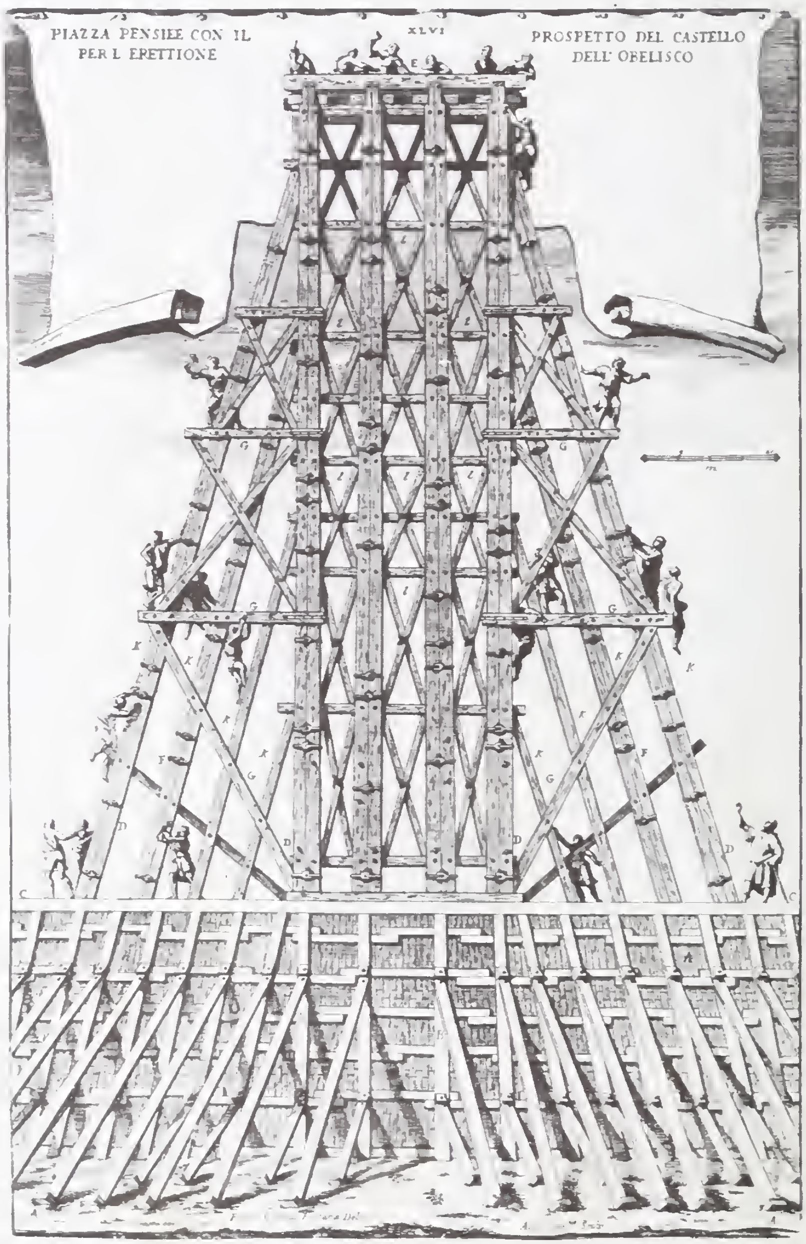
Sixtus V expressed his desires very precisely to Fontana: "Eradicate the memory of the superstitions of antiquity by raising the greatest footing ever for the Holy Cross."

On October 5, 1585, the pope, bypassing his own committee, ordered an edict of authority issued to Fontana for as long as it took to move the obelisk, granting him blanket license to impress men, draft animals, requisition timber, equipment, and subsistence of any sort, and even create a right of way in the city—which meant he could tear down any private house that got in his way. The decree also freed Fontana from the threat of litigation due to possible damage incurred in the operation. Everyone in the Holy See was given strict orders not to interfere in any way with the architect's actions or requirements. They were enjoined, on the contrary, to obey him, favor him, and help him.

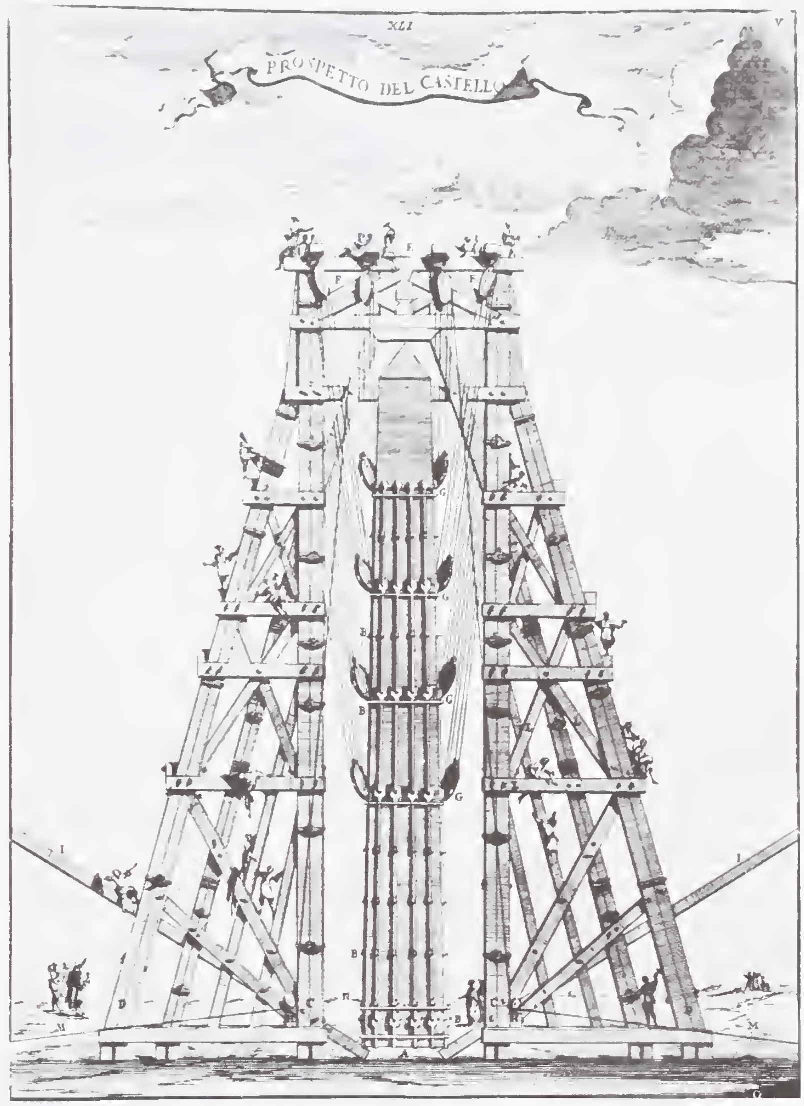
Various models were designed to move the Vatican obelisk. Fontana measured the height of the monolith as 83 feet on a base of 9 feet 2 inches, narrowing to a little less than 6 feet at the beginning of the 4-foot-high pyramidion. He estimated its weight to be 681,222 pounds. Forty capstans—truncated cones of timber around which the ropes were wound—would be needed to raise 90 percent of the obelisk's weight. Each rope had to be 3 inches in diameter, and 1,000 feet long. In determining the diameter and tensile strength of the rope, Fontana based his calculation on the premise that the steady pulling force of a horse would average 100 pounds. Two horses to a capstan with a nine-to-one ratio gave him a pull of 1,800 pounds per capstan. And when the ropes were passed through pulleys or blocks with a two-to-one ratio attached to four points of the obelisk's length, Fontana obtained an increase of motive power of 2×4×1,800, or 14,400 pounds per capstan. For the additional 10 percent lifting power, Fontana relied on the leverage of the long timbers by which the capstans would be turned.

Fontana's first problem was to create a solid base around the obelisk where the soil was soft and wet. For this he used pile drivers to pound oak beams 20 feet long and 9 inches in diameter deep into the ground, capping them with a layer of peeled, rot-resisting chestnut beams. On top of these he poured an aggregate of finely crushed basalt, flint, stone, and broken brick, mixed with a mortar of lime and clay, which set very hard. As a religious observance, appropriate to the occasion, votive bronze medals of the patron pope were laid in the concrete.

Fontana next had to create in real life the machine he had modeled for raising the obelisk. It meant building a *castello,* or huge scaffold of tall timber beams, high



Fontana tried to break one of the ropes with a pull of 50,000 pounds, but failed; so he concluded that this margin of safety would cover not only variations in the rope manufacture but also the peaks of tension imposed on any one capstan when other capstans might run slack. The blocks were made of wrought iron 5 feet long, with six metal sheaves, or grooved wheels, set in layers of three each. When the ropes were laid out on the ground, they passed over rollers to keep the thousands of feet from fouling.



enough above the obelisk to sustain the ropes and pulleys by means of which he planned to lift it, and strong enough to withstand a weight of almost 350 tons. Each sustaining member of this *castello* had to be built up of four columns of timber, 92 feet tall, each 11 feet square, bound together by iron hoops. To obtain the requisite 20-by-20-inch oak beams, 30 feet long, Fontana had to scour afield halfway to Naples. Each beam was then dragged to Rome from Campomorto, Santa Severa, or Terracina by teams of fourteen oxen. Iron bands and huge iron bolts with which to weld together the beams were obtained from ironsmiths in Ronciglione and Subiaco.

As soon as the *castello* was ready, Fontana had the obelisk protected by a double layer of reed matting over which was placed a layer of 2-inch planking, the whole held together by the great iron hoops. The long ropes were attached, leading to massive capstans, or wooden winches, like truncated cones, which could be revolved with levers to tighten the ropes. Realizing how vital the ropes were to success, Fontana personally occupied himself with their manufacture, going to the picturesque Umbrian town of Foligno near Assisi, where thousands of feet of rope were handwoven from endless strands of hemp.

All of these complex preparations took seven months of febrile work. By the end of April 1586, all was in order. Fontana set April 30 as the date for lowering the obelisk. A last preparatory task was the removal of the ancient metal ball still atop the obelisk, placed there fifteen centuries earlier by Romans in the belief it contained the ashes of Julius Caesar. When the ball was taken off, no ashes were found, and the myth was gently dispelled. Only no one bothered to ask what purpose the ball might have served.

On April 30, two hours before dawn, two masses were said in the small church of Santa Martinella, an annex of the Palazzo del Priorato, right off Saint Peter's Square. All around the great piazza, the access roads were blocked off with barricades and wooden palisades, making of it a closed *serraglio,* where a ban forbade anyone, on pain of death, from entering on the day the obelisk was to be moved, with the exception of those assigned to the job.

Crowding Saint Peter's Square

When all these hardy fellows had communed and made their prayers, they went into the *serraglio* just before break of day.

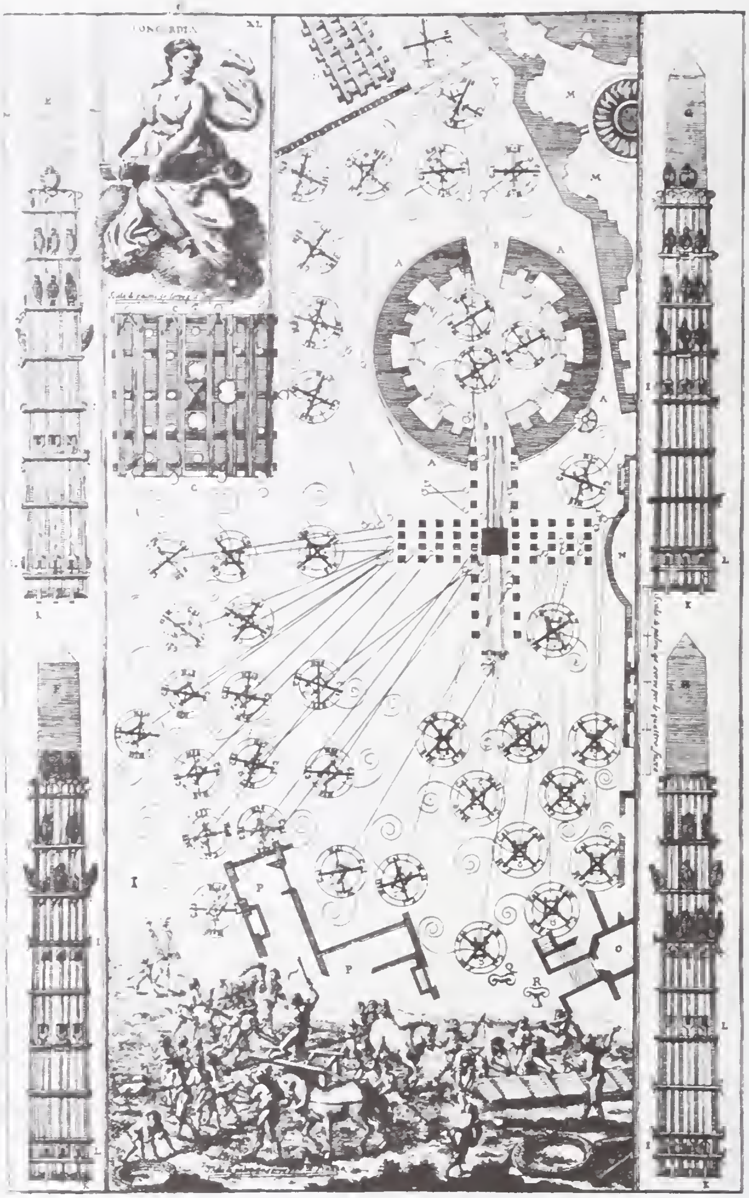
People were at the windows, on the balconies, and on the roofs of all the surrounding houses, even on the cornices of Saint Peter's Basilica, and on the drum of Michelangelo's still unfinished cupola. Among the spectators were the pope's sister, Camilla, the majority of the college of cardinals, and virtually all the religious and lay authorities of Rome, as well as many foreigners who had appeared from all over Italy and Europe to witness so extraordinary and marvelous a spectacle.

The city police, under the local sheriff, reinforced by Swiss Guards and a special detachment of cavalry, kept the swarming populace in order, administering summary punishment to anyone who misbehaved. No one was allowed to speak, spit, or make a noise of any sort during the course of the operations; and in anticipation of possible executions, a gibbet had been raised on the spot.

By each of the forty capstans, around which the great hawsers had been wound, stood two horses and twenty workers, all together seventy-six horses and eight hundred men, most of whom had their heads protected with metal helmets. The success of the enterprise depended on the uniform distribution of the great weight over the many ropes holding the obelisk, with no rope straining more than any other. To ensure that all the capstans turned synchronously, and to prevent some of the ropes from stretching harder than others, Fontana arranged for a trumpet to be blown every time he gave the order (from a high spot visible to all), and everyone was to make his wheel turn. The moment a bell was rung, this time from atop the *castello,* everyone was to stop. Two foremen were assigned to each capstan and twenty extra men were assigned to emergency calls; their task was to quickly bring rope, blocks, or replacement parts when failure threatened. Twenty more horses and drivers were placed in reserve, ready to move toward any point of need. Additional men with sledges and mauls clambered through the *castello* and around the obelisk, driving wedges to tighten the binding members and stiffen the system.

When all was ready, and Fontana had reminded those present that the work was being performed for the glory of God, everyone knelt and followed him in prayer. As soon as they had recited a *Pater Noster* and an *Ave Maria,* Fontana gave the signal for the trumpet to be blown. Nine

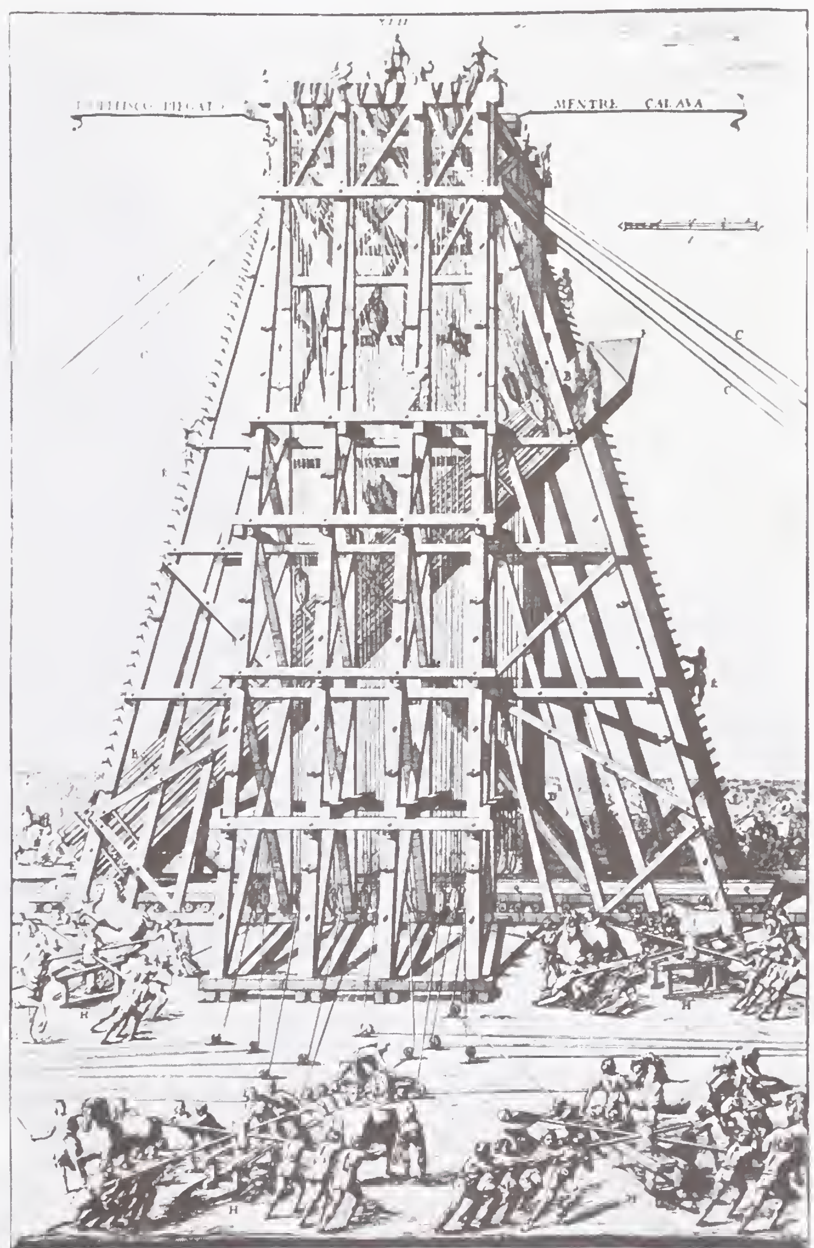
Aerial view of Saint Peter's Square



hundred and seven men and seventy-six horses pulled on the forty capstans. The ropes tightened to the breaking point. As Fontana described the scene, the earth appeared to tremble and the *castello* gave forth a terrible and agonizing screech. Those who had competed against Fontana in the competition now jeered at his plan, proclaiming that the ropes would fail because of unequal stress.

After the terrible creaking, when nothing seemed to have given way, and no man seemed to have suffered, Fontana gave the signal for the bell. Foremen ran to examine the equipment. It was noticed that one of the horizontal bands, closest to the top, had broken. All the other metal bands had also suffered, either having slid from their original positions or been twisted and nearly broken. Their radial component of tension had evidently been underestimated. But as all the rope bindings had held, Fontana decreed that the metal bands be replaced by ropes.

Repairs were made and power was once more exerted on the capstans to raise the obelisk. Up it went, millimeter by millimeter, till it had been lifted about a palm and the sun stood almost directly above it. Not wanting the work to be interrupted, Fontana had lunch brought to the workers on the spot in large baskets, the menu being bread, sausage, cheese, and smoked ham. All together two full barrels of wine were consumed. When work was

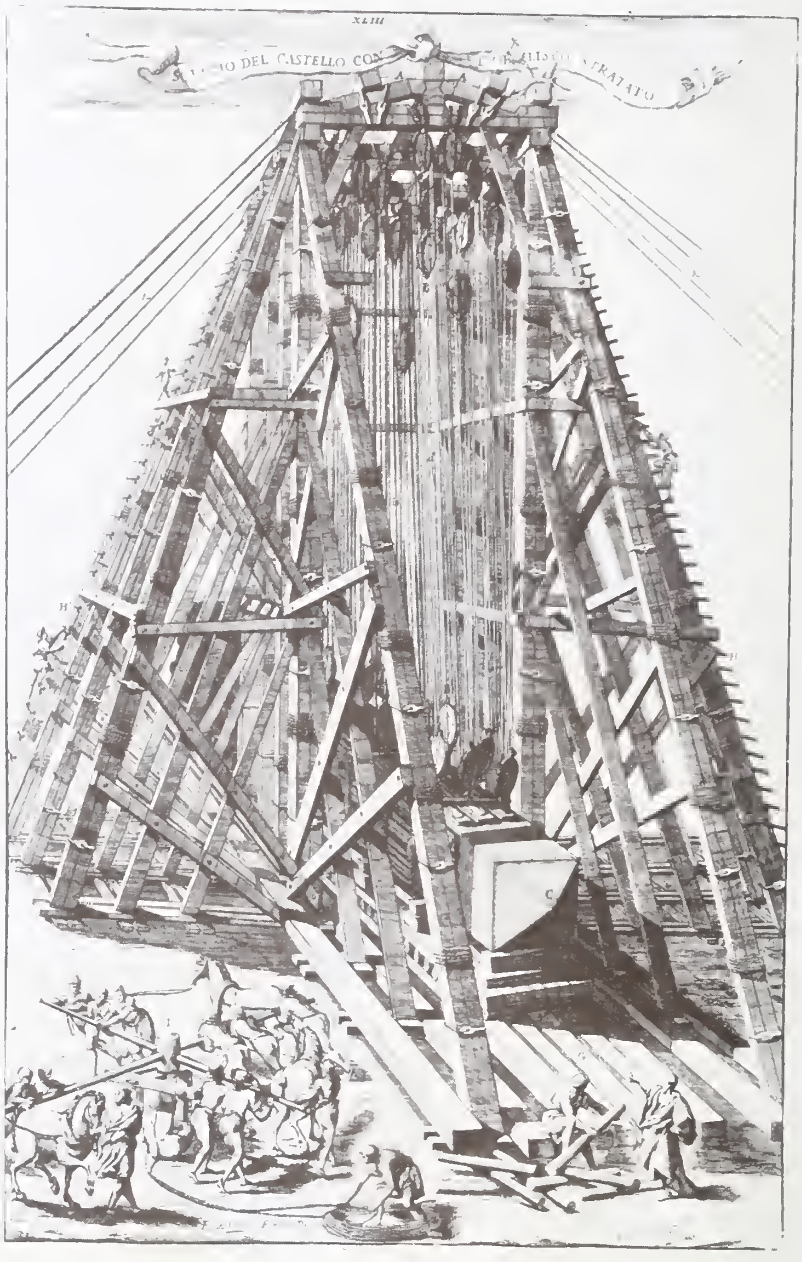


Lowering the obelisk

resumed, the obelisk was raised in further short increments until it reached a height of 2¾ palms, or 61 centimeters, above its base, the amount necessary to insert a dolly of beams on rollers. This was to facilitate lowering the obelisk from its vertical to a horizontal position.

By ten o'clock that evening, the obelisk rested upright on its dolly. The quitting signal was sounded. Success for this first part of the operation was celebrated by the firing of a signal gun, which was answered by a burst of artillery from the city's batteries, and by a great show of joy from the multitude.

The obelisk now had to be lowered from its vertical position and gently laid on a huge wooden cradle which

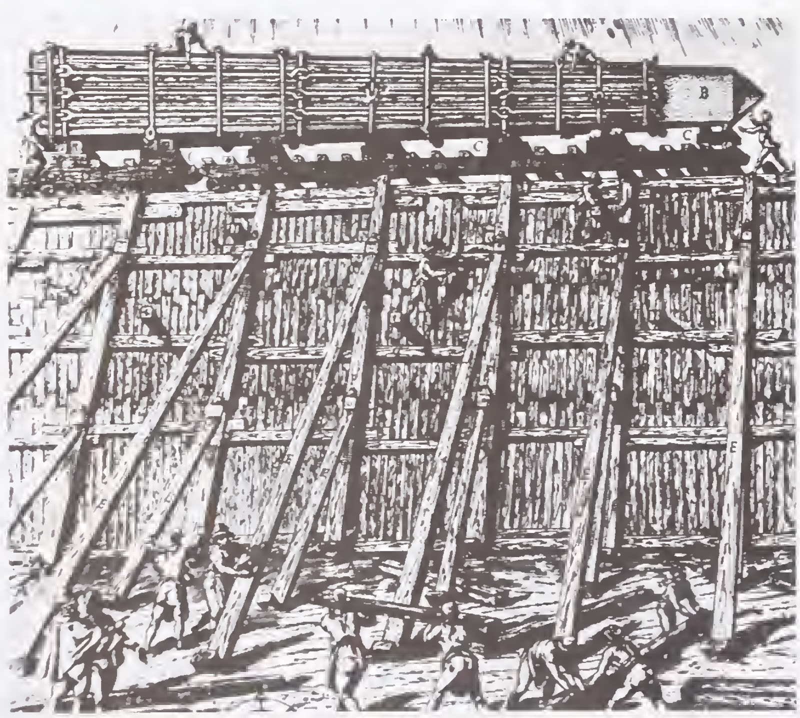


The obelisk safely on its cradle

was to move it on rollers to its new location. Room had to be made for its butt to swing out, so the shaft could be laid flat. This meant demolishing the walls of the sacristy of Saint Peter's Basilica, then rebuilding them. The great granite base also had to be unearthed and moved to its new position. And the four bronze crabs had to be removed to be replaced by recumbent bronze lions. Above all, the great *castello* had to be demolished and reassembled in its new location.

These operations took longer than expected. To dig out the pedestal, fifteen hundred years of accumulated earth and debris had to be removed from around the base. The solid bronze astragal crabs turned out to weigh 600 pounds apiece. Using hot lead the ancient Romans had so cunningly inserted them that masons could not pry them loose. Finally they had to chip them out. The main granite base was found to be a cube, 8½ feet on a side, weighing 55 tons. Beneath it, a rougher base weighed 63 tons. Farther down, as a footing, was a solid white marble slab. All of these, weighing a total of 140 tons, had to be raised and transported to the new site. When reassembled, they would reach a height of 27 feet.

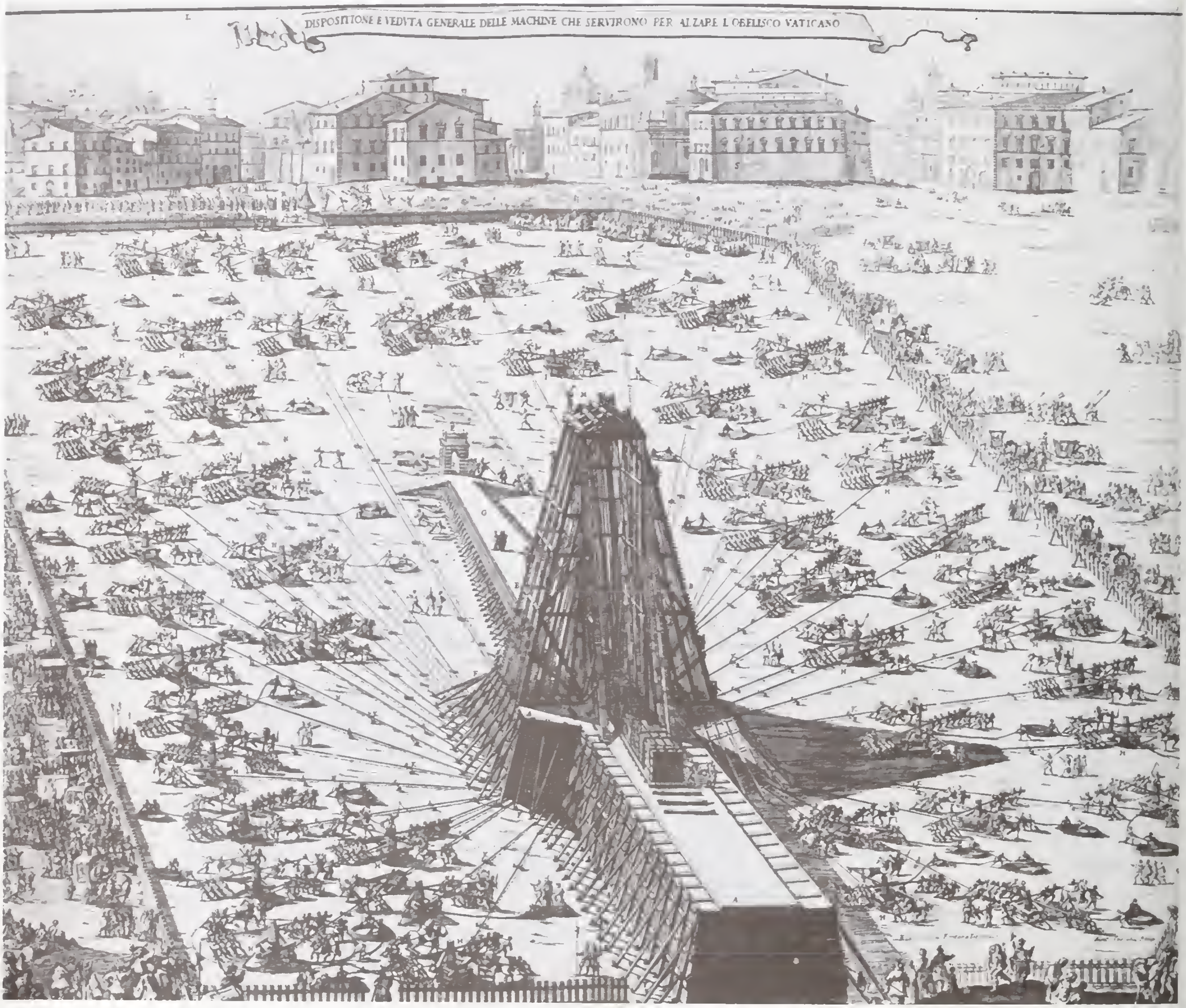
As the obelisk itself had to be dragged 115 canes (256.4 meters) to a spot 40 palms lower on the hill, and Fontana wished to avoid having to go almost 9 meters downhill with the obelisk and then having to raise it again that much, he had a great causeway built of earth dug from the Vatican Hill and held in place by a shored timber crib which maintained the level.



Fontana's causeway had to be 37 feet across at the top, widening at its terminus to provide room for repositioning the *castello* which was to swing the obelisk back to a vertical position.

By May 7 the obelisk was laid on its dolly, intact, without having caused harm to a single person. The pope was overjoyed, and the crowd accompanied Fontana to his home to the sound of drums and trumpets.

Preparations for resetting the obelisk dragged on through June and July. The *castello*'s timbers had to be moved one by one to the new site and carefully reerected on the broadened causeway. Despite the heat of summer, the work continued without pause. The pope declared he would not move to his summer residence until the obelisk was safely emplaced, which meant work had to continue all through August. But the heat became intolerable. Work



Fontana's rendition of the great square of Saint Peter's with his teams of 140 horses and 800 men ready to attempt to hoist the obelisk to its new position on the morning of September 10, 1586 was suspended so that the ropes would not catch fire. On August 30 the whole piazza was closed off with high palisades to prevent onlookers from seeing what was going on.

Sixtus hoped to be able to inaugurate the raised obelisk on September 14, the Feast of the Exaltation of the Cross. And to meet that deadline work was resumed. In order to superintend and to keep things on the go, the pope took his meals in rooms overlooking the piazza. On September 10, a Wednesday, everything appeared to be ready, despite a heat which still threatened the ropes. Again two masses were said before daybreak, this time in the Church of Santo Spirito, at the end of the piazza, toward the south. When the ceremony ended, each took up his allotted place. This time, because of the heavier strain in raising the obelisk, the number of horses had to be increased to 140. At dawn the forty capstans were ready and fully manned.

It was the crucial test. According to one source, the pope blessed Fontana and warned him to be most careful in what he was about to do that day, because he would have to pay for any error with his head. At the same time, says this source, Sixtus V, in his ambivalent love for Fontana, ordered that at all four gates of the borough horses be readied, so that if anything sinister should occur, Fontana would have a chance to escape the pope's ire. Other sources, less romantic, attribute to Fontana the preparation of the horses.

As the trumpet blew, 140 beasts and 800 men turned their capstans, tightening the ropes, and the obelisk slowly rose from its bed. By noon it had reached the critical halfway mark of 45°, at which point it was firmly trussed, and everyone broke for lunch. When work was resumed, the heat was tremendous and the tension on the ropes at its highest. The story goes that at one crucial point the strain became so great the ropes were again on the verge of catching fire. Despite the ban, on pain of death, of uttering a word, a boy is said to have shattered the silence of the great piazza with the cry of "Moisten the lines," which being done, the obelisk was saved from crashing down. The pope, so the story goes, instead of punishing the bold youth, rewarded him and his descendants in perpetuity, with the lucrative concession of bringing palms to the Palm Sunday festivities. The story, not substantiated by any contemporary sources or the research of Cesare d'Onofrio, is illustrated by a later fresco in the Vatican which depicts the boy being apprehended by papal guards.

Fresco in the Vatican showing the arrest of the boy for calling out, "Moisten the lines"

Most spectators, not to miss a single move, remained at their places throughout the day without even going home at mealtimes. Hawkers, selling food, made a fortune. By evening, as the French ambassador, the duke of Luxembourg, came to render his first obedience to the pope, he stopped to watch two separate heaves of the obelisk. At the end of fifty-two pulls and pauses, the obelisk was firmly vertical above its dolly.

The pope, on his way back from Pietro da Monte Cavallo to give a public consistory for the French ambassador, was advised that the obelisk was erect, and declared himself happy. It was September 14. Mortars were fired to inform Castel Sant'Angelo, from which many pieces of artillery resounded. Once more, the whole city rejoiced, running to Fontana's house with the usual noisy hosannahs.

Fireworks at Castel Sant'Angelo

On September 16 the dolly was removed, and the obelisk rested squarely on its base, held in place no longer by the astragal crabs of the ancient Romans but by four gilded lions of modern Rome. Created by the sculptor Prospero Bresciano, the lions were an architectural anomaly in that each lion had one head and two half-bodies, split down the middle like a hotdog bun so as to show a flank from any direction, of which d'Onofrio remarked, "I do not think there is any more monstrous invention around and about the streets of Rome." The allegorical significance of these lions, apart from the fact that they were the heraldic symbols on the Peretti coat of arms, was in demonstrating that just as the lions had been yoked by the weight of the obelisk, so the ferocity and arrogance of gentiles had been suppressed by true religion. Now all that was needed was to uncover the structure, embellish it with finishing touches, and bring the great square back to an even level.

By the twenty-seventh the obelisk stood in its pristine glory. The pope, admiring it from the windows of the Vatican Palace, ordered a procession to consecrate it with a golden cross and to purge it of its pagan past.

The first Friday after the erection, a bishop celebrated a most solemn Mass of the Holy Cross. When the procession reached the obelisk, the bishop blessed a great iron cross which was to be placed atop its pyramidion. With various exorcisms he proceeded to purge the obelisk, dousing it the while with holy water, and scratching crosses on its sides. The great iron cross was then hoisted by a rope, while a subdeacon climbed a ladder to hold the metal in place until it could be fastened to the top of the obelisk.

The obelisk standing before Saint Peter's Basilica, still bereft of Michelangelo's cupola, and of Bernini's colonnade

The event was celebrated by reading the poems of forty-five poets, including the Jesuit-educated Torquato Tasso, who, though he suffered from delusions of heresy, correctly noted that the Egyptians considered their obelisks symbols of the rays of the sun and named their pharaohs sons of the sun. Music followed the poets, and at the sound of trumpets the crowd all knelt. A public indulgence of fifteen years was conceded by His Holiness to all present, and to all who, passing the cross, should honor it. Artillery was fired from the battlements of Castel Sant'Angelo and the bishop cried out: "I exorcise you; creature of stone, in the name of omnipotent God, that you may become an exorcised stone worthy of supporting the Holy Cross, and be freed from any vestige of impurity or

The new alphabet of ornamental "Christian" letters designed by Sixtus's protégé, Luca Orfeo of Fanok, to adorn Christian monuments instead of the pagan inscriptions of ancient Rome

shred of paganism and from any assault of spiritual impurity."

But this was not enough for the pope. He considered the exorcism insufficient, and had the formula immortalized in large "Christian" letters (to differentiate them from pagan Roman letters) on the eastern and western sides of the base, just below the bodies of the four bronze lions.

Fontana's work had lasted exactly thirteen months, and had cost the Reverend Household 37,975 scudi, though Fontana in his bid for the competition had estimated only 16,000. To protect himself against this obvious eventuality, Fontana had all the while wisely maintained a regular public-relations office issuing bulletins and magnificent prints to illustrate the progress of the work, drawn mostly by Giovanni Guerra and etched by Natale Bonifacio, with ample captions by Fontana. They not only informed the world of the progress of the work, but were to form the basis for Fontana's own book on the subject, *Della trasportatione dell'obelisco vaticano,* printed in 1590, which left to posterity one of the most complete and handsome records, in format, type, and engraving, of what was considered by contemporary Europeans one of the greatest engineering feats ever performed. The pope was only too happy to pay Fontana in full.

On October 1, 1586, Sixtus V announced he had given his architect a chain of 80 gold scudi to support a gold medallion bearing the image of His Beatitude, along with a yearly pension of 2,000 scudi, of which 800 could be left to his heirs. Fontana was also made a citizen of Rome, a Knight of the Golden Spur, and a Palatine count with an escutcheon bearing a golden obelisk on an azure field. He received gratis all the lumber and equipment left over from the moving of the obelisk; and architectural commissions were thrust upon him. The pope, with a ghastly pun, had Fontana kneel as he dubbed him *"te nobelisco eternamente."*

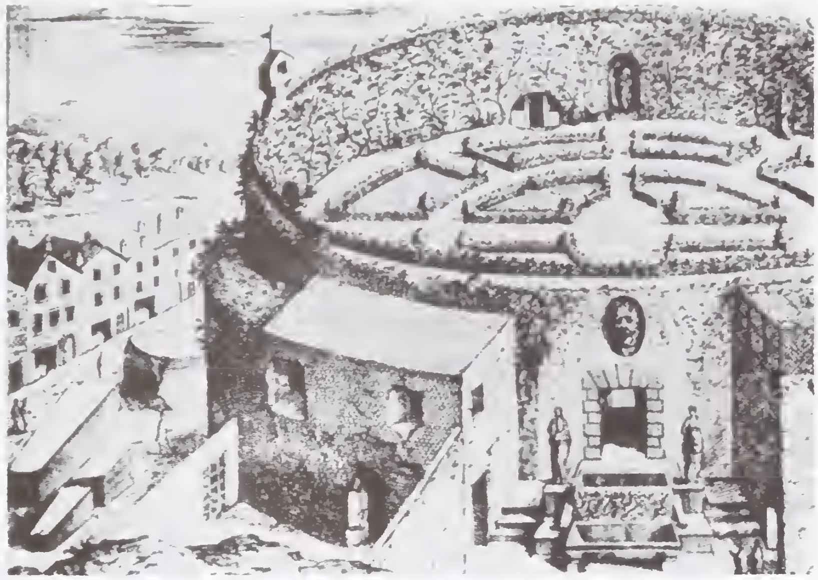
Scathingly, d'Onofrio remarks that Pope Sixtus V, hated by his people, managed to spend 80,000 scudi of their money in what amounted to a singular affirmation of his own personal power. By placing his name carved in beautiful letters on the base of the obelisk, says d'Onofrio, Sixtus V compared himself in greatness to the pharaohs who had first raised the obelisks and to the deified Roman emperors, such as Augustus, who had moved them to Rome. As d'Onofrio points out, not everyone in Rome was happy with the exploit, paid for by insufferable taxes wrung from the people. In a fierce lampoon of December 16, 1586, it was suggested that the

Fontana ennobled

architect transfer Saint Peter's *"guglia,"* or prick, to a more honorable and more decent place for such a tool: his own backside.

Unperturbed by such negative reactions, Sixtus V continued in the grip of his compulsion to erect great obelisks, starting a vogue which was to become the standard Freudian fantasy of a whole succession of Roman pontiffs up to the present. So ingrained is the Roman taste for anal and phallic jokes that as late as 1948, on the occasion of the Holy Year, or Anno Santo, when a great avenue of phoney obelisks was erected by Pius XII along the hideous via della Conciliazione (which

Augustus's mausoleum, built in the second decade B.C. on the confines of the Campus Martius, surrounded by sacred groves. Two obelisks, raised in the Alexandrine style, stood by the entrance until the fourth century A.D. One can be seen lying broken in the side street; the other is presumably buried.



runs straight from the Tiber to Saint Peter's Square, entirely destroying the former stunning shock of coming suddenly on Bernini's great colonnade), Romans were quick to dub the row of obelisks *supposte dell'Ano Santo,* suppositories for the Holy Anus.

As early as September 1586, while the scaffolding was being demolished in Saint Peter's Square, Sixtus summoned Fontana and ordered him to raise another obelisk. The only one left unburied in Rome lay in three fragments near Augustus's mausoleum, where it had been dug up during the reign of Leo X (1513–21). Fontana studied the possibility of putting the pieces of this relic together, but finally concurred with Leo's great military architects, Baldassare Peruzzi and Antonio da Sangallo, who had both declared it unsalvageable.

Instead, Fontana pursued the century-old rumor that a barber in the Campus Martius area, digging for a latrine in his tiny kitchen garden, had knocked against the base of an ancient obelisk, buried hard by the Church of San Lorenzo in Lucina. Almost a century earlier the antiquarians of Pope Julius II had viewed this relic and recognized it as a piece of one of the obelisks brought from Egypt by Augustus, and had urged the pope to re-erect it where it once stood in the Campus Martius. Julius II, occupied with his many wars, could not be persuaded, so the barber had reburied the obelisk. Now Fontana took picks and shovels to the site and began to dig, finding an obelisk that was broken into five pieces. In order for Sixtus V conveniently to observe these half-buried fragments, a wall was specially knocked down, but when the pope saw that the obelisk was in even worse condition than the one by Augustus's mausoleum and that several houses would

Luxurious summer villa of Sixtus V, known as Casa Peretti, on the Esquiline Hill, surrounded by its vast acreage of gardens

have to be destroyed in order to remove it, he decided to have the fragments reburied where they lay.

Yet Sixtus remained determined to have an obelisk to embellish the entrance to his private villa, recently completed by Fontana, on the Esquiline Hill near the Basilica of Santa Maria Maggiore. There, surrounded by vast gardens, his sister, Camilla, who had given up her job as washerwoman to take care of him, held sway over Sixtus's nieces and nephews, judiciously marrying them one by one into the nobility of Rome, where they produced for the Peretti family a succession of Roman princes both secular and churchly.

Sixtus's only alternative for an obelisk was to revive the possibility of putting together the three pieces of Augustus's other relic, which still lay near his mausoleum by the Church of San Rocco along the via Ripetta, a hazard to passersby and to traffic on its way to Piazza del Popolo. This time Fontana agreed; but perhaps because he doubted the outcome of the venture, he gave the delicate job of moving the fragments to his brother Marsilio, aided by his nephew, Carlo Moderno. To everyone's amazement the three pieces reached the piazza in front of Santa Maria Maggiore without mishap. There Fontana raised one above the other to hold firm on the spot where they still stand, a grand entrance to the gates of the papal villa, which, in the meantime, has given way to Mussolini's atrocious Terminus railway station.

Encouraged by this second success, and still prone to more erections, Sixtus summoned his historian, Monsignor Michele Mercati, to collect for him from the Vatican Library all the data he could find from classical authors on the subject of obelisks. Such a study might indicate where

The third obelisk of Sixtus V, raised at the back of the Basilica of Santa Maria Maggiore so as to face the entrance to his summer villa. To make way for the pedestal, Sixtus had several houses and old Roman ruins demolished. The inscription tries to link Augustus with the birth of Christ. The papal emblem and the cross atop the obelisk disguise the fact that its pyramidion had been destroyed sometime before it was buried. The etching is by Piranesi.

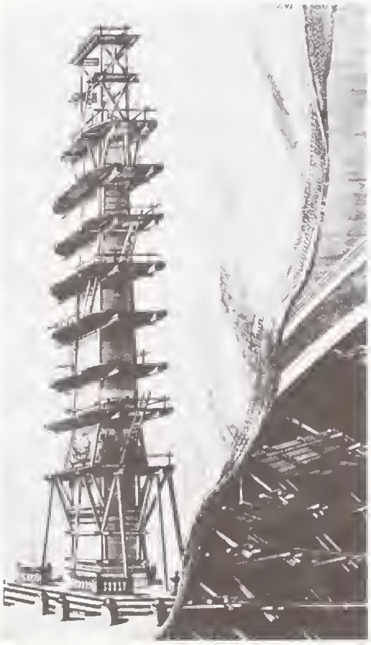
more obelisks lay buried in Rome. Mercati, who was later to put the fruit of this research to his own use in the first authoritative book on the subject of obelisks (*De gli obelischi di Roma,* 1589), came running to the pope, texts in hand, to inform him that there had once been two great obelisks in the Circus Maximus, the one raised by Augustus and another by Constantius. As no one, Mercati argued, could have lifted them, they must still be there, either whole or in pieces, somewhere under the vast expanse of vineyards and vegetable gardens of the friars of Santa Maria in Cosmedin, which now covered what had once been the great circus. This meant several acres would have to be probed. But no one knew exactly where to look, or how deep, and dowsing for needles was as yet an underdeveloped art. So the pope offered a prize to whoever could first locate a missing obelisk.

Spurred by the offer, an enterprising fellow named Matteo Bartalani da Castello fashioned for himself a 6-meter rod, with a sharp point for easier penetration and a ring handle for easier withdrawal, to probe the area. A few months later, in February 1587, while poking in a cabbage patch, Bartalani came across something hard at a depth of 5 meters. Digging a larger hole, he saw that he had struck the side of an obelisk, which turned out, after more digging, to be part of the great 106-foot-high obelisk brought to Rome by Constantius, the largest ever moved

across the sea, and which now lay broken in three large pieces.

Four days later, some thirty paces away, in the direction of the old Baths of Caracalla, Bartalani struck a second obelisk, smaller than the first. From the account of Diodorus Siculus, it was clear to Monsignor Mercati that the obelisk must be the one Augustus had brought from Heliopolis to raise in his circus.

Hole dug by Carlo Moderno in the Circus Maximus, overshadowed by the ancient Baths of Caracalla



For his efforts, Bartalani received from the pope the relatively enormous prize of 600 scudi, "a munificence," says Cesare d'Onofrio, "quite incomprehensible in Sixtus V, were it not for the fact that these labors had been performed by Bartalani under the aegis of his favorite, Fontana, who had obtained from the pope the new concession for his nephew Carlo Moderno of digging up the obelisks."

To bring to the surface the two monoliths from where they lay buried in the mud, more than 20 feet below the surface of the kitchen garden, was an enormous task, mostly because of the great amount of water that continually seeped through the ground from springs on the nearby Palatine Hill. Five hundred men were needed to work at the job, three hundred of whom were kept busy day and night drawing off water by various means. By May, both obelisks had been cleared of earth and laboriously raised to the surface under the guidance of Fontana's nephew.

Yet the hardest part was still to come. The three pieces of Constantius's obelisk had to be dragged to the spot where Sixtus V intended to raise them as a single obelisk in the square outside Saint John Lateran, a distance of over 3 kilometers, through narrow streets and up the

Constantius's Circus Maximus obelisks—reraised by Sixtus V in the Lateran Square before the new winter palace built for him by Fontana—had originally been raised in Karnak by Thothmes IV, in 1492 B.C. Spared by Cambyses, in 521 B.C. (when he tripped on his gown and pierced himself with his dagger), the needle, though reduced 3 feet by Fontana to 105 feet, is still the tallest monolithic obelisk standing in the world. Further to destroy pagan Rome, Sixtus ordered the perfectly preserved Arch of Janus demolished to build a base for the obelisk. Fortunately contemporary Roman conservationists raised such a protest, the arch still stands. The obelisk lying in the foreground belonged to Sallustius, and was eventually raised in the Pincio.

The Madonna del Popolo church, at the main entrance to Rome, was deliberately built to lay to rest the ghost of Nero, who was believed to haunt the area. After a cross was placed atop the exorcised obelisk, the spot was used as the starting point for horseracing up the Corso, and as an ideal setting for public executions.
The obelisk, originally quarried by Seti I, second pharaoh of the Ninth Dynasty, was raised by his son Ramses II in Heliopolis about 1300 B.C. Removed to Rome by Augustus it was set up along the spine of the Circus Maximus in 10 B.C. and overturned and buried in the Middle Ages. The original dedicatory inscription of Augustus was replaced on a new pedestal, along with the pious words of Sixtus V.

steep climb to the top of Monte Celio, which required the construction of a massive sloping roadway.

Working fast, Fontana was able to place the first piece on its base a year later, on July 5, 1588. By the twentieth, with the aid of the reconstructed and lengthened *castello* brought piece by piece from Saint Peter's Square, the second fragment had been securely placed above the first. By August 10, another great cross was raised above the pyramidion of the tallest obelisk in Rome. A fresh inscription specially carved into the base told obelisk-weary Romans of the apocryphal tradition that in that same piazza, a few feet from the raised obelisk, Constantine had been baptized the first Christian emperor of Rome.

Further to exalt the cross and demonstrate how "true religion had subjugated idolatry," Sixtus had Fontana drag the second obelisk, the one brought from Alexandria by Augustus, to the Piazza del Popolo, there to be raised, in

The message Sixtus V wished to convey *urbi et orbi* with the reerection of his obelisks was the ultimate triumph of the church militant against the demons of paganism. Each of his three obelisks in its new Christian surroundings became, in the words of Erik Iversen, "a monumental emblem on a gigantic scale, a sacred allegory and a subtle hieroglyphic enigma of the fashion of the period, to be expounded by the initiated and deciphered by the erudite."

The reraising of Sixtus's obelisks was considered an epoch-making technical achievement. It marked, says Iversen, the end of the Renaissance and the birth of the new orthodoxy of the baroque and the Counterreformation. Everywhere obelisks began to appear on cornices, pinnacles, roofs, buttresses, or as detached monuments in parks and squares. Yet these Catholic symbols were to be taken over almost *in toto* as the Freemasons' symbols of liberty.

the words of Mercati, "as the spoils of war won from paganism by triumphant religion." As the base of this obelisk was in very bad shape, almost 3 palms (76 centimeters) had to sliced away, leaving the obelisk only 23.9 meters long. Thus truncated to a mere 78 feet, Augustus's 235-ton obelisk was raised by Fontana and consecrated on March 25, 1589, with a gilded bronze cross above a star and some mountains to symbolize the reigning pontiff.

The advantage of placing Augustus's obelisk in the Piazza del Popolo was that it could be seen from the end of four of Rome's main streets: the Corso, the Babuino, and the Ripetta, as well as entering Rome from the Flaminias. The disadvantage to Romans in achieving these grand vistas was the destruction of whole neighborhoods of popular hostelries and wineshops. Also destroyed, to provide a new base for the obelisk, was one of the most beautiful of ancient Roman travertine buildings, the Septizodium of Septimus Severus.

Sixtus V—who considered it his duty to destroy as much of pagan Rome as possible—had his name and the date chiseled on one side of the base in bold "Christian" letters. On another side, Cardinal Antoniani, the papal secretary of state, placed a fatuously punning inscription which read as if it were the obelisk speaking: "More august and happier I rise before the sacred temple of her from whose virginal bosom [Santa Maria del Popolo] the sun of justice [Jesus] was born during the empire of Augustus."


ΘΕΟϹ

3. SYMBOLS OF HERESY

What might have given Sixtus a clue to the original purpose of his newly raised obelisk were the inscriptions on its four sides beautifully carved in hieroglyphs. But these were a mystery to one and all. What little was known about the enigmatic writing of the ancient Egyptians had been painstakingly gleaned from Greek and Roman authors, none of whom, as the Danish historian Erik Iversen puts it, "knew what they were writing about."

Diodorus, who traveled extensively in Egypt in the first century B.C., explained the hieroglyphs as "metaphysical and symbolic." He said that when the Egyptians drew a hawk they meant by it to signify anything that moved swiftly—a concept which they transferred to all swift things. For evil, said Diodorus, the Egyptians used as their symbol a crocodile.

How far the Sicilian was off the mark may be judged by recent discoveries that the crocodile was used by the Egyptians as a symbol for the benevolent dragon in the polar constellation of Draco (the plumed serpent of the Mexicans, and the celestial dragon of the Chinese), and it was also used to express the natatory power of the sun god Horus, who, as a crocodile, could traverse the waters of the deep from equinox to equinox, from Virgo in the fall to Pisces in the spring. Even more esoterically, the crocodile was the symbol of the initiate to the "mysteries" because it could see in the water even with its eyelids closed.

More sensible among the classical authors was Plutarch, the Greek biographer of the first century A.D., who said he was an initiate into the secret mysteries, and considered the hieroglyphs to be rebuslike pictorial expressions of divine ideas and sacred knowledge. The only treatises on hieroglyphs known to have existed were attributed to one of Plutarch's contemporaries, the Alexandrine scholar Chairemon, who was also a tutor to Nero. These had been lost, but fragments quoted from them describe nine hieroglyphs, one of which, a weeping figure, was largely understood to convey the concept of misfortune. Clearly, the classical visitors to Egypt had understood no more of the glyphs than modern tourists, although most of the Greeks and Romans, as Iversen, the most lucid modern scholar on the subject, cuttingly notes,

Hermes, known as Trismegistus, or thrice great (as philosopher, priest, and king), is the reputed author of innumerable books, and revealer to mankind of the science of medicine, chemistry, law, art, astrology, music, rhetoric, philosophy, geography, mathematics, anatomy, oratory, and—magic. He is also considered the author of Masonic initiatory rituals, for "nearly all the Masonic symbols are Hermetic in character." Forty-two of the most important of the scientific books attributed to Hermes are believed to have been destroyed in the burning of Alexandria; says Manly P. Hall, "the Romans—and later the Christians—realized that until these books were eliminated they could never bring the Egyptians into subjugation." Hermes' *The Pymander* contains an exposition of Hermetic cosmogony, and the secret sciences of the Egyptians regarding the unfoldment of the human soul, the key to which is the phrase "He who realizes that the body is the tomb of his soul, rises to immortality."

As the Egyptians likened humanity to a flock of sheep of whom the Supreme Being was the Shepherd, Hermes was depicted as the shepherd's dog. According to Manly P. Hall, the name Hermes is derived from "Herm," a form of Chiram, the personified universal life principle, generally represented by fire. The Greeks equated Hermes with the Egyptian god Thoth.
Hermes, regarded as the embodiment of the human mind, explained how mortal man came to his plight. The Father, the Supreme Mind, says Hermes, being Light and Life, fashioned a glorious universal Man in its own image, not an earthly man but a heavenly Man dwelling in the Light of God. But the Man beheld a shadow upon the earth and a likeness mirrored in the waters, which shadow and likeness were a reflection of Himself. The Man fell in love with His own shadow and desired to descend into it. Nature, beholding the descent, wrapped herself around the man she loved, and the two were mingled. For this reason earthly man is composite. Within him is the Sky Man, immortal and beautiful, without is Nature, mortal and destructible. Thus, suffering is the result of the Immortal Man's falling in love with His shadow and giving up Reality to dwell in the darkness of illusion. . . ."

"tried to cover their ignorance with the pompous cloak of a learned 'philosophical terminology.'"

By the time the Egyptians had become Christianized *en masse* in the second-century reign of the emperor Justinian, the hieroglyphs had been reduced to sinful pagan symbols, no longer to be read, discussed, or understood. Wherever possible they were to be disfigured or destroyed. With the burning of the great library of Alexandria a further quietus was laid on the subject which was to last a thousand years. Having burned the libraries and defaced the inscriptions, says Manly P. Hall, "Christians invented a ridiculous conglomeration of puerility which for several hundred years was palmed off upon a comparatively illiterate world under the name of Egyptology." And so it wasn't until the fifteenth century that any new light could be shed on the significance of the mysterious glyphs.

What the bright young minds of the Renaissance were to learn about their meaning was based largely on three manuscripts, fortuitously recovered, from late classical authors. One of these was found in 1414 in a monastery in Germany by the Florentine Poggio Bracciolini, later chancellor of the Florentine Republic. It consisted of the last eighteen books of the history of Rome written in the fourth century A.D. by Rome's last major historian, Ammianus Marcellinus. In Florence, the manuscript was given to Niccolò de Nicolli, then the greatest authority on classical bibliography, who had it copied and circulated in humanistic circles. Book seventeen contained a history of the obelisk of Constantius, and included a short general digression on obelisks and on Egyptian writing; there Ammianus said the Egyptians did not write with letters "as we do," but with signs expressing whole words or concepts. As an example he used the honeybee to represent a king, "for kings must exercise their rule with sweetness and also possess a sting."

Ammianus gave an extensive translation into Greek of the inscription on Augustus's Circus Maximus obelisk, which he said was quoted from the work of Hermapion, about whose person or work little or nothing was, or is, known, other than that he is presumed to have been a Hellenistic scholar living in Rome about the time of Augustus.

From Ammianus's manuscript the Florentines learned that the obelisk Augustus had raised in the Circus Maximus had once stood in Heliopolis, where it had been erected by the pharaoh Seti I, presumably about 1300 B.C.; also, that Seti had died before the inscription could be completed, a job carried on by his son Ramses II. As

Glyphs on Augustus's obelisk. In the Renaissance, says William R. Heckscher, obelisks were considered "the most powerful witnesses of a primordial religiosity and spirituality" and were accordingly interpreted as links between earth and heaven, "for if one looked at them from base to apex they would seem to suggest by their evanescence the transition from things terrestrial to incorporeal Divinity itself." To this Heckscher adds that, more importantly, if seen conversely, the obelisks, by their pyramidal shape, might be compared to the pencil of rays issuing from the center of the sun. Thus the "Egyptologists" of the Renaissance deduced from the classical authors of Greece and Rome that "through their obelisks the Egyptians imitated the rays of the sun whom they themselves worshipped."

to which of the enigmatic symbols represented what words or letters in Latin, Greek, or in any other language, the mystery remained, only slightly illuminated by a second document which surfaced five years later, in 1419.

This was a manuscript found on the Greek island of Andros by another Florentine traveler, Cristoforo Buondelmonte, who brought it back to Florence in 1422. Entitled *Hieroglyphica,* it purported to be a sixth-century A.D. translation into Greek of an original treatise on hieroglyphs written by one Horapollo of Nilopolis—an obvious pseudonym concocted from the gods Horus and Apollo—believed to have been an Egyptian scribe who had lived a couple of centuries earlier than the translator. Though the Greek was considered inferior, and the meaning of the glyphs had evidently already been lost by the time the original work was composed, it still constituted the only major treatise on hieroglyphs to have survived from classical times. As such, if only because of its uniqueness, it was, as Iversen points out, one of the first manuscripts to be set in print, in 1505, along with Aesop's fables, becoming for a while the canonical authority on all hieroglyphical questions.

The work is divided into two books, similar but possibly from different sources. Each of a total of 189 paragraphs deals with a separate hieroglyph, and its purported meaning.

To denote impudence, said Horapollo, the Egyptians represented a housefly, because "though perpetually driven away, it nevertheless returns." The ant, according to the *Hieroglyphica,* was the Egyptian glyph for knowledge, "For whatever a man may carefully conceal, this creature obtains a knowledge of." More discerning is his Egyptian glyph for discernment: a mouse. "When many different sorts of bread lie before him, the mouse selects the purest from among them, and eats it. Hence the baker's selection is guided by mice."

The number 16 was used by the Egyptians, according to Horapollo, to indicate voluptuousness, the explanation being that sixteen is the age "when men begin to hold commerce with women and to procreate children." Sexual intercourse was depicted by two 16s; and in Cory's English translation of the Greek, the explanation is discreetly left in Latin: *"Cum enim sedecim voluptatem esse disimus: congressus autem, duplici constet, maris ac foeminae, voluptate, proptera alia sedici adscribunt";* which simply means that as intercourse requires voluptuousness from both male and female, another 16 must be added. Some of the Horapollion aphorisms were drawn

Thoth, self-produced divine intelligence, at the creation, uttered the words which formed the material world, is depicted as a man with the head of an ibis. He was known as the "Scribe of the company of Gods," and was the author of the secret *Book of Thoth,* since lost, which was said to contain the arcana of the mysteries. Filled with hieroglyphics, the book was purported to give those acquainted with its use unlimited power over the spirits of the air and over subterranean divinities. From the older Egyptians, the Ptolomaic priests learned that Thoth bore the head of an ibis because the bird sleeping with its head beneath its wing assumes the shape of a heart—seat of life and true intelligence. The footstep or pace of the ibis was said to measure exactly 1 cubit a unit considered sacred and which, according to initiates, was given by Thoth, and appears mathematically in all the measures of the universe. The ibis's intestines were said to be exactly 96 cubits, or 144 feet, long.

from folklore. The beaver was to symbolize a man with self-inflicted injuries. "For the beaver," says Horapollo "tears out his own testicles, and casts them as spoil to his pursuer." Other bits of wisdom verge on magic, similiar to that of the Hawaiian Huna, who, according to Harvard's modern epigrapher, Barry Fell, may be descendants of the same Egyptians. To symbolize a woman who miscarries, notes Horapollo, the Egyptians depicted a mare kicking a wolf: "Not only by kicking a wolf does a mare miscarry, but it immediately miscarries if it should merely tread on the footstep of a wolf." Despite such farfetched homilies, there remain in the paragraphs of Horapollo strains of the perennial wisdom of the ancients, as is evident when he uses the grasshopper as a symbol for mystic man, a notion which survived through the Platonic philosopher Apuleius to Collodi in Pinocchio's talking cricket, who, in Horapollo's words, "does not utter sounds through his mouth, but chirping by means of his spine sings a sweet melody." And although only a dozen of the seven-score glyphs or symbols described by Horapollo turned out to be even closely related to their meaning in Egyptian, as deciphered by modern Egyptologists, publication of the book launched a vast quest into their secret meaning.

The best clue was to come from the most extraordinary of the three documents that surfaced in the fifteenth century, one which was to have a powerful revolutionary effect on political minds to this day, a Greek manuscript in seventeen books brought from Macedonia to Cosimo de' Medici. It was said to contain the secret wisdom of Thoth, the Egyptian sage whom the Greeks called Hermes Trismegistus, or the Thrice Great Hermes. Translated into Latin by Marsilio Ficino in 1471, it came to be known as the *Corpus Hermeticum,* a source for all the various and powerfully effective Hermetic philosophies that followed. According to Ficino, a quiet, scholarly philosopher with strong leanings toward paganism, Thoth, or Hermes, considered a contemporary or predecessor of Moses, had attained to gnosis, or the knowledge of God, by a sort of union with the godhead. Hermes was thus considered the first great teacher of the gnosis. After his death, he became a god, "as anyone who attains to gnosis becomes a god after death."

Man, according to Hermes, had taken on a mortal body merely to commune with nature, but at heart remained a spirit, a divine, creative, and immortal essence. Living beings did not die, but, being composite, dissolved the bond in order to reunite and re-form. Nothing dies; it only

Marsilio Ficino (1433–1499), Florentine philosopher patronized by Cosimo de' Medici, was the guiding spirit of Florence's Platonic Academy, which he wished to make into a spiritual community. He revived the Neoplatonic doctrine of a world-soul and identified demons with the Christian hierarchy of angels, "supercelestial" and "elemental," with souls and etheric bodies according to their status, of a like nature to human spirits. Ficino believed that the Egyptians with their magic could bring down spiritual entities into their statues of gods and maintain communication with them.

Giovanni Pico della Mirandola (1463–1494)

dissolves and transforms. The gnosis consisted in re-becoming a god.

To keep this explosive knowledge secret from those who might profane it, yet have it available to the initiate, it was, said Ficino, originally recorded in the Hermetic language of glyphs. As an explanation, he adduced that "the Egyptian priests, when they wished to signify divine things, did not use letters, but whole figures. . . ." This he followed with the Goethian notion that "God doubtless has a knowledge of things which is not complex discursive thought about its subject, but is, the simple steadfast form of it."

To Ficino the hieroglyphs were Platonic ideas about the universe and its spiritual realms, made visible, and through his translations into Latin of the works of Plato and of the Neoplatonist Plotinus, Ficino brought to the Renaissance an entirely new concept of Egypt as the source of the cosmic wisdom of both Plato and Pythagoras.

From Plotinus, the Florentines learned that the hieroglyphs were not images of the things they represented but Hermetic symbols devised by Hermes and endowed with qualities by means of which the symbols could recall to the initiate an insight into the very essence and substance of reality. Functioning not through rationalization, but by divine inspiration or illumination, they were to reveal the world of the soul, leading to an ultimate understanding of the true nature of the cosmos; this to be made possible by an immediate contact between the human intellect and divine ideas. Compared with the pedestrian tenets of Aristotle and Aquinas, these were flighty concepts. But because Plotinus was born in Egypt, and because Clement of Alexandria was also from Egypt, the men of the Renaissance were willing to go along with this interpretation of the hieroglyphs.

Convinced by such sensitive minds as that of Ficino's brilliant pupil, Giovanni Pico della Mirandola, who had mastered Hebrew, Chaldee, and Arabic as well as Latin and Greek, that profound religious doctrine was best expressed in enigmas, Renaissance scholars realized that the mysterious hieroglyphs which appeared on the obelisks could be explained as symbols by means of which it might be possible to express the innermost secrets of life, and open a window onto the world of magic. Magic, as practiced by the Renaissance magus, or master of esoteric wisdom, was designed to enable the "magus-man" to regain powers which were virtually godlike, there being, they believed, no latent force in heaven or on earth which could not be released by an initiate through proper inducements: a conceit, in the eyes of the Church, which bordered on heresy.

By blending the wisdom of the Jewish Cabala with the gnostic-Neoplatonist tradition to create the foundations of his higher magic, Pico found in meditative trances the technique for escaping from his body to explore higher realms of consciousness. And here came the rub. Both Ficino and Pico stressed the essentially sexual essence of their magic. Both provided justification for sexual magic as an ecstatic reconciliation of opposites in which a higher state could be attained.

An early forerunner of the political martyr Wilhelm Reich, Ficino regarded sexual desire as a current of energy responsible for the cohesion of the entire universe. To Florentine sensitives, erotic love could thus be a method of absorption into, or magical mastery of, the world of the divine. Ficino even went so far as to commend the pagan revels of Bacchus (or Pan) as a way of escaping from normal human limitations into an ecstasy in which the soul was miraculously transformed into the beloved god himself. To the churchmen of Rome, who officially condemned sex as satanic and evil, though they were personally clandestinely happy to indulge, this was heresy, to be dealt with by torture and the stake.

Because of the heretical nature of Pico's pronouncements, and especially because of his surprising thesis that no science gave a better confirmation of the divinity of Christ than "magia and the Kabbalah," he was arrested by the self-appointed vicar of Christ, Pope Innocent VIII (1484-92), a supposed celibate who openly subsidized a litter of bastards at the Church's expense (funded from the sale of indulgences to those guilty of killing innocent heretics) and who had launched his reign by issuing a bull ordering a holy war for the extermination of all witches and magicians. Only by making a public apology was Pico able to avoid being burned at the stake. Influenced by his friend, the reforming monk Girolamo Savonarola—who *was* burned, for constantly inveighing against the infamously corrupt rule of Innocent and accurately prophesying his imminent death—Pico, a tall, handsome young man, much loved by the ladies, chose to abandon the gay life of a Renaissance nobleman with his princely patrimony, to wander barefoot through the world preaching the simple Christianity of Jesus of Nazareth. Though somewhat vindicated by Innocent's successor, Alexander VI, Pico, to avoid further persecution, judiciously translated himself to another dimension at the early age of thirty-one, depriving the world of one of its brightest minds and its sweetest

When Savonarola raised his voice in the pulpit against the gangster methods and the gross corruption of the Church, prophesying a holocaust if the pope did not reform, he was offered a cardinal's hat to desist. When he replied, "No hat will I wear but that of a martyr reddened by my own blood," he was seized and obliged of his request. For forty days he was tortured to elicit a false confession, then hung on a cross with two of his accomplices and burned alive before a howling mob.

Cartoon deriding Alexander VI as venal and corrupt. A Spaniard by birth, known as the "infamous Roderic Borgia, greedy for gold and lustful for women," he owed his cardinal's hat to the nepotism of an uncle, Pope Calixtus III, and his papal crown to the vast sums of money he spent bribing other cardinals to obtain their vote. Once in office, Borgia lavished several fortunes on a score of illegitimate children provided by a variety of mistresses. His son Caesar, named archbishop of Valencia at 16, was made a cardinal at 18, along with his nephew Giovanni. Another son became duke of Gandia, owner of a vast personal fiefdom carved out of Church property. For himself, Borgia indulged in a life of extraordinary luxury, enlivened—as pornographically described in his secretary's memoirs—with dancing, stage plays, and sexual orgies. Only when the corpse of the duke of Gandia was washed up by the Tiber did Alexander shut himself up in Castel Sant'Angelo, overcome with grief, and promise to reform the Church. But this too proved an idle promise when suspicion of the murder fell on his son Caesar, then the most powerful cardinal in Rome. Alexander rewarded the suspect with the confiscated property of another noble, and allowed him to become a general to launch a series of military campaigns designed to refill the papal coffers. Cardinal Michaeli was cynically poisoned and his property seized. Any cardinal, nobleman, or official with money could be accused of an offense, imprisoned, tortured, and made to confess; murdered, he was deprived of his property. Anyone trying to oppose such action was seized by the pope's Spanish mercenaries and punished with death. When Alexander finally died at the age of 72, apparently by poison he intended for someone else, Caesar kept the news from the world long enough to seize the papal treasury. By the time the pope's death was announced, his body was so horribly decomposed it had to be quickly and forcibly stuffed into the first available coffin, too small for his rotting six-foot carcass.

souls. Ficino, determined to pursue the magical lore derived from the Egyptians, managed to avoid the stake only by taking holy orders.

What Pico had been guilty of was following two dangerously libertarian notions—as spelled out in Ficino's translation of Hermes's *The Pimander* and *The Asclepius*—which the Catholic Church, a political institution determined to defend by force its temporal power and financial benefits, could not tolerate. The first of the notions considered anathema by the Church, because it made superfluous the role of priest, bishop, or pope, consisted in the suggestion that "unless you make yourself equal to God, you cannot understand God; for like is not intelligible save to like. . . ." This was followed by the simple recipe for attaining to such a grand conceit: "make yourself grow to a greatness beyond measure; by a bound free yourself from the body; raise yourself above all time, become Eternity; then you will understand God." The divinity in question was, of course, neither the vindictive patriarch of Moses nor the caster-into-hellfire of the Roman Inquisitors, but the gnostic's wonderfully loving and all-pervasive One.

As the Church suspected that the revival of the Hermetic tradition—going back to the wisdom of the ancient Egyptian religion as symbolized by the great obelisks and their enigmatic hieroglyphs—posed a direct threat to its control, and that this "heretical" wisdom might be more truly a religion of love than their own debased and cruel version, popes and Inquisition began to exterminate on a grand scale followers of the gnosis wherever its proponents overtly displayed their beliefs.

As early as A.D. 321, when Constantine became the first Christian emperor, the Church of Rome set about suppressing all that was pagan, refusing to recognize the ancient mysteries. No longer teaching a universal religion, the Church pronounced the arts of ancient Egypt wicked and magical. Of these arts, hieroglyphic writing was considered the worst because it appeared to concentrate the secrets of them all.

At the Council of Nicea, presided over by Constantine—ostensibly to suppress the Arian heresy—the spiritual considerations of Christianity became once and for all subordinate to political control. Shortly after Constantine's death, to secure total temporal power, the Church produced what one historian has labeled perhaps the most shameless forgery in the history of false presences: the Donation of Constantine. "This document," says historian Michael Harrison, "purported to be the instrument by which the Emperor Constantine surrendered the imperial

Constantine defeating Maxentius at the Milvian Bridge

insignia of sovereignty over the Western Empire to the Pope of Rome"—applying to himself and his successors forever the emperor's title of Pontifex Maximus. "Appeal to this impudent forgery," says Harrison, "was made by Pope after Pope for centuries until, indeed, with the smashing of Rome's total power by the Reformation, the Donation of Constantine might be denounced for the swindle that men had long known it to be."

By the seventh century the Church had rewritten Catholic dogma to obliterate most of the original teachings of Jesus, substituting for the gentle Christian Gospels the narrow authoritarianism of Rome. Gone was the original Christian doctrine of reincarnation in favor of what has been called "a one-way trip to heaven or hell." This limited view, coupled with the Church's unwillingness to recognize the value of human sexuality, or the ancient pagan rites of fertility, was to have a deadly effect on man and nature, worsening as the centuries passed.

Then came the papal encyclical cynically laying perpetual sexual chastity on the priests of Rome. Unable to contract a valid marriage and thus beget legitimate heirs, priests and prelates could only will their property back to a Church which could only grow richer; that is, all with the exception of the cardinals and popes, who managed to create an enduring "black" aristocracy with the property they alienated from the Church to their "nephews." Being a rule and not an option, priestly chastity had the effect of unleashing on Christian women a pack of sex-starved clerics who could only satisfy their lust illicitly, with a sense of guilt to besmirch any tenderness or love, a shift from the world of eros to that of porno, and the sadistic persecution of happier, healthier mortals.

Blinding the archbishop of Ravenna

Piercing the eyes of an "heretical" bishop with a sharp iron

Using a hodgepodge of undigested mythology picked up from Egypt and the East, the Church set about scaring those who would not obey them (and pay them a 10-percent tax) with threats of eternal damnation in a fiery hell for sins or purported sins which only the Church could forgive, against payment of cash. Thanks to the sale of indulgences, crime without risk could be committed by payment in advance of the required sum: 7 pounds for perjury, 36 for incest, 1 ducat and 4 pounds for parricide, 11 ducats 6 pounds for poisoning a stranger.

But the system, further corrupted by simony, risked total collapse, and the Church, determined to survive, hit upon the only method it could envisage: the extermination of its enemies. For the dirty work, the pontiffs organized an SS Corps of investigating executioners: the Inquisition.

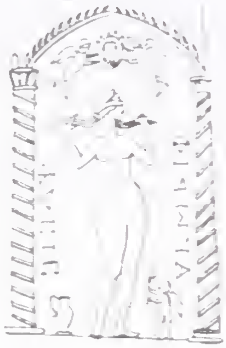
Anyone teaching a gospel closer to that of the ancient Egyptians—such as the Essene, the Therapeut, the gnostic, and the Manichee—was relentlessly persecuted, tortured, and painfully put to death.

Theodorus (642-649) started the vogue of dipping his pen into consecrated wine when signing the death warrants of heretics. The inhuman ordeal of torture by water was invented by Eugenius II (824-827). Gregory II (996-999) had the eyes of antipope John pierced and his nose and tongue cut out.

Among the first to be executed was Manes, originator of the Manichaean "heresy," which he had learned from the Egyptian philosopher and magician Terebinthus. Manes was crucified and flayed alive for having considered the philosophical system of the pagan sages superior to that of either Judaism or Christianity. The followers of Manes, known as the "Sons of the Widow" in memory of the widowed Isis and of the Osirian mysteries of Egypt, were accused of the crime of believing the spirit of God to be Light, radiant with the virtue of love, faith, fidelity, high-mindedness, wisdom, meekness, knowledge, understanding, mystery, and insight. Like the Essenes, the Manichaeans called themselves "Sons of the Light." Believing in metempsychosis and the ultimate salvation of all men, they held enlightened and purified love as the highest of human emotions, a love expressed through kindliness, friendliness, tolerance, and patience. In their opinion, only those who truly loved their fellow men and women and proved that affection through the defense of the rights of man were entitled to regard themselves as religious.

Gnostic sects, who found their primeval wisdom in the ancient mysteries of Egypt, and in the efficacy of numbers and hieroglyphs, were found guilty of searching for the

Gnostic symbols



At the end of World War II in the cave-riddled mountains of Jabal-al-Tarif in Upper Egypt, a discovery was made which threw light on the beliefs of the early Christian gnostics. Most of what had been known about them had come from their Catholic detractors who considered them heretics. In a cave, where they were hiding in the course of a blood feud, two Arabs (who had just murdered a rival, dismembered his body and eaten his heart) came upon a red earthen jar about a meter high. Inside were thirteen papyrus books bound in leather. Several were used to make fires, but in what remained scholars were to decipher fifty-two texts in Coptic dating from the early Christian era. They contained previously unknown gospels such as that of Thomas, of Philip, and of The Egyptians,

esoteric meaning in religion, and ritually massacred by the early followers of the Church. What the sexually tortured Fathers held against the gnostics was their love feasts, which the Fathers, without a glimmer of the philosophy entailed, characterized as grossly perverted orgies. Early Christian gnostics were accused of putting out the lamps in their churches at the end of evening services to indulge in indiscriminate sexual intercourse; also of practicing the Tantric ritual of offering human semen as a sacrament.

Even the Neoplatonic school of Alexandria was attacked; its beautiful and eloquent leader Hypatia, stripped naked by a mob of Catholic monks, was barbarously murdered with the complicity of Cyril, bishop of Alexandria. Yet from the Alexandrine school the ancient mysteries of the Egyptian gnostic-Christians were kept alive by the sect of Sufis, overtly Moslem, but with deeper philosophical roots. In Islam, Hermes became Idris, master of the Hermetic mystery, known only to the few. A Sufi heir to the mystery cults was Dhun-Nun, an Upper Nile Egyptian who derived his gnosis, or vision of unity, from a decipherment of hieroglyphs on the Egyptian temples. His ideal of an interreligious reconciliation was carried on by the sect of Ismaeli, who passed on to the Crusaders from the West, and especially to the Knights Templar, elements of Sufi esotericism and what came to be known as the Rosicrucian secrets.

Brought from the Levant to southern Europe, the Egyptian beliefs of gnostic, Manichee, and Sufi gave rise to the Bogomils, Cathars, Albigeois, Paulicians, Pataranes, Tisserands, and Waldensians. Secret assemblies of the Manichees and Cathars were dedicated to the liberation of human beings from the despotism and tyranny of the Roman Church, so that in the end all nations might dwell together in peace, governed by just laws and noble examples.

The Albigensians, with a stronghold in the south of France during the twelfth and thirteenth centuries, went even further. Heirs to a magical secret inherited from Egypt, known to gnostic and early Christian, they could help a soul painlessly across the threshold of death into what they termed "reunion with the Light." The Albigensian creed offered an escape from the endless wheel of reincarnation, an escape from the illusory prison of the body, with its seeming pleasures, and a "return within the compass of a single life into union with spirit." Here was an echo of the ancient Vedas, along with the message of the Buddha. Nirvana to the Albigensians was not an annihilation of consciousness but a participation in the evidently translations made about 400 A.D. of more ancient Greek manuscripts, possibly earlier than the Canonical Gospels attributed to Mark, Matthew, Luke and John. The content of the gospels, condemned by "orthodox" Catholics some time after Constantine, ranged from descriptions of the origin of the universe to myths, magic and instruction in mystical practice. One of the reasons for condemning these "Gnostic Gospels," as they came to be known, is given by Elaine Pagels in her book by that title. From the Apocalyse of Peter, she quotes the risen Christ as explaining to Peter that those "who name themselves bishop and also deacon, as if they had received their authority from God, are in reality waterless canals" and although they "do not understand mystery, boast that the mystery of truth belongs to them alone." The author of this little known gospel accuses the orthodox of setting up an "imitation Church" in place of the true Christian "brotherhood."

Another reason for condemning these early Christian texts may be found in the Gospel of Mary Magdalene, which hints at an erotic relationship between Jesus and his lovable follower; though, as Pagels is quick to point out, mystics have constantly chosen sexual metaphors to describe mystical experiences. But the most obvious reason for condemning these gospels—which some dedicated soul took the trouble to secrete in a cave some sixteen hundred years ago—was clearly political. Whoever could claim to *know* through inner vision could claim that his or her authority equalled or even surpassed that of Peter and his bloodthirsty successors. The gnosis, offering the initiate a direct access to divinity—of which priests and bishops might even be ignorant—also offered a theological justification for refusing to obey either bishop or priest. So the moment the Catholic Church obtained political and military power, the subversive gospels were everywhere destroyed and their proponents butchered.

universal consciousness—a state of love bordering on the divine.

In the Roman Church, the Albigensians saw an institution ridden with superstition, lacking in philosophical depth, corrupt and cruel; it seemed to them that Satan himself must have been responsible for setting up the Churches of Christendom as a means of destroying human souls. Like the Cathars, they renounced not Satan and his works and pomp, but "the harlot Church."

To the Albigeois enforced marriage by the Church was odious; he recognized no other sanction for the union of man and woman than mutual attraction. Some went so far as to proclaim the sacraments useless, suggesting that women ought to be communalized on account of the vanity of the pleasure obtained from them. Yet an advanced Cathar would not commit adultery, nor homicide, nor lie, nor swear an oath, nor pick and steal, nor do unto another that which he would not have wished done unto himself. He was to pardon wrongdoers, love his enemies, pray for them that calumniated him, offer the other cheek to the smiter, give up his mantle to him that took his tunic, and neither judge nor condemn.

Dante is reputed to have been a secret member of the Albigensian Church and to have officiated as a pastor in various European cities. He was also a member of a group called Fedeli d'Amore, or Faithful in Love; and Roberto Cesare Ambesi in his *I rosa croce* mentions a ciphered Rosicrucian wisdom hidden in the lines of the *Divine Comedy,* obtained mystically and by initiation, which, says Ambesi, transcends the limits of the times in which Dante lived.

The gnostics' radiant cult of the spirit, which took possession of men, a cult without vast buildings, elaborate decorations, pontifical hierarchy, or rich vestments, was seen by the popes as a serious threat to their materialistic church. Once it became clear that perhaps a third of all nominal Christians were secretly practicing an heretical religion, Christian persuasion was replaced by the rack, the gibbet, and the stake. Declaring that anyone who attempted to construe a personal view of God which conflicted with the dogma of the Church of Rome must be burned without pity, Pope Innocent III decided on a crusade "to exterminate the impious," accusing the Cathars of being "lascivious sects, who, overflowing with libertine ardor, are but slaves to the pleasures of the flesh."

To the cold nobility of northern France he offered as a lure the conquest of temperate and independent Provence,

Burning a victim of religious persecution

with its beautiful châteaus, its luscious vineyards, olives, and fig trees. German mercenaries were enlisted on the promise of looting the rich southern towns and of raping their lovely women, renowned as lighthearted, hot-blooded, and perversely sensuous.

And so was inflicted on the south of France one of the most ferocious massacres in history. Bands of northern brigands pillaged and plundered. In the Cathedral of Saint-Nazaire twelve thousand "heretics" were killed when the roof collapsed. Those who tried to flee were cut down and butchered. Thousands more were burned at the stake. At Toulouse, Bishop Foulque put to death ten thousand people accused of heresy. At Beziers the entire population of more than twenty thousand was slaughtered. At Citeau, when asked how to distinguish Catholics from Catharists, the abbé replied with his famed cynicism: "Kill them all; God will know his own."

Thus it fell to the Knights Templar to act as custodians of the esoteric tradition descended from the Egyptian and Chaldean sages. Anomalously acting as "military apostles of the religion of love," they dedicated themselves to the restoration of the Church as they believed it to have existed in the time of the apostles, setting up a bulwark against the abuses of the theocratic regime in Rome, with its cruel and despotic Inquisitors. From their Moslem peers in the Orient the Templars had learned to acknowledge Jesus as a great and holy prophet, one who had been taken to Egypt to be initiated into the highest degrees of occult science, recognized by the priests of Osiris as the long-promised incarnation of Horus, eventually to be consecrated Sovereign Pontiff of a Universal Religion.

Along with a reverence for the doctrines of alchemy, astrology, magic, and cabalistic talismans, the Templars

The torture and execution of Waldensian "heretics"

Grand Master of Templars

Templar uniforms and arms

appear to have brought to Europe from the East the secret teachings of the gnostics and the Sufis dealing with Tantric sex. According to the nineteenth-century German historian von Hammer-Purgstall the Templars secretly adopted a form of the rites of Gnosticism founded on phallic worship or reverence for the sexual principle in nature.

Formed in Palestine in 1118 by Hugues de Payen and Godefroy de Saint-Aumer, with seven other French knights, the Templars set up their order in the ruins of the Temple of Solomon; and the symbolic rebuilding of the temple was to become one of their spiritual goals: the temple of God being man. Digging in the foundations, they are said to have found a rare manuscript which traced for them the procedure employed by King Solomon in realizing the *Great Work,* the alchemical transmutation of the human soul back into light.

It was then that the Templars came into contact with the sect of the Johannite followers of Saint John the Apostle, whose secret objective was the restoration of the esoteric Egyptian tradition, to be achieved by the overthrow of the Bishops of Rome, in order to establish universal civil liberty, and thus reunite mankind under the one eternal religion of the world. This goal became the secret dream of the Templars: the formation of a civilization that would reconcile East and West, starting with a unique brotherhood of Christian and Moslem. But to achieve their goal they chose the same anomalous path as their opponents: they set about amassing great riches, becoming not only the greatest soldiers of the West, but its greatest bankers. They also became great builders of cathedrals, accomplished diplomatists, and the most reliable chamberlains at the courts of Europe.

Encounter between Christians and Saracens at Mt. Hattin in Palestine on July 4, 1187. Thirty thousand Moslems and Jews were massacred in Jerusalem by Christian crusaders. To stop this senseless slaughter, the Knights Templar found means of communicating with their Moslem brothers-in-arms as brothers in spirit.

Knights Templar entering their fortified temple in Paris, built in the thirteenth century opposite the Louvre

Then came disaster. King Philip the Fair of France developed a similar idea of making himself ruler of a vast Christian empire centered at Jerusalem. He also needed money. First he seized all the Jews in his kingdom and forced them to give up their fortunes by removing one of their eyes and threatening to remove the other. Then he so debased the value of the national currency he was obliged to take refuge from an angry populace in the Paris temple. There, among his protecting Templars, he coined the idea of seizing their riches.

On October 13, 1307, throughout France, some five thousand knights were arrested by officers of the king. Seized without warning, and kept in ignorance of their fellow knights, they were told that others had confessed and that their lives would be spared if they too confessed. But to what?

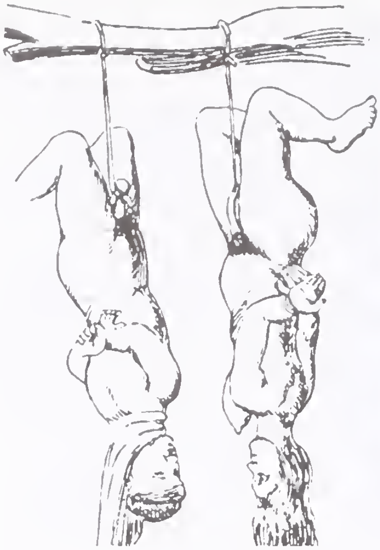
To have charged the Templars with planning an ecumenical world would have meant unveiling Philip's own scheme. So recourse was had to the easier charge of magic and heresy. Public indignation was aroused by further charges of sodomy and orgies with female demons. To these accusations were added denying Christ, spitting on the Cross, and worshiping the devil in the form of an idol called Baphomet.

Grand Master Jacques de Molay, with his bodyguard of sixty knights, was imprisoned in his own temple. Only a few hundred knights escaped. The rest were turned over for interrogation to Guillaume de Paris, Grand Inquisitor for France. Of the 140 Templars seized in Paris 36 soon died under torture; 54 more, in horrible torment, some being strung up by the testicles, confessed to whatever the Inquisitors asked, but repudiated their confessions as

Philip the Fair, king of France from 1285 to 1314

Baphomet, the Templar symbol of Gnostic rites based on phallic worship and the power of directed will. The androgynous figure with a goat's beard and cloven hooves is linked to the horned god of antiquity, the Goat of Mendes. The Tantric sexual symbolism of the figure is highlighted by the caduceus in place of the phallus. Modern exegesists see in the androgynous glyph the formula of sexual magic, symbolizing "the perfect fusion of Solar and Lunar energies in one organism."

The torture of de Molay



Templar strung up by the testicles

Clement V (Pope, 1305-1314)—Bertrand de Got, a Frenchman and former archbishop of Bordeaux—had the seat of the papacy transferred from Rome to Avignon by King Philippe le Bel. He is accused by historians of issuing "a series of bulls, perhaps the most disgraceful that ever proceeded from a vice-regent of God." Thirsting for the Templar riches, he let himself be bribed by the Knights of Saint John to share the loot. In what is described as "the most suggestive sale of indulgence on record," he offered Edward II of England full remission of his sins if he allowed reinstatement of the use of torture by the Inquisition. A month after the burning of de Molay, Clement died in agony from the loathsome disease of lupus.

soon as the torture was stopped. They were piled into wagons and carried to the fields near the convent of Saint-Antoine, where they were tortured to death by slow fire. All refused offers of pardon if they recanted, manifesting instead a constancy which, as a contemporary chronicler tells us, "placed their souls in great peril of damnation, for it led people to believe they were innocent."

Anyone who dared defend the knights was himself accused of heresy and condemned to death. When the pope, Clement V, tried to intervene on behalf of the imprisoned Templars, he was thwarted by Philip. Being a Frenchman who held court at Avignon, dependent on Philip for his freedom, the pope quickly gave in. And he too had his eye on the riches of the Templars.

De Molay, de Charney, de Peraud, and de Gonneville, the top officers of the Temple, were kept in jail for seven years, repeatedly tortured, until they confessed. Brought to trial and condemned to perpetual imprisonment, de Molay and de Charney, to everyone's amazement, arose and declared themselves guilty not of the crimes imputed to them, but of having basely betrayed the order to save their lives under torture.

On the same day, by sunset, two stakes had been erected on a small island near Notre Dame, the Island of Jews, opposite the king's gardens, piled around with burning charcoal to cause a slow death. When Grand Master de Molay saw the fire he stripped and slowly approached the patibulum, his body already so scarred that the skin of his back, belly, and thighs hung in shreds. It took all night and all day for him to die in a drawn-out, deliberate agony.

With the Temple suppressed in France, Philip seized what he could of its vast fortune. But the spirit of the

Templars was long to outlive him. In prison, de Molay is said to have secretly instituted four lodges of occult Masonry and to have designated a hiding place for much of the order's wealth. Some of the Templars who managed to escape from France took refuge in Scotland and England. In the latter the Temple survived in London's Inns of Court, keeping alive, underground, the ancient wisdom of Egypt passed on by Cathar, Manichee, gnostic, Sufi, Albigensian, and Free Mason.

With the suppression of the guilds on the Continent, the secret wisdom was no longer built into the stonework of the great cathedrals funded by the Templars. It was to survive instead in the veiled ritual of the lodge, and in the Hermetic language of the poet.

The same lawyer, de Nogaret, who prosecuted the Templars had previously seized and imprisoned Pope Boniface VIII, the shock of which so maddened the old pope he killed himself by beating his head against the walls of his room. Boniface had excommunicated Philip for contravening canon law by taxing French clergy to finance his war against England. After Boniface's death Philip, in order to have all his bulls annulled, especially *Unam sanctum* (which asserted the supremacy of the papacy over any temporal ruler), had his docile minion Clement V condemn Boniface posthumously for sodomy, murder, sorcery, and consulting with demons. Boniface was further accused by de Nogaret of murdering his predecessor, the weak-minded Pope Celestine V, by drilling a hole in the wall of his bedchamber and representing his voice as that of a messenger of God.

4. ELIZABETHAN WITS AND WIZARDS

What the Church most disliked about magic was the notion that individuals might commune directly with disembodied entities, especially to use them as intermediaries with higher or angelic realms. The priests of Rome wished to keep for themselves the sole right to deal with the beyond; and though they maintained they could invoke into their own churches a holy spirit, they considered anyone else who did anything similar worthy only of hell.

It was not that the Church did not believe in the existence of spirits that communed with mortals; the churchmen simply changed their nature from Greek δαενοης—immaterial beings or departed souls believed to hold a middle ground between man and the deities of the pagans—into Latin demons, characterized by the Church as evil and satanic.

On the authority of Aquinas, any commerce with such demons, though it might bring instant reward, was believed in the end to serve only the demons who were considered deceptive, and even if apparently good, actually only lying in wait to delude those who sought them.

Jan Wierus, one of the best known physicians of the sixteenth century, considered an originator of modern psychiatry, and famous in his time for an outspoken opposition to the persecution and torture of witches, even took a census in which he counted 7,405,926 demons, divided into 72 companies, under a captain or a prince, all commanded by *the* Evil One, a fiend, who, in the eyes of the Church, bore a relentless hatred for the human race. That these devils of an airy substance could penetrate human beings, "could take possession of a human spirit, and give rise to spectral images," Wierus had no doubt. So *all* magic, black or white, with the exception of that perpetrated by the Church in its own rites and incantations, became taboo.

This trend against magic had been growing in the Roman Church since the reign of Pope John XXII (1316–49), who issued a bull *Super Illius Specula* against the use of magic, and ordered all books on the subject turned in for burning. Accusing his opponents of heresy, sorcery and demon worship, he condemned those accused of magic, and especially those who claimed to commune with spirits, to be tortured and burned alive—a profitable

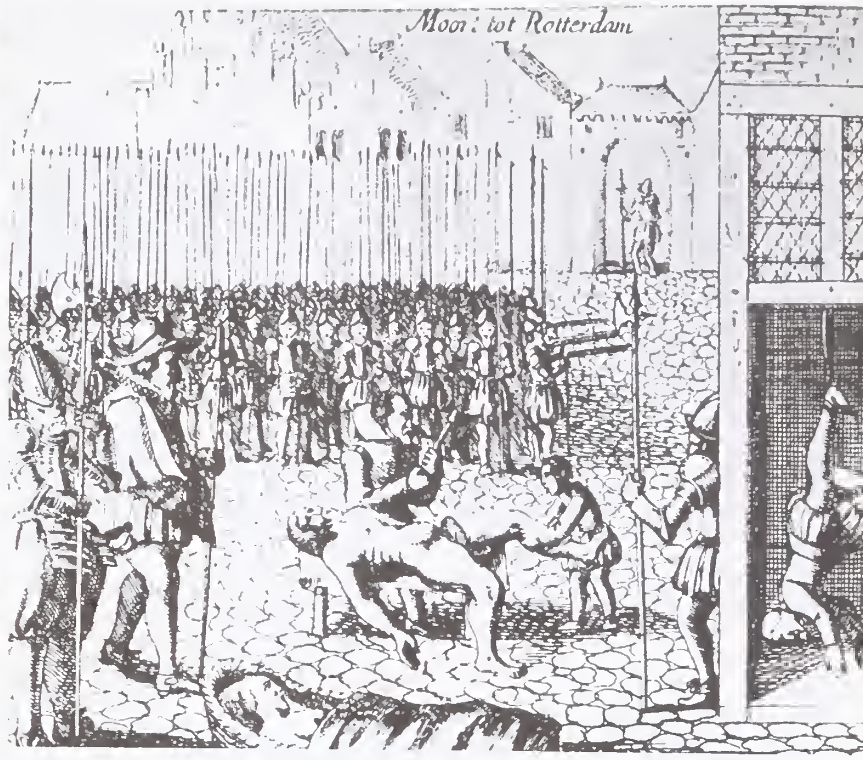
According to Saint Augustine, two realms have existed since the beginning of the world, the City of God (which includes the angels and good people) and the City of the Devil, in which he included not only demons, but the whole pagan world with its cult of demons. By magic, says Augustine, people try to compel the assistance of demons, but the demons in the end seduce people into worshiping them as gods. The magicians maintained, to the contrary, that only the pure in heart could practice the art of magic and that the demons were commanded through the power of God.

In a bull dated 1478, Sixtus IV allowed Ferdinand and Isabella of Spain "to appoint and depose Inquisitors and to possess themselves of the property of the condemned for the royal treasury." This Inquisition developed into a secret association of spies, fanatics, and informers determined to destroy freethinkers, philosophers, scholars, mystics, and anyone not crassly subservient to the "authority" of Rome. Under the system anyone could be accused by anyone, anonymously or otherwise, of suspicion of heresy. The mere accusation removed the victim from the jurisdiction of the state to that of a special ecclesiastical court. Once in the hands of the Inquisition, all friends and family had to cease association with the victim. Any "sympathy" displayed for a "heretic" was considered tantamount to heresy. There was no recourse to the civil law, no *habeas corpus*. All regular police officers, magistrates, and public officials, including governors and viceroys, were obliged to assist the Inquisition on pain of being considered sympathetic to the heretic. No one, no matter how high his station, was immune from persecution. Anyone was a heretic who spoke disrespectfully of church services, read or lent books condemned by the Inquisition, ate meat on fast days, missed mass, disapproved of anything done by the Inquisition, denied any assertion made by an Inquisitor, believed that the adherent of any other form of religion could be saved, or that the Church itself might someday be reformed and primitive Christianity restored.

process, as the property of the condemned was split between Church and Inquisition, a system of revenue legalized by Sixtus IV with a papal bull in 1478.

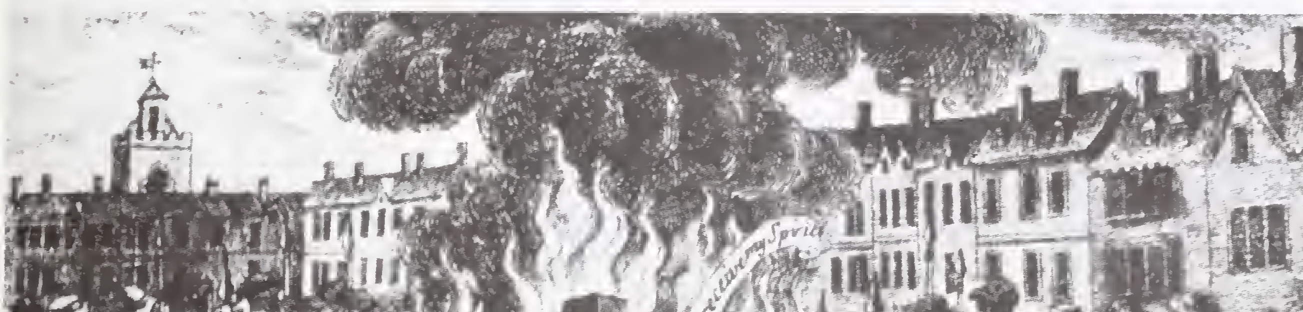
Throughout Europe the slaughter grew out of bounds. The entire population of the Netherlands was declared heretical and condemned to death by the Catholic Inquisition. Whole cities were denuded of men, the women systematically raped. Recalcitrants were buried alive, strangled, beheaded or had their breasts ripped off with red hot pincers. In Germany a hundred thousand perished; many more died in agony in Switzerland, France, and Italy; altogether more than a quarter of a million souls. Protestants were no better; Calvin and Luther, bigoted, intolerant, heartless, determined to crush what to them was "heresy" or "unorthodoxy," by the same means of physical terror employed by the Catholics. Protestant Dutchmen were crueler still in the revenge against Catholics and nonconformists.

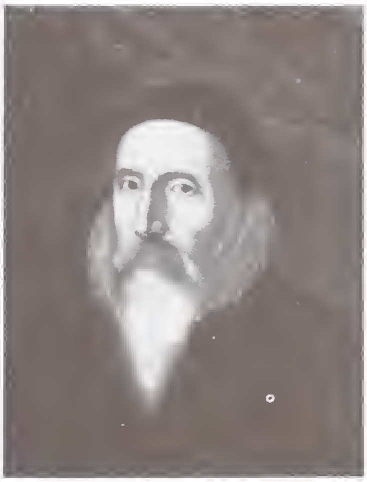
In England the butchery was not so widespread, but nonetheless fiendish. John Rogers, minister of the gospel in London, the first Protestant martyr in Catholic Mary Tudor's reign, was burned alive at the stake at Smithfield in February 1554 while his wife and nine children, one of them still at the breast, were obliged to watch. But the Spanish archbishop Caranza, who introduced the Inquisition to England, only managed to do away with three hundred victims before he was driven from the country. After Bloody Mary's death in 1558, Catholics suffered similar persecution. Dermid O'Hurley, Catholic archbishop of Cashel, was fastened to a tree, his boots filled with combustibles, and set on fire, a fire which was alternately



All over Europe Christians butchered one another in the cruelest ways in the name of God.

The burning of John Rogers





Dr. John Dee (1527-1608) was not only Elizabeth's occult adviser but acted as secret agent for the queen on frequent trips to Europe. Code-named 007, his adventures were even stranger than Bond's. A friend of Francis Bacon and Walter Raleigh, he was a member of the circle known as The School of Night, which met secretly at Raleigh's house in Dorset to discuss occult and scientific policy. A religious Hermeticist and practitioner of the religion of love and unity, Dee encouraged toleration to heal the breach in Christendom and establish a new Golden Age in which man could recover his intellectual capacity, his beauty, and his place beside God. Dee believed that through a mystical rapport with the world man could rediscover and regenerate the divine within. He was convinced that within man was an "astral" spirit, whose powers could be channeled to achieve more with science than did nature unaided. Aware, like Bruno, that all was ensouled, he believed man could do wonders with the effluvia from the stars, and that the main weapon of the magus was his own imagination. But Dee's theurgy, or invoking of spirits, got him in trouble with James I, who abhorred witchcraft, and once more he was nearly burned for sorcery.

quenched and relighted, prolonging his torture through four successive days.

But by this time the tune was changing at the court of Elizabeth. An Hermeticist follower of Pico and Ficino—very nearly burned for sorcery and treason by Mary Tudor when he cast her horoscope and that of her Catholic husband, Philip of Spain—was nevertheless convinced that Protestant and Catholic could yet be united through a return to the early Christian religion of universal love and to the more ancient Egyptian cult on which it was based. He was Dr. John Dee. Under Queen Elizabeth's protection, this venerable magus was able to propagate in England the Egyptian wisdom acquired in his prolonged and various travels in Europe, often as a secret agent of Elizabeth. Through his constant efforts, and his tutoring of the highborn nearest Elizabeth, Dee was to come close to fulfilling his dream of a united and spiritualized Christendom.

Avid for data on magic and how to perform it, Dee had gradually built up at his country house at Mortlake, 30 miles up the Thames from London, the greatest library in England, one far superior to those of either Oxford or Cambridge, with a special leaning toward the occult. On its shelves he accumulated all of Ficino's works, the greatest number of the manuscripts of Roger Bacon, the works of Paracelsus, Cardano, Agrippa, and as many of the other magicians whose treatises were available in manuscript or print. Still, he complained that no man and no book could give him the answers he required. To fill this void he "beseeched the giver of wisdom" to communicate to him what he sought through an angelic intermediary, as had been done with Abraham, and later with Ficino and Pico. Dee's plea was rewarded with the appearance of Edward Talbott, a strange sensitive who assumed the bogus name of Sir Edward Kelley, a scryer, or crystal-ball gazer, who could evoke what he called nonterrestrial entities in a black stone the size of a hat crown, specially polished and treated to catch the spectral forms of unearthly visitors.

As the operation is described by Dee, these forms would point to certain letters on various tablets and put together messages in what came to be called "Enochian," each message spelled backwards because "the words contained such potency that direct communication would have invoked forces disruptive of the whole work." Enochian, according to Dee, was a definite, though unknown, language, which he classified as "angelic." Through it, Dee developed nineteen calls, or keys, the first eighteen

With Kelly as his medium, Dee claimed he chiefly communicated with the archangels Michael, Gabriel, Raphael, and Uriel, who had instructed the Hebrew patriarch Enoch—hence Dee's use of that name for his angelic language. Enoch was said to have lived before the Flood, to have "walked with God," and been raised living into heaven after having engraved the primitive elements of religion and universal science on the two "columns of Enoch." The Book of Enoch purports to tell the story of the "sons of God" who came down from heaven to mate with the daughters of man—who then learned their secret magic. The civilizing force which the Hebrews personified in Enoch was the Trismegistus of the Egyptians, the Cadmus of the Greeks. Enoch-Hermes was said to have seen the living stones of Thebes rise up to the strains of Amphion's lyre.

By means of the "shew-stone" as a scrying instrument, Dee obtained his Enochian language from a number of charts divided into squares, each with a letter of the alphabet. Kelley would see visions of an angel pointing letter by letter as it spelled out a message.

The Enochian tablets consisted of 156 pyramids, each with over a hundred squares filled with letters, totalling 2401. Dee used one or more of these tables (as a rule 49 × 49), some full of letters, others only lettered on alternate squares. Kelley would gaze into the "shew-stone" and tell Dee the angel was pointing to a square, but not mention the letter.

being to summon various elements, the nineteenth enabling him to envisage thirty Aethyrs, or "spheres of the spirit world." So adept was Kelley at summoning spirits, he became scryer-in-residence at Mortlake at £50 a year, and the minutes of his seances, carefully noted by Dee over a period of eight years, cover several hundred pages now in the British Museum along with the original black "shew-stone."

One of the books produced by Dee on various scientific subjects, his *Steganographia,* gives details of the procedure required for summoning "angels who govern the various planets and various parts of the earth." Dee's magic was also designed to protect the soul during its upward journey through the various spirit realms toward the goal of Gnosis. And that is how Dee got in trouble with Pope Sixtus V, nearly at the cost of his life. In Prague, at the court of Rudolph II, Dee conjured spirits for a friend, Francesco Pucci, an Italian Catholic, also infused with the Hermetic ideals, who had abjured the Church. Apprised of the magical seances, the papal nuncio in Prague sent word to Sixtus, who immediately ordered Rudolph to have Dee and Kelley delivered to Rome for interrogation, an order which Rudolph would have been bound to enforce had not Dee, forewarned, wisely left Prague and taken refuge with Kelley in a castle at Tribau. Pucci, who had decided to return to the Church to explain his ecumenical, Hermetic views to the religious authorities in Rome, foolhardily traveled under the nuncio's safe-conduct, only to be seized, condemned, and promptly beheaded as a heretic.

Had Sixtus known of Dee and Kelley's next adventures in the realm of angelic or demonic forces, he would, doubtless, have been even more outraged. Kelley, suspicious that the manifesting spirits might—as the papal nuncio had insisted—be demons, and that he might be lured to his destruction, wished to desist. Dee, considering himself a pious man and a devoted Christian, was determined to continue obeying the messages from what he considered angelic voices.

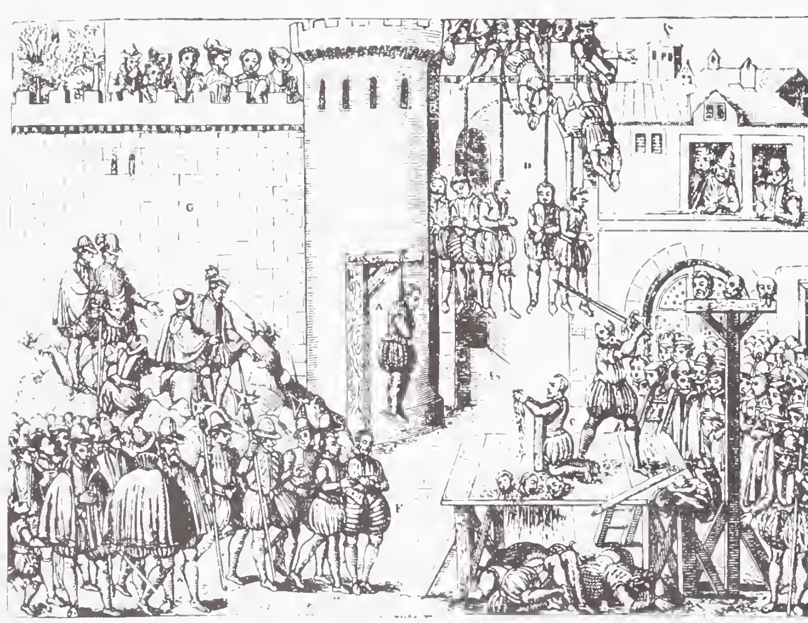
Queen Elizabeth of England had a double agent at the Vatican, appropriately known as le Chevalier Carré, and the perfidy of Sixtus V is exemplified by his having kept Elizabeth informed by le Carré of every detail of the organization of the great Spanish Armada for the invasion of England. At the same time Sixtus cunningly offered Philip II of Spain a million gold scudi to be paid as soon as he had successfully landed on the territory of "the bastard heretic" in England, hoping so to weaken Philip by a "Bay of Pigs" landing that Sixtus could, unopposed, seize from him a plum he longed for: the Kingdom of Naples.

The ensuing situation turned into a limited agape, or early Christian sharing, with overtones of experiments in Tantric sex, when—as reported in chronicles of the time—Kelley "cast a lustful eye on Dee's shapely vivacious young wife." Speaking through Kelley, a spirit named Mandini told both men "they had their wives in such sort that they should use them in common." When Dee asked Mandini if that meant spiritual or carnal copulation, the answer was "both." At dinner the decision was conveyed to the ladies. Surprised or not, they were evidently willing to comply; and for several months the quartet enjoyed a joint relationship until Kelley went back to Prague to be knighted in return for the promise of producing for the Bohemian sovereign alchemical gold by means of a red dust Dee had found in the grave of a bishop at Glastonbury Abbey.

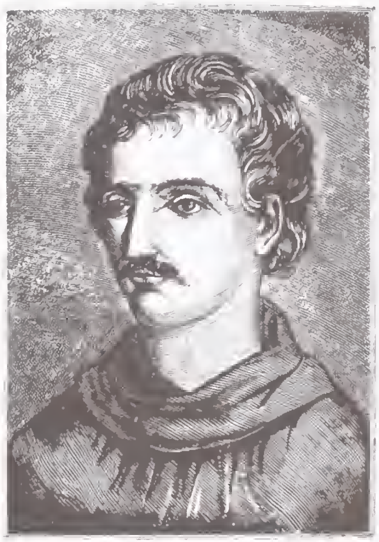
Back home at Mortlake, Dee found that a mob, accusing him of necromancy and of desecrating graves in order to have intercourse with spiritual essences, had ransacked and vandalized his great library, which caused him to compare the persecution he was suffering to the "raging slaunder of the Malicious Ignorant" endured by his young mentor Pico della Mirandola. But once more under Elizabeth's protection, Dee's house resumed its function as a meeting place for that distinguished cabal of English Hermeticists close to the Crown, such as Sir Francis Bacon, the Earl of Southampton, the Earl of Leicester and Sir Philip Sydney to whom Dee had been tutor. With great subtlety the group was using Shakespeare's plays as a means of political and religious pamphleteering for a return to the Hermetic values of Egypt, the secret wisdom of which they had been nurtured on by Dee, and by studying law in the old Temple, or the Inns of Court. As members of the Queen's Privy council, they too, if only to save their necks, wished to avoid the ghastly religious intolerance and religious warfare which was rending Europe.

To add his wisdom to this clandestine group of wits, there came from Italy perhaps the greatest philosopher of the sixteenth century, a fiery "heretic" who was to pay with his life for overtly challenging the Church of Rome whom he accused of having missed the secret message in the Egyptian glyphs adorning the obelisks and of having fallen from the path of the ancient wisdom.

Shortly before Sixtus V had come to the throne, Henry III of France, anxious for the hand of Elizabeth, had named as ambassador to the Court of Saint James's, Michel de Castelnau, marquis of Mauvissière, who, according to his peers, was a "remarkable and attractive man whose humanity transcended the religious cleavages of the times." Ten years earlier, Mauvissière had been sent by Henry's elder brother, Charles IX, equally interested in Elizabeth's hand, to try to pacify the outraged English queen after the ghastly Saint Bartholomew massacre, when a hundred thousand French Protestant men, women, and children had been cold-bloodedly ambushed and butchered by bigoted Catholics. This time, Mauvissière chose to take with him as a companion to the London of Shakespeare an Italian ex-monk, Giordano Bruno of Nola.



On the day of Saint Bartholomew, August 24, 1572, French Catholics ambushed and murdered all the French Protestants they could seize—men, women, and children—even ripping infants from the womb to prevent any survivors. As blood flowed in rivers and the streets were choked with corpses, the Catholic murderers went about the slaughter with white crosses on their hats and capes to be distinguished from their victims. In Rome the news was greeted with great feasts and gaieties.



Philosopher, poet, dramatist and intrepid supporter of intellectual freedom, Giordano Bruno obtained his doctorate in philosophy at Toulouse. With vast erudition, a vivid imagination, and originality of thought, Bruno lashed out with subtle irony and biting sarcasm against pedants in religion, science, philosophy or letters. In England, Sir Philip Sidney, who had studied jurisprudence at the University of Padua and was imbued with a love of Italian culture, may have financed the publication of Bruno's Italian works. Bruno dedicated to him his *Spaccio della bestia trionfante* and *De gli eroici furori.* Of Bruno's influence on contemporary drama, his biographer, Vincenzo Spampanato, points out that no less than ten of Molière's plots were influenced by Bruno's comedy, and he argues that half a dozen of Shakespeare's plays are strongly reminiscent of Bruno's work.

Bruno's reputation for dangerous views on matters spiritual had preceded him to England. Elizabeth's chief of intelligence, Sir Francis Walsingham, received a note from the British ambassador in Paris, Sir Henry Cobham, that "Dr. Jordano Bruno Nolano, a professor of philosophy, intendeth to pass into England whose religion I cannot commend." Indeed, in her *Bruno and the Hermetic Tradition,* Frances Yates—that remarkable historian of the Elizabethan age—suggests that the Italian was specifically brought to England on a secret political assignment of an obviously Hermetic or anti-Jesuit nature.

A small, thin man, with a meager dark beard, scornful of his attire—three buttons off his coat and hose pieced together from bits of his abandoned Dominican gown—Bruno seemed hardly presentable in society; yet this defrocked priest was to become such an intimate of the Hermetic conspiracy formed around the wits behind Shakespeare that he turned up in *Love's Labor's Lost* as the character Berowne. Charged with unorthodoxy for reading Erasmus in the toilet of his Dominican monastery in Naples, Bruno had escaped across the Alps to France to avoid being tried on a more serious count of heresy. What threatened to damn him was his conviction that a return to the Hermetic wisdom of the ancient Egyptians was the sole remedy against the fratricidal warfare ravaging Europe. An opinion identical with that of John Dee, who Peter J. French, in his biography of the old magus, suggests "was perhaps the only person in England who could have prepared the Sidney circle for that wild but brilliant ex-friar."

The England to which Bruno came was a haven for foreigners persecuted for their religious beliefs. Sensitive Elizabethans had been looking, since the guidance of Dee, to Renaissance Italy for the light of Hermeticism. Scores of distinguished Italians had taken refuge in London, including another ex-Dominican monk, Matteo Bandello, whose *Novelle* formed the basis of *Romeo and Juliet* and *Taming of the Shrew.* Bruno was quickly introduced by Mauvissière into the heart of the Shakespeare cabal, and was quickly patronized by Philip Sidney, by Walter Raleigh, who had been educated at Oxford with Sidney, and by Sidney's uncle, the queen's beloved Earl of Leicester, then chancellor of that stronghold of conservative Aristotelian study, Oxford University.

Bruno, who considered Aristotle *"stupidissimus omnium philosophorum,"* paralyzed his Oxonian audience with astonishment and indignation by expounding Hermetic conceits and by supporting what the ancient Egyptians

Nicolaus Copernicus (1473-1543), Polish astronomer, canon of the cathedral of Frauenburg, practiced medicine, giving his services free to the poor. His *De revolutionibus orbium coelestium,* dedicated to Paul III, described the sun as the center of a great system, with the earth as one of several planets revolving around it. But the first printed copy only reached him on his deathbed, saving him from the acrimonious debates of those who wished to refute a heliocentric system known to the Egyptians for several thousand years.

had known all along, Copernicus's proposition that the sun and not the earth was the center of the solar system, flatly contradicting Aristotle's notion of a finite universe constructed out of fixed geometric circles. Bruno insisted instead that the universe was infinite, that the sun was merely another star, and that stars were not fixed, but in reality suns, each with its own train of planets, cycling through the universe, "like great animals, animated by the divine life"—all of which had been standard to the ancient Egyptians, but denied and buried by the priests of the Catholic Church.

Following the Hermetic tradition, and the lead given by the magician Cornelius Agrippa, Bruno said he considered it unreasonable to suppose that the stars which give life and animation to all should themselves be without life and animation. Laying the Hermetic vision before his audience, the ex-monk allowed that he found it hard to believe any part of the universe could be without soul-life, without sensation, without organic structure. "From this infinite All, full of beauty and splendor, from the worlds which circle above us, to the sparkling dust of the stars beyond, the conclusion is drawn that there are an infinity of creatures, a vast multitude, which, each in its degree, mirrors forth the splendor, wisdom, and excellence of the divine beauty." Taking Copernicus's revalidation of the sun as the center of the solar system, Bruno used it to herald the dawn of a new age, the return of the Egyptian sun god Horus, and of the magical sun-worshiping religion of ancient Egypt, a true Aurora for philosophy after its burial in the dark ages of corrupted Christianity.

The Oxford academies received Bruno less than warmly. His lectures led to so much acrimony, he was forced to decamp in haste. For his part, the impression left on him by members of the university was that of a "pedantic pigheadedness fit to try the patience of Job." He accused the pedants of using empty words with which to mouth a sterile philosophy in language both trivial and superficial, without magical or incantatory power, instead of appealing to the magical hieroglyphic language of the Egyptians with its wisdom of the ages. As Bruno put it, by using the symbolic language of hieroglyphs, the Egyptians had managed to capture with marvelous skill the language of nature. "Later when letters of the kind we now use were invented by Thoth, or some other, it brought about a great rift both in memory and in the divine magical sciences." The most essential element in Bruno's outlook, says Fances Yates, was to find "these living 'voices,' signs, images, seals, to heal the rift in the means of communica-

In *Del'infinito universo et mondi* Bruno goes beyond Copernicus in his speculation about the nature of the universe, attacking the foundations of Aristotle's cosmology. And in *La cena de le ceneri* Bruno, expanding the Copernican theory, inveighs against contemporary English scholars, especially those at Oxford whose world he describes as "a constellation of the most pedantic, obstinate ignorance and presumption, mixed with a kind of rustic incivility, which would try the patience of Job." In his *Spaccio* Bruno reveals his strong attraction to Egyptian religion, condemning the hypocrisy of sixteenth-century princes who, with their sycophants, had created a "faithless, dissolute, irresponsible and indolent upper class." But for Queen Elizabeth, whom he visited frequently with Ambassador Castelnau, Bruno had great admiration because of her "judgement, wisdom, council and rule."

tion with divine nature which had been introduced by pedantry." In some trancelike experience, Bruno wished to unify through these "voices" the universe as reflected in the psyche "and thereby obtain the Magus' powers to live the life of the Egyptian priest in magical communion with nature."

And it is here that Frances Yates finds a link between Bruno and the Shakespeare texts where the English poet, rather than using the vacuous language of the pedants, searches for "significant" language with which, in Bruno's words, "to capture the voices of the gods." It warrants, she says, an entirely new approach to the relation between the two poets, both of whom subscribe to the same Hermetic philosophy championed by Dee.

In the works Bruno wrote in Italian during his stay in London, especially the *Cena delle ceneri* and the *Spaccio della bestia triumphante,* he preached a general reformation of the world based on a vision of nature achieved through Hermetic comtemplative exercises—a return to the magical metaphysical communion with other dimensions of consciousness, as practiced in Egypt. The basic theme of Bruno's *Spaccio* is the glorification of the magical religion of the ancient Egyptians, as described in Ficino's translation of the *Asclepius*. In his *De immenso,* Bruno attacked those who had destroyed this Egyptian religion, spreading instead cruelty, schism, evil customs, and contempt for the law. Like Ficino, Bruno picked up the gauntlet of the Renaissance magus in his stand for the dignity of man, for liberty, for toleration, for the right to say what he thought, irrespective of ideological censors.

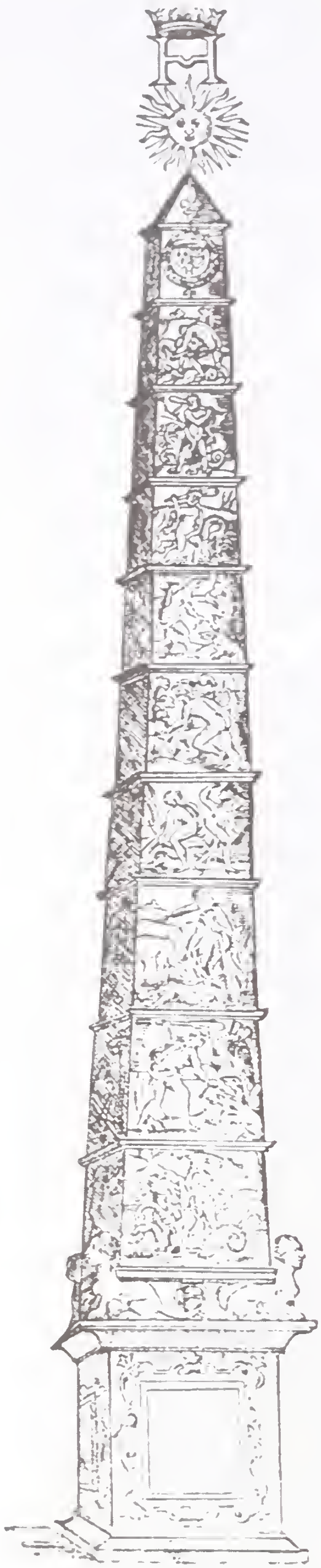
Bruno upheld the value of both "heroic" and "profane" love, as opposed to what the pedants had made of Christianity. For Bruno, all religious persecution, all war in the name of religion, broke the law of love. Varying the Renaissance theme of Platonic love treatises, Bruno opposed to profane love heroic love, or "frenzy" as he called it, pointing out that heroic love, as the Gnostics practiced it, had a divine object and led the soul in a gradual ascent from the sense world through intelligible objects toward the divinity.

As Yates sums it up, Bruno's fundamental ideal was a God-informed, God-governed universe, a universe embodying power, wisdom, and love, a universe essentially accessible to the human consciousness, partially now and progressively more so with the development of that consciousness. In a cabalistic sense, Bruno saw love as the living virtue in all things, one which the magician could intercept to lead him up from lower-level love to the supercelestial reality of divine love.

As for sexual love, far from condemning it, Bruno believed that man should make use of *all* his faculties. In an address to Philip Sidney he wrote: "It is not for me to oppose the sacred order of nature . . . God forbid that such a thought should ever enter my head . . . I never had a desire to become a eunuch. On the contrary I should be ashamed if I agreed to yield on that score were it only a hair to any man worth his salt in order to serve nature and God." Admitting that he had not managed to possess quite as many women as King Solomon, Bruno added that it had not been for lack of trying. And he did not believe in being tied down. "For I am certain that all the laces and tags that all present and future dealers in laces and tags have ever been able, or will be able, to plait or knot, even though they were aided by death itself, would not suffice for that purpose."

When Bruno left England, to resume his wanderings through Europe, he preached, as Yates notes, a kind of Egyptian Counterreformation, prophesying a return to Egyptianism in which the religious difficulties of the age would be dispelled. There would follow a moral reform with an emphasis on social good works and an ethic of social utility. Breaking with the Christianity of all the Churches, Bruno favored, as had the Gnostics, the Cathars, and the Albigeois, a purer religion which he considered the very essence of original Christianity.

The trouble, says Yates, is that by his rejection of orthodox Christianity and his enthusiastic adoption of Hermetic Egyptianisms, Bruno moved toward a form of



Obelisk raised for Henri IV on the occasion of his triumphant entry into Rouen in 1596.

magic which went beyond the mild "Christian" variety of Ficino, designed to reunite the soul with the deity. Bruno aspired to what she calls "a more medieval necromancy," one in which he wished to expand Ficino's magic into a full restoration of the magical religion of Hermes's *Asclepius,* a return, in Yates's eyes, to an old-style, frankly "demonic" conjuring. Hence the rub, as it had been for Ficino and Pico, and for Dee. The very heart of this magic (considered deadly dangerous by the Church) was not only the summoning into manifestation of spiritual entities, but the raising of consciousness to an ecstatic vision by means of sexual arousal, awakening the dormant serpent of fire. Somewhere Bruno appeared to have learned the secrets of Tantric sex.

In his *Opera Latine conscripta* he makes an attempt to outline a technique for controlling all emotions which is explicitly based on sexual attraction. And in *De vinculis in genere* he discusses "linking" through love or sexual attraction. As Yates cautiously remarks: "the problem can be put in terms of Eros." In the *Pimander,* in the Hermetic account of the creation of the magus man, this half-divine being came down to earth because he loved beautiful nature and was united to her in a passionate embrace.

But the world was not ready for Bruno's Egyptian Renaissance with its pagan love of nature—a nature in which man could find the image of a loving deity. Catholic and Protestant both turned on Bruno in disgust. In Wittenberg he was warned to leave town. From Marburg he was obliged to escape the malevolence of the rector of the university. In Helmstedt he was excommunicated from the Reformed Church. Frankfurt refused to let him lodge in the town, and the prior of the Carmelite convent, who did give him hospice, scathingly described him as "writing all day or walking up and down filled with fantastic meditations."

By this time Bruno had developed his life-long study of the art of memory into a technique for training the imagination into acting as the instrument for obtaining the magical power with which to communicate with "angels, demons, the effigies of stars, and the inner 'statues' of gods and goddesses in contact with celestial things." Here the hieroglyphs on the obelisks of Egypt took on a function as magical keys to another dimension. To Bruno the glyphs were symbols which, when imprinted on the memory through an imaginative effort, enabled man to recover knowledge of his true self, remember past lives, his spiritual essence, and become again one with the universe. But his opponents continued to dog him until in Zurich he received the invitation from an apparent support-

Henry IV (1553-1610), King of France and of Navarre, reared as a Protestant, only saved himself from the Massacre of Saint Bartholomew by announcing himself a Catholic. Returning to his faith he was excluded from succeeding Henry III, until he abjured his Protestantism and entered Paris in 1594. Excommunicated by Gregory XIV, he was assassinated by a Catholic fanatic, François Ravaillac.

Gregory XIII (Pope, 1572-85) joyfully receiving the severed head of Protestant leader Gaspard de Coligny, first victim of the Massacre of Saint Bartholomew, which Gregory celebrated in Rome with a festival of public thanksgiving

er, a young Venetian nobelman (Zuane, or Juan, or Giovanni Mocenigo), to visit Venice and there teach him the art of memory as well as any other magical tricks he might be able to impart, presumably Tantric and sexual.

Somewhat foolhardily Bruno agreed to return to Catholic Venice in 1591. Sixtus V, the city's old Inquisitor, had been dead a year, and the atmosphere appeared to have softened sufficiently for Francesco Patrizi's *Nova de universalis philosophia* to be published, containing a new edition of the Hermetica along with a dedication to the new pope, Gregory XIV (Nicolò Sfondrati, 1590-91), in which Patrizi urged the pontiff to have taught everywhere and especially in the schools of the Jesuits this peace-loving Hermetic religious philosophy. But Gregory, subservient to Philip II of Spain, was not that liberal, and replied by excommunicating the one sovereign in whom Bruno had put his faith as a potential Hermeticist, Henry IV of Navarre, who had projected a unified Christian Europe. Only Henry's eventual murder by an aspirant Jesuit was to put the quietus on another Nolan dream.

In Mocenigo's Venetian house, Bruno found his host's behavior peculiar. As impatient with ignorance as he was scornful of prejudice, Bruno argued with his pupil, and decided to return to Frankfurt, where his extraordinary work *De triplici minimo* had just been published, and where he wished to have more manuscripts put into print. Mocenigo, jealous that Bruno might impart his secret knowledge to others, threatened to have the ex-monk detained by the Holy Office—no idle threat, as Mocenigo had once been attached to the Venetian Inquisition.

That Mocenigo was looking for a way to trap his teacher is clear from the fact that he had collected from Bruno's works and conversations a mass of testimony bearing on his heretical beliefs, which he turned over to the Father Inquisitor of Venice. When Bruno continued to insist on leaving, Mocenigo had a band of toughs rouse him from sleep on May 23, 1592, and drag him to a Holy Office dungeon. Though he did not know it, for Bruno it was to be the end of freedom.

The Venetian procurator, Federico Contarini, explained to the doge that Bruno's crimes of heresy were most serious, "though he is otherwise one of the most excellent and rare talents that can be desired, and of exquisite doctrine and knowledge."

Brought before the Inquisition, Bruno made a confession of faith: "I presuppose an infinite universe, a work of infinite Divine Power, because I consider it unworthy of the Divine Power and Goodness to produce only this world when it could have created infinitely many worlds similar to our earth, which I understand along with Pythagoras, to be an orb similar to the moon, and the other planets and stars, inhabited worlds, the immesurable number of which, in infinite space, forms an endless universe." This statement alone, in direct contradiction to the concepts of Aristotle and Ptolemy, was considered by the officials of the Inquisition "altogether the most absurd of horrors" (*horrenda prosus absurdissima*), and was enough to condemn the prisoner as heretical.

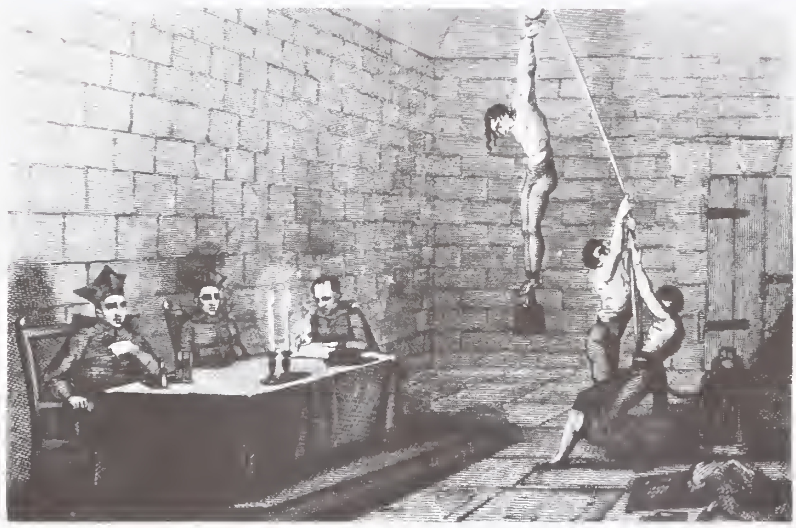
Cardinal Santaseverina, the Supreme Inquisitor of Rome, who had declared the massacre of St. Bartholomew "a glorious day, exceedingly agreeable to Catholics," ordered Bruno conveyed to the Holy See to stand trial before the supreme tribunal of the Inquisition, accused formally of heresy and of having composed various books in which he praised the queen of England and other heretical persons. Convinced that if he could reach the font of authority at the Holy See, he would eventually not only be understood, but even honored, and his writings accepted, Bruno seems to have welcomed the transfer to Rome.

In February 1593 he passed through the dungeons of the Roman Inquisition, where he was visited by his judges, the lord cardinals who cross-examined the prisoner on his heresies and interrogated him concerning his necessities. As a result, he was provided with a cloak, a pillow, and a copy of the *Summa* of Saint Thomas Aquinas. With no pen or paper on which to compose his defense or make use of his talent for writing, Bruno was left to rot, his verbal

The papal fortress of Sant'Angelo in which prisoners were tortured and interrogated. If required, their bodies could be dumped down secret chutes directly into the Tiber.

A victim being broken on the rack while being interrogated by Inquisitors

A victim's arms being dislocated by jerks on a pulley



petitions unheeded. Four slow years went by before the prisoner was again visited by the cardinals, in 1597. After another cross-examination and probable torture, they told him he would have to relinquish "his vanities concerning diverse worlds." On January 14, 1599, eight heretical propositions were extracted from Bruno's works and read aloud to him in prison. He was given six days in which to recant. When faced with a decision, Bruno said simply: "I ought not to recant; therefore I will not."

He agreed, however, to accept the personal decision of the pope as to whether his system of thought was or was not heretical; but he insisted on being allowed to defend his views in writing. Pen and paper were provided. In his "Memorial to the Pope," Bruno claimed that his opinions had been unadroitly excerpted from context by ministers of the Holy Office, that he was prepared to give an account of all his writings and defend them against any

Clement VIII (Pope 1592-1605), renowned for his piety, declared that it was sinful to accept the smallest degree of venereal pleasure, and that anyone should be denounced to the Inquisition who maintained that kissing, touching, and embracing for the sake of sexual pleasure were not grievous sins. The sexual act had already been declared sinful in itself by Saint Augustine, as "the essence of original sin was the concupiscence which accompanied the act of generation." Priests were given explicit instructions on how to punish sexual infractions of all imaginable sorts. A raped girl could douche herself only during the first ten hours, or risk Hell. Once conception had taken place, she could do nothing. A man was not to masturbate even to produce sperm for a doctor; both would be commiting a deadly sin.

Francesco Romolo Bellarmino (1542-1621) entered the Society of Jesus in 1560 and was made a cardinal in 1599. As a consultant to the Holy Office (or Inquisition) he took a prominent part in the first examination of Galileo's "heretical" writings. A strong supporter of the Jesuits at the Vatican, Bellarmino came to be considered the greatest Roman Catholic controversialist of his day.

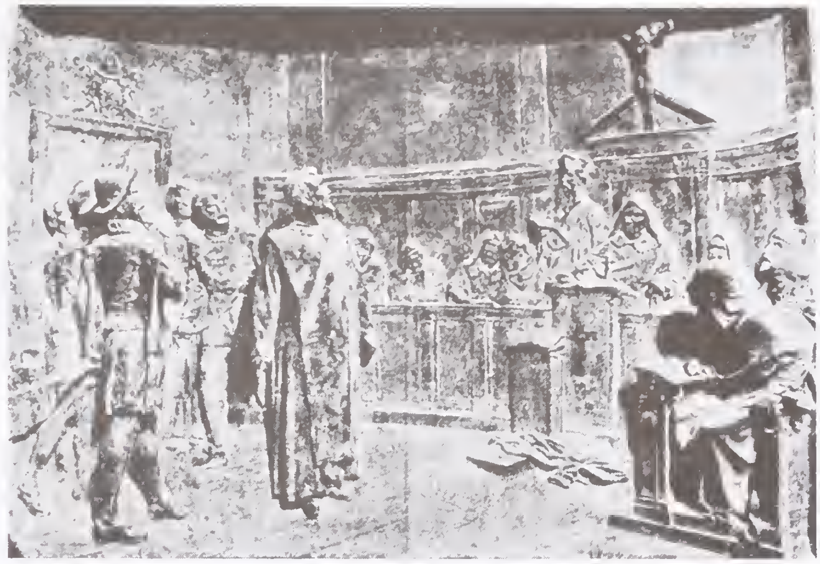
theologian. However, he would only abide by the opinion of the pope concerning things said or written by him, or by sacred canons if it should be proved there was anything in his writings or sayings contrary to them. Bruno further declared that if the Apostolic See and His Holiness definitely declared his eight propositions to be heretical, if His Holiness knew them to be so, or by the power of the Holy Spirit declared them to be so, then he was disposed to retract.

Along with the memorial went a long written defense of his position addressed to the new Pope, Clement VIII (Ippolito Aldobrandini, 1592-1605), who had succeeded Gregory XIV and had just ordered the beheading of Beatrice Cenci. But Clement, who has been described by the French author R. Gagey as "more audacious than Boniface VIII, more dominating than Sixtus V, and more perfidious than Alexander VI," was not even going to see Bruno's paper. On January 20, 1600, Bruno's "Memorial to the Pope" was opened by the Inquisition, but was apparently not passed on to the pontiff.

On February 4, Clement decreed before a full Congregation of Cardinals that if Bruno recognized his propositions as heretical, well and good; if not, he was to be condemned after forty days "to the treatment usual for impenitent and pertinacious persons." At his final trial, Bruno was pathetically certain that if only he could make his judges understand what he had to say, they would welcome his philosophy. In the great hall of the consistory with its baroque gilding and its damask hangings, Bruno knelt, pale, thin, while the judges remained obdurate and negative, especially Cardinal Bellarmine, who for twenty years embodied the Curia's opposition to science, and now did his best to secure a condemnation. After a short delay, the inquisitional notary pronounced sentence of death upon Bruno, ordering him turned over to the civil authorities for execution. Bruno heard the fatal words, unflinchingly, then rose and in a clear voice replied: "It may be that you fear more to deliver this judgement, than do I to hear it."

On February 8, the condemned man was subjected to the demeaning ritual of deconsecration of a former monk, and transferred from the ecclesiastical to the secular arm of the law with the cynical request that he be punished "as mercifully as possible and without shedding of blood"—the Church's sophistical formula for being burned alive at the stake. Locked in the Tor di Nona jail, near Sixtus's new bridge across the Tiber, Bruno awaited execution. As Rome at that time was full of Catholic

Bruno rebutting his judges in the Court of the Inquisition



pilgrims from all countries, the Inquisition prepared a monstrous spectacle for the occasion. Faggots were stacked around a stake in front of Pompey's theater in the Campo dei Fiori.

Early on the morning of February 17, Bruno was made to attend mass in the prison chapel and then fed a frugal breakfast of sweetmeats and wine from Ischia, so as not to faint on the way to the scaffold. At last the ghastly procession started from the prison of the Inquisition, as Bruno was led out through a jeering, leering crowd of Catholics come to see a "Lutheran" heretic meet his deserved doom. Accompanying the victim were the hooded Brothers of the Holy Sepulcher, chanting a lugubrious litany, and sardonically carrying green candles to symbolize the three theological virtues: the wick for faith; the wax for hope; the flame for charity.

Rome's Campo dei Fiori, or Field of Flowers, where Bruno met his death

Bruno given to the flames

With a firm step Bruno mounted the *patibolum,* consoling himself no doubt with his own gnostic dictum: "He who still fears for his life has not yet made himself one with the godhead." An eyewitness described the victim being bound to the stake, around which wood was piled. As the fires were lit, the "mystical poet, whose love encompassed the entire universe," turned his head from the proffered consolation of a crucifix and delivered his final words: "I die a martyr, willingly."

Bruno's body was burned and his ashes scattered to the winds so that not a trace be left on earth of any of his corporeal shell. But, judged from his own words, death to Bruno was only a slightly greater change than takes place every day in our bodies, in no way a diminution of life, but an exaltation of it: "We suffer a perpetual transmutation, whereby we receive a perpetual flow of fresh atoms, while those that we have received are leaving us." In his *Cabala del Cavallo Pegaseo* Bruno had openly accepted the reality of reincarnation, a tenet condemned by the Church since the Council of Nicea.

The Church, not satisfied with killing its victim, set about ruining his reputation, both as a thinker and as a man. All of Bruno's works were placed on the Index of forbidden reading; as many as possible were burned. For two hundred years Bruno's reputation for atheism, impiety, and misconduct was such that his writings were completely taboo, not only among Catholics, but even among Protestants. As late as 1830 they were forbidden to be shown in the public library of Dresden. Many were lost or remained unknown in archives of the Inquisition. Of those known to exist, no complete or reasonably accurate edition was published for more than two centuries. Yet the Hermetic tradition continued, and sensitive souls became aware of the magnitude of Bruno's contribution to philosophy. Through his intuition and vision he had anticipated a number of ideas which others in later centuries were to adopt and develop on the basis of more solid evidence.

The doctrine of evolution, the progressive development of nature, an idea unknown to classical philosophy, was first pronounced by Bruno, not vaguely or partially: he extended its laws to the inorganic as well as the organic world, maintaining that unbroken line of evolution from matter to man which only modern science later began to recognize.

In a number of ways Bruno's cosmology anticipated the conception of the universe as it was to be developed by modern physics and astronomy. In her recent thesis on Bruno, Dr. Ksenija Atanasijevic says: "Bruno's contribution to the development of subsequent philosophy and modern astronomy is beyond proper evaluation not only in terms of his conception of the infinity of the universe; with his comprehensively conceived and elaborately argued doctrine of the triple minimum he is also one of the leading forerunners of later monadology, atomism and the teachings about the discontinuity of space, time, motion, and geometrical bodies. . . . Bruno laid the firm foundations upon which was to rise, in the course of time, the magnificent edifice of new atomic science."

And she concludes: "By pointing out the complexity and non-uniformity of the ultimate parts of substance, Bruno revealed not only the unfailing correctness of his intuition but also the whole depth of his philosophical mind and thus became the illuminated precurser of later atomists and monadologists as well as the founder of geometrical finitism."

Philosophically, what Bruno died for was the belief that man could stand again "under the faithful guidance of the eye of the divine intelligence," and, with the powers within him, by the gnostic ascent, recover his knowledge of an infinite god in an infinite universe, a divinity, as Bruno reminded his audience, not far distant, but within us, its center everywhere, its circumference nowhere.

Holy Mountain of Initiation

5. SUB ROSA CRUCIS

With the death of Elizabeth of England in 1603, there was no monarch left to guarantee an original or outspoken thinker or follower of the Hermetic Egyptian wisdom preached by Bruno; so it went underground to be pursued *sub rosa*. Francis Bacon and John Dee ran into trouble with Elizabeth's successor James I, and in Bohemia, Rudolph II was forced by the Jesuit spearhead of the Counter Reformation to flee his ideal Hermetic court at Prague, leaving his library and laboratory to be sacked and destroyed. As Yates points out, the Egyptian philosophy, freely debated in the fifteenth century, struggling for supremacy in the sixteenth, was relegated, in the seventeenth, to the care of a minority of hidden initiates: the Rosicrucians.

Francis Bacon, Baron Verulam, and Viscount St. Albans (1561-1626?). Philosopher and statesman, lord chancellor of England, formulated and proclaimed the inductive method of modern science in opposition to the *a priori* method of scholasticism, the official philosophy of the Roman Catholic Church.

To perpetuate the Egyptian heritage as outlined by Ficino, Pico, Dee, and Bruno, there sprang up in the German states, or was revived there, a restricted society of conspirators announcing themselves to the world as the Brothers of the Rosy Cross. Pamphlets detailing their tenets appeared from secret presses, known as the *Fama Fraternitatis,* the *Confessio Fraternitas,* and *The Chemical Wedding of Christian Rosenkreutz.* Considering themselves good Christians, the brothers addressed the intelligentsia, warning against egotism and materialist covetousness, suggesting that it is man, not the Creator, who causes the bloodshed which ravages the world.

Johann Valentin Andreae

Some occultists would have it that Francis Bacon, as the reincarnation of Christian Rosenkreutz, reconstituted the fraternity in England whence he took it to Germany after a faked death, to reappear as Johann Valentin Andreae, presumed author of the three Rosicrucian manifestos. What actually happened has not been resolved historically. It is certain, though, that Bacon was involved with the brotherhood, which aimed to revive and spread throughout Europe and the world the wisdom of Hermes Trismegistus. Overtly in his *Advancement of Learning,* written shortly after Elizabeth's death, and in *Novum Organum* fifteen years later, Bacon professes the ideal of a reconstruction of science. In his "posthumous" *New Atlantis,* he sets forth the dream of an equally ideal religion and scientific society, and promises more, cryptically hinting on the title page that *"Tempora patet occulta veritas,"* or "with time, the hidden truth will out."

Christian Rosenkreutz, legendary founder of the Brotherhood of the Rosy Cross, is said to have traveled to Damascus, city of 300 mosques, to read the sacred books of the Sufis and acquire the wisdom of a mystic and cabalist. In Fez, with its 600 fountains, he went to learn magic from a school of astrologers, and how to communicate with elementals so as to govern the hidden forces of nature and open access to the realm of angels. Back in Germany with the mysterious book of *"M,"* he is reputed to have founded a brotherhood, originally inspired by Thothmes III, to give to European society the light and knowledge of the mysteries of Egypt, and so spread the doctrine of tolerance and the brotherhood of man. The Brothers' tenet that through love it was possible to be reabsorbed into the divine essence begat such virulent opposition it obliged the Brothers to go underground, communicating thereafter through allegory and cipher.

The *Chemical Wedding of Christian Rosenkreutz,* an Hermetic fantasy, suggested that real alchemy deals not with the transmutation of base metals into gold, but with regenerating the human soul. Its attribution to Johann Valentin Andreae is contested on the grounds that he would have been a mere boy at the time of its appearance; a more likely author is believed by occultists to be Francis Bacon.

The *Fama fraternitatis* recounts in allegory the rediscovery of an ancient philosophy, related to medicine and healing, the revelation of which would bring about a general reformation and advancement of learning leading man to an understanding of his true nobility and worth. In terms similar to those of Dee, Bruno, Ficino, and their antecedents, the Brothers of the Rosy Cross called upon the learned and the great of Europe to support them in a quest for a deeper understanding of nature, urging the world to desert the false philosophical teachings of Aristotle and the popes, and abandon the false medicine of Galen. The objective of the Brothers is de-

The Rosicrucian program was to reconcile Christianity with science, a program to be carried out by an elite of the wise, leading to a regeneration of religion and society. The intent was to revive what they considered to have been original Christianity, along with the healing talents of the therapeut and the Egyptian magical communion with spirits, plus the technique of the alchemist, in whose philosopher's stone they saw tne human heart, transmutable into a golden light. In nature, the Rosicrucian saw all around him the hieroglyphic symbols of divinity, crying out to be deciphered—the same nature, extolled by Bruno, in which he preached that all that there is to be known can be read.

But the Counter Reformation, spearheaded by the Jesuits, was in full swing. Reaction from Rome was violent: the Hapsburg-Jesuit alliance was on the point of achieving a universal victory of Catholicism over the Reformed Churches, loosing a fresh wave of persecution across Europe. As Catholics gained the upper hand, sorcerers and magicians were again burned by the thousand. Libraries of rare books and manuscripts were pillaged and given to the flames. It got so bad that the Rosicrucian Brothers issued a poster announcing they were leaving the fray to retire to Tibet. Whether they did or not, the Hermetic wisdom of Egypt disappeared from sight to find temporary succor with the strangest of foster mothers: the very organization devoted to its destruction: Ignatius Loyola's Society of Jesus.

Just as the French Jesuit François Garasse was accusing the Rosicrucians in 1623 of being wicked sorcerers, dangerous to religion and the state, "witch-like characters belonging to a diabolical secret society who should be broken on the wheel or hanged on the gallows," a twenty-year-old postulant Jesuit, Athanasius Kircher, unaccountably found himself holding the torch of Hermes. Asked to find a book in the library of the German Jesuit college in which he was a probationer, Kircher accidentally put his hand to Hans Georg Hörwarth von Hohenburg's *Thesaurus* with its illustrations of the hieroglyphs on the obelisks erected in Rome by Sixtus V. The magic of the obelisks had its instant effect. "My curiosity," said Kircher, "was aroused, and I began to speculate on the meaning of these mysterious glyphs."

But another flare-up of religious intolerance—the Thirty Years' War—cut short his speculations. As a Jesuit, Kircher found himself pursued by angry Protestants. Forced to flee Germany, he swam across the icy Rhine, nearly getting himself hanged by a Protestant patrol, but scribed as the liberation of humanity from ignorance, disease, and poverty. Their hope was to bring about a spiritual awakening of society, to extend human faculties beyond the physical plane into what would later be described as the "etheric, astral and spiritual worlds," reaching up to a transcendental plane of illumination.

Father Athanasius Kircher, S.J.

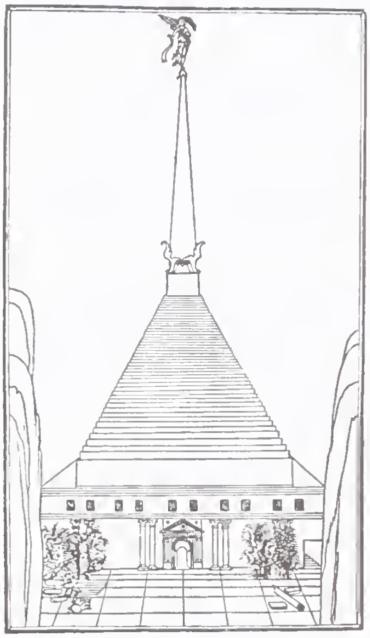
Nicholas Claude de Peiresc

eventually managing to find refuge in the papal city of Avignon, where he was able to continue his passion for obelisks and hieroglyphs by teaching mathematics and biblical languages in the local Jesuit college, cuckooing the wisdom of Hermes into the very organization designed to destroy it.

In those days, material on ancient Egypt was almost nonexistent; but fate propelled Kircher to a remarkable source in the nearby city of Aix-en-Provence, in the house of one of the most erudite and wealthy of antiquarian collectors, Nicholas Claude Fabri de Peiresc, a humanist and amateur scientist, a friend and correspondent of Galileo, who had found and brought back from his travels in Egypt a long roll of papyrus, discovered in a box at the foot of a mummy, whose hieroglyphs he hoped Kircher might help him decipher. Also in Peiresc's collection were several manuscripts never before seen in Europe, written in Coptic, the language of the Christian descendants of the Ptolemaic Egyptians, mostly biblical translations and lives of the saints. Spelled with an ordinary Greek alphabet—supplemented by seven special characters—the Coptic language had become virtually extinct since the Arab conquest of Egypt in the sixth century, except for its use in Upper Egypt in liturgical ceremonies. But Kircher was convinced that a study of this late-Egyptian language might give him a lead to the decipherment of the Egyptian hieroglyphs.

Kircher also found a rare manuscript attributed to the Arab author Rabbi Brachis Apenephius, which purported to give a method for interpreting the glyphs. But just as the young Jesuit was progressing in his study of Coptic, he

Cavalier Bernini



A Rosicrucian clue to Tantra, in which Poliphilo, in his dream of love, is led by a nymph to an agape, or orgy of love, and thence to witness an ancient rite dedicated to the phallic god Priapus, said to be the son of Hermes. Poliphilo also attends the nuptial rites of two ancient androgynous Roman deities, Vertunno and Pomona, indicating, according to Cesare Ambesi, the marriage of cosmic and telluric forces which, together, bring forth life on the planet, a mechanism admirably detailed by the modern Rosicrucian Rudolf Steiner. To Ambesi, Colonna's extraordinary poem links all the

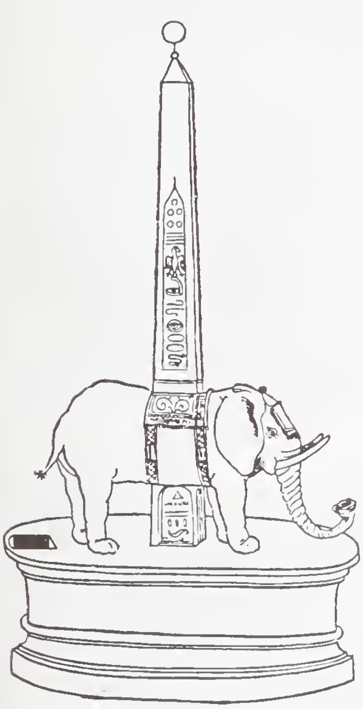
received orders from Rome to replace Johann Keppler as mathematician to the anti-Protestant Holy Roman Emperor Ferdinand II at the court of Vienna. It was an unwelcome assignment; it meant giving up his Egyptological studies. Fortunately for Kircher, Peiresc was on good enough terms with Urban VIII (Matteo Barberini), to have the pope countermand the order—which turned out to be welcome news also to the pope's nephew, Cardinal Francesco Barberini, who had just brought to his palace gardens an obelisk which had been found in the vineyard of certain Saccoccia brothers outside the Porta Maggiore in what had once been Heliogabalus's old circus. The cardinal was anxious to have Kircher come to Rome to see if he could fathom its hieroglyphs, and help him raise the 12-meter obelisk on a stone elephant as designed by his favorite baroque architect, Giovanni Lorenzo Bernini.

According to historian Cesare d'Onofrio, what may have suggested the idea of the elephant was nothing more hermetic than the recent arrival in Rome of a pachyderm for a sideshow to entertain curious Romans who had not seen such an animal since the king of Portugal had sent one as a present to Pope Leo X almost a century earlier. But New York's art historian William S. Heckscher in a fascinatingly erudite article on *Bernini's Elephant and Obelisk* in The Art Bulletin, of June 1973, thinks Bernini got the idea from a sketch which appeared in Francesco Colonna's *Hypnerotomachia Poliphili,* or *The Strife of Love on a Dreame,* originally published in Venice in 1499, translated into Elizabethan English in 1598, and into French in 1600. If so, both Bernini and Kircher were dealing with the subtlest of Rosicrucian symbolism. As analyzed by Alberto Cesare Ambesi in *I Rosa Croce,* Colonna's work "marks the true birth of the Rosy Cross, but in code," or what Italian philosopher Benedetto Croce calls "a language which intentionally suggests and underlines another more effective one." Like Dante's *Divine Comedy,* the tale starts with the hero lost in the woods. Asleep in a valley Poliphilo dreams of an elephant with an obelisk on his back and of another taller obelisk rising from a stepped pyramid, surmounted by a winged nymph. Into this obelisk Poliphilo is led by Cupid for initiation into the mysteries of love and life.

Bernini made several *bozzetti* for an obelisk atop an elephant, but for reasons that are unclear the project was dropped by the cardinal who set Kircher to transcribing the hieroglyphs from the broken pieces of obelisk lying in the garden of his palace in the hope that a translation might divulge their hidden meaning.

The obelisk in Palazzo Barberini

previous esoteric literature of the Middle Ages, including that of the Templars and Dante's *Faithful in Love,* to the future texts of the Rosicrucians, marking the true beginning of the fraternity. In the poem, Eros is the love force which moves the sun and the stars; and lovemaking between humans is associated with the power that makes for the growth of crystals, and the levitating force of trees toward the sun. The depicted obelisks represent access to superhuman states of consciousness, and the cornucopia held by the winged creature atop the obelisk is a symbol of the abundance that flows from the conquest of angelic states, leading to deeper esoteric levels of Sufi wisdom, the seven inner levels that must be conquered to become one with an occult sun.



Of assistance to Kircher in this puzzling assignment was a Roman patrician, Pietro della Valle, who had acquired in Egypt a unique manuscript in the form of a Coptic-Arabic dictionary. Kircher, with his knowledge of Arabic, soon found that Coptic differed decidedly from Hebrew, Chaldean, Syrian, Ethiopian, Armenian, and Samaritan, which further encouraged him to believe he was on the track of the enigmatic language of the ancient Egyptians.

At the Collegio Romano, a model university where the Jesuits trained their most talented scholars, Kircher was given the chair of mathematics, vacated by Father Christoforo Schein, who had been sent to Vienna in his stead. But it was a sad time for science: Lucilio Vanini, a brilliant young free-thinking teacher, who claimed that nature should be worshiped as the source of all things, was condemned for atheism. On his way to the scaffold to be burned he said: "Let us go joyfully to die, as becomes a philosopher." His tongue was forced from his mouth and severed by the executioner's knife. The ex-Dominican philosopher Tommaso Campanella, author of the splendid *City of the Sun,* with its ideal society, reflective of Bruno's admiration for the ancient Egyptians, had been kept in prison twenty-seven years, and frequently tortured—despite his having performed salutary magic for Urban VIII—and only escaped execution by pretending to be mad. Peiresc's friend Galileo had just been condemned by the Inquisition, and the Congregation of Cardinals in Rome, prodded by Bruno's nemesis Cardinal Bellarmine, prohibited the printing, reading, or possession of the works of Descartes. Even Jesuits were not immune from persecution, and Father Friederich von Spee was imprisoned for writing in his *Cantio criminalis* against the torture of witches, and only just escaped with his life.

Kircher, who was inclined to side with Galileo on the Copernican theory, took care to deny such an opinion, fearing the fate of Bruno, Vanini, and Campanella. Publicly he declared: "In case we seem to assert anything contrary to the decrees and instructions of the Holy Roman Church, we declare that we deny both the idea of the mobility of the earth, and of the inhabitants of the other heavenly globes." Hard to swallow, for an astronomer of his caliber.

To keep well out of trouble, Kircher plunged deeper into the study of Coptic. By 1636 he had produced his first book, *Prodromus Copticus sive Aegyptiacus,* in which he attempted an interpretation of hieroglyphs, which he explained as a symbolic system for expressing the theological teachings of the Egyptians. Publication of the book caused a stir among patrons of the arts wealthy enough to acquire it. Fascinated by Egyptian antiquities, Kircher's patrons knew little or nothing about Egypt other than from the fragments passed on to them in the Renaissance from Greek and Roman authors. Next, Kircher produced *Lingua Aegyptica restituta,* or *The Language of Egypt Restored,* which in no way delivered what it implied, though it contained della Valle's Coptic-Arabic dictionary, slightly updated.

From his reading of the classics and the Neoplatonists of the Renaissance, Kircher was convinced that the temples of ancient Egypt incorporated not only the cosmology of the ancients, but their system of physics. In 1639 he sent to Egypt a young man, Tito Livio Burattini, to measure the Great Pyramid of Cheops, inside and out, to see if he could find in its dimensions a figure for the circumference of the earth, as had been correctly suggested by the Milanese mathematician and astrologer Girolamo Cardano. Excitedly Kircher awaited Burattini's return with the careful measurements he had made as well as meticulous copies of many hieroglyphic texts taken from temples and obelisks. But Burattini was seized by bandits on his way back to Rome through the Balkans, and his invaluable manuscripts were scattered and destroyed. This left Kircher with nothing to go on but the few letters with data which Burattini had managed to send from Egypt.

Kircher's reconstruction of ancient alphabets, leading to his understanding of Coptic

For Kircher to do better, he needed more hieroglyphs, hence more obelisks. His opportunity came in 1644 with the death of Pope Urban VIII and the enthronement of Innocent X (Giambattista Pamfili). In a field along the old Appian Way, in what had once been the circus of the emperor Maxentius, four broken pieces of an obelisk

The Circus of Maxentius, with its broken obelisk, etched by du Perac in 1575
The fertility gods Ceres and Consus appeared at the end of Roman circuses, and recently excavated pre-Roman Etruscan tombs show chariots in a circus racing around conical obelisks.

surfaced from the area where they had been originally raised by the emperor Domitian late in the first century A.D. What better monument, Kircher reasoned, than to raise this obelisk in honor of Innocent X? The product of an old Umbrian family which had settled in Rome in the fifteenth century, the new pope was anxious to embellish the front of the house where he had been born and which his widowed sister-in-law and "confidante," Donna Olimpia Maidalchini, had begun refurbishing into a princely palace with the help of papal funds. Appropriately, it overlooked the oblong Piazza Navona, which had once been the stadium of Domitian, and earlier still, even more appropriately, one of the circuses attributed to the founders Rome, called by them *Agona,* site of the large *Ago,* or needle.

To Kircher's suggestion, the pope replied: "Father, we have decided to raise up this obelisk of no small bulk. It will be your task to work out the meaning of the inscriptions that are on it. We would like you, therefore, since you have been endowed by God with such gifts, to give yourself wholeheartedly to the task, doing all you can so that those who are amazed by the bulk of this great obelisk may come, through your endeavors, to understand the secret meaning of the inscriptions."

A committee was formed with Father Kircher as field director to excavate the obelisk from the ancient circus; but it was soon discovered that several pieces were missing from the fractured monolith, most of which appeared to be in the hands of local antiquarians. When it became known that the pope wanted the missing fragments restored, those who disliked or were jealous of Kircher decided to withhold the fragments to see if the Jesuit was canny enough to correctly fill in the vacant spaces with substitutes of his own creation.

The result, according to Kircher, was to vindicate his understanding of the subject. "Through the illumination God gave me, all unworthy though I was, I so formed the figures on the obelisk . . . that they fitted in perfectly with what was there already and in no way differed from those which were on the actual missing pieces. They were all amazed and could think of no explanation to my skill except that the Holy Spirit had given me the key to the inscriptions." Later "experts," less convinced, scoffed at Kircher for the folly of such presumption, though they could do no better.

Next came the problem of raising the obelisk. As no one had put one up since Fontana, models were requested from several leading architects, including Bernini's rival Francisco Borromini, who succeeded in obtaining the commission by submitting a pretty but banal sketch. Bernini, who had fallen out of grace with the Vatican since the death of his patron Urban VIII, was outraged, yet determined, with the help of his protector, Prince Niccolò Ludovisi, nephew of Pope Gregory XV, to steal the commission. As a stratagem, Bernini cast his model in solid silver and donated it as a bribe to the voraciously avid Donna Olimpia, with the proviso that it be placed in her house where her brother-in-law the pope would be bound to see it during one of his visits—regular enough to cause rumors of a more than brotherly attachment.

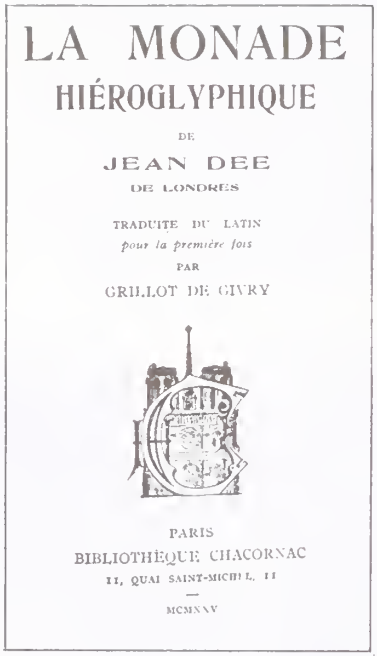
Arriving for lunch on the Feast of the Annunciation, after a hearty morning ride, Innocent was so struck by Bernini's model that he immediately gave him the commission with the quip: "To avoid a Bernini project, one must simply not see it."

Borromini's sketch for the Piazza Navona obelisk

The architect's grandiose project to erect a relatively short obelisk high above the piazza on a stunning baroque fountain was not cheap. Money for the job had to be raised through a special tax imposed on all the citizens of Rome, which hit the poorest, cutting down their bread. Bitterness was expressed in lampoons and pasquinades, the most savage of which were directed against the pope's sister-in-law, who was rightly suspected of being behind the scheme to glorify her brother's family. Much scurrilous play was made of her name, which lent itself to being fractioned into *olim pia,* Latin for "once virtuous," implying, as have several historians, a sexual relation with the pope. Every night as the great fragments of stone were left to rest along the streets of Rome on their slow way from the Via Appia to the Piazza Navona, there were cries of *"pane, pane, non fontane."* Anonymous hands attached to the obelisk placards, one of which played on words from the Bible: "If only these stones would turn to bread!"

But once the great phallus was raised, Romans consoled themselves with the gush of delicious *acqua vergine,* the best water in Rome, which issued from Bernini's fountain symbolizing the four great rivers of the world—the Ganges, the Amazon, the Danube, and the Nile, the last discreetly represented by a figure with its eyes covered because the river's source was unknown. Jokes were soon forthcoming about how the sculpted blackamoor representing the river Ganges was holding up his hand not in awe of the great obelisk, but for fear that the façade to Borromini's Church of Santa Teresa, which forms a backdrop to the fountain, was so badly built it would fall on his head.

That the obelisk had been raised with no significance other than to honor the Pamfili family, was clear to all. To resolve any doubts, an inscription was placed on the base spelling out the Pamfili emblems: "Above the noxious Egyptian monstrosities [the heiroglyphs] rests the innocent dove, wreathed in lilies of virtue, offering the olive branch of peace." The dove triumphant was to symbolize not the Holy Ghost but Innocent X Pamfili. Bernini, driving past his opus, is said to have drawn the curtains to his carriage with the remark: "How ashamed I am of such bad work."



LA MONADE
HIÉROGLYPHIQUE
DE
JEAN DEE
DE LONDRES
TRADUITE DU LATIN
pour la première fois
PAR
GRILLOT DE GIVRY

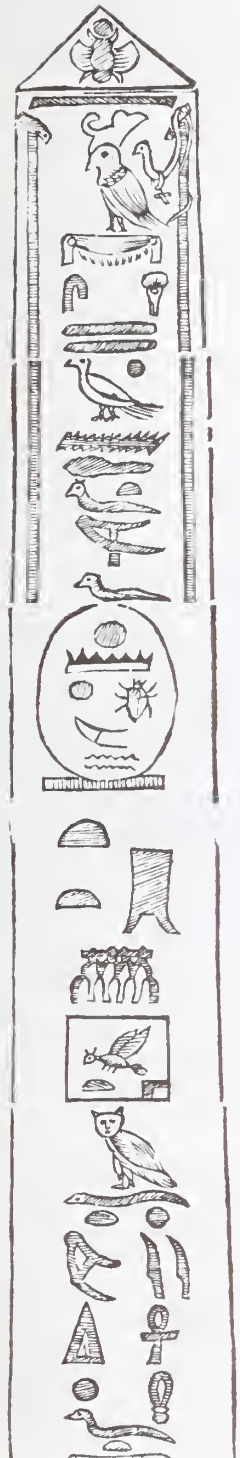
PARIS
BIBLIOTHÈQUE CHACORNAC
11, QUAI SAINT-MICHEL, 11
—
MCMXXV

Dee's *Monas hieroglyphica,* which Frances Yates considers to be at the heart of the Rosicrucian mystery, deals with the mathematical properties of symbols—a subject as close to Kircher's heart as it had been to Dee's. Like Bruno, Dee pursued a philosophy of nature "which sought the divine meaning of the hieroglyphic characters written by God into the universe." And like Bacon, Dee presaged a scientific era in which man would compel nature to unleash forces to serve him to an extent undreamed of. Dee's notion that man could use numbers to achieve fantastic magical results is all too apparent in what passes for modern science, whose proponents, unlike Dee, do not appear to have been initiated into the secrets of alchemy and its great work of *spiritual* transformation.

Innocent X celebrated the raising of the obelisk by asking Kircher to publish an account of the entire proceedings, which gave Kircher the chance to put into print in some five hundred pages his attitude toward Egyptological problems in general, and hieroglyphs in particular. Entitled *Obeliscus Pamphilis,* and adorned with elaborate prints, only its second part treated of the obelisk in the Piazza Navona. The first part included an excursus on John Dee's *Monas* glyph, which Kircher connected with the Egyptian ankh, or symbol of life, and which he interpreted as a symbol of the ascendency of spirit over matter.

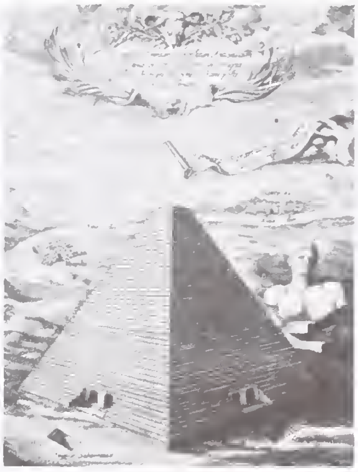
Delving into the arcane and the cabalistic, Kircher's fundamental thesis about the hieroglyphs was a reiteration of the Hermetic tradition: the glyphs were not an ordinary system of writing but "a sacred instrument bequeathed by the gods to the Egyptians . . . enabling them to express their wisdom and the secrets of esoteric knowledge in symbolic pictures the meaning of which was directly revealed to initiates by divine inspiration." For Kircher, each inscription had a quadruple sense: "literal, figurative, allegorical and analogical, to express the same thing." As Erik Iversen puts it: "With an absolute confidence in the authority of his sources, and in the firm conviction that all leading metaphysicians of antiquity, Pythagoras and Plato as well as Plotinus and Iamblichus, had been directly influenced by Egyptian theology, Kircher had no doubt that his studies of their works combined with his knowledge of the Cabbala and the Hermetica, had given him a complete insight into what he considered Egyptian philosophy and thought."

With this as a premise, all that Kircher needed was to identify each hieroglyph with the basic Neoplatonic concept applied to it. The notion was genial. But despite his enormous erudition, his enthusiasm, and his almost superhuman industry, the results were inconclusive. Fortunately for Kircher, although at the time there was no one sufficiently equipped to confirm his argument, there was also no one equipped to refute it.



Kircher's translation of the glyphs on this Minervan obelisk deals with a supreme twofold spirit—the great Hemphta—whose generative powers infuse stars and sun to bring forth the bounties of life. In what sounds like a Tantric allusion, he calls the Left Hand of Nature "the Fount of Hecate."

Kircher next produced his *Oedipus Aegypticus,* a formidable work of almost two thousand pages, with numerous engravings, which appeared in four volumes between 1652 and 1654. New type had to be cast for the oriental languages he quoted, and for the Ethiopian, Chinese and Egyptian glyphs he reproduced. Expert printers and engravers had to be hired, which could only be done with the lavish patronage of the Holy Roman Emperor, the scholarly composer of music, raised by the Jesuits, Ferdinand III. In Iversen's words, Kircher, "as a modern Oedipus attempted to solve the riddle of the Egyptian Sphinx."



The Great Pyramid of Cheops as reconstructed by Kircher from Burattini's measurements

In the body of his *Oedipus,* Kircher came close to doing just that, defining a symbol as "the significant sign of a hidden mystery, whose nature is to lead one's mind through meditation on certain similarities to the comprehension of something much different from the thing presented to external senses, the nature of which can be said to be transcendent or hidden, as obscured by a veil." As an example he noted that the Egyptian scarab did not symbolize the actual sun but "the secret and mysterious operations of that body which foster growth and generation." In the body of his *Oedipus,* Kircher clarifies and explains the more important of his ideas relating to Egyptian language and antiquities, to their mathematics, mechanics, medicine, chemistry, theology, and magic. But the last part is largely a rehash of his earlier notions on hieroglyphs, the result of twenty years' study during which he consulted some three hundred ancient authors, including all the favorites of the Hermeticists.

Kircher said he regarded the Hebrews after Moses as betrayers of the Egyptian wisdom, perverting the Egyptian fertility cult into what he called crude phallic worship, and he objected to Islam because it promised a heaven of sex-fulfillment. Somewhat incongruously he also attacked the occult sciences of magic, alchemy, dowsing, divination by dreams, theurgy, and chiromancy, leading Joscelyn Godwin, in *Kircher, A Renaissance Man and the Quest for Lost Knowledge,* to wonder "whether his protestations are just a blind, enabling him to expound dangerous doctrines with impunity." Certain it is that in so doing, Kircher kept the ancient wisdom bubbling in an otherwise stagnant sludge of orthodoxy.

In his *Oedipus,* the obelisks of Rome are illustrated with glyphs that do not always resemble their originals all that closely. On the basis of Burattini's surviving tracings, Kircher was nevertheless able to add better reproductions from the two obelisks still standing in Alexandria and Heliopolis.

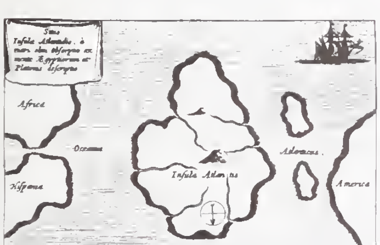
Kircher's method of decipherment was an identification of each glyph with its metaphysical idea. ‡ he identified with "generation"; ‡ with "force"; ‡ with "infernal"; ‡ with "supernal" or "celestial"; ‡ with "emanating from above." None, alas, was to be supported in the light of orthodox Egyptological deciphering. Yet intuitively Kircher sensed that though some of the glyphs represented ordinary material objects, they could also be used alphabetically as letters. The sign ‡ he correctly identified as "water," and went further, correctly, to suggest the phonetic value of *m,* with a reference to the Coptic word for water: *mu*. As Iversen writes: "It is Kircher's incontestable merit as the first to have determined the phonetic value of an Egyptian hieroglyph. Yet he remained more interested in the possible symbolism of the glyphs and the esoteric knowledge they might transmit."

In the *Oedipus,* Kircher follows Pico in comparing the glyphs of the Cabala with those of the Hermetica, and though he agrees with Ficino and Bruno about the magical power of the Egyptian cross, or ankh, he condemns cabalistic magic. Yet, in the end, he makes his Hermetic point by including Hermes's hymn from the *Pimander,* adding a hieroglyph enjoining silence and secrecy concerning these sublime doctrines—the colophon employed by the Brothers of the Rosy Cross!

The two human figures represent man surveying and measuring the planet, which is suspended by a chain to the hand of God. Sun and moon affect the twelve varying zephyrs of the cartographer's wind rose, clearly indicating Kircher's understanding of the Copernican notion of the earth spinning in the void around the sun, an earth whose circumference he correctly believed the Egyptians to have measured and incorporated into the Great Pyramid on the Ghiza plateau.

The year after the last volume of *Oedipus* appeared, the pompous and austere Innocent X died, to be succeeded by Alexander VII (Fabio Chigi), at last a philosopher and poet, who yet favored the Jesuits in general and Kircher in particular. A patron of the humanities, who had devoted his resources as cardinal to the promotion of art and science, the new pope was to embellish Saint Peter's basilica with Bernini's stunning baroque colonnade, and to offer Kircher a decade of undisturbed study in his favorite subjects, which were becoming more catholic—in the original sense of the word. Refreshingly, the new pontiff was an extraordinary anomaly: an Hermetic scholar who took a personal interest in Kircher's hieroglyphical studies, contributing generously to the publication of Kircher's many more works, and so, indirectly, to keeping alive the wisdom of Ficino, Pico, and their Thrice Great Master.

By climbing down the maw of erupting Vesuvius, and by exploring the famous "cave of the dog," whose volcanic fumes of carbon dioxide hovering along the ground would kill that animal, but leave a man unaffected, Kircher got involved in the mysteries of the world beneath the soil, which led to perhaps his most famous work, *Mundus subterraneus*. Fascinated with astronomy (on which subject he produced his *Iter extaticum*), Kircher was a firm believer in the influence of heavenly bodies on earthly happenings and phenomena. A student of Paracelsus, he mirrored the Swiss master's notions of a panspermia, or universal seed of all things, "a certain material spirit, or something made from the most subtle heavenly aura or from portions of the elements, a certain spiritous sulphurous-saline-mercurial vapor, the universal seed of things."



Kircher's Atlantis

Of the existence of Plato's Atlantis, Kircher had no doubt, placing it as a large island in the middle of the

Atlantic, about where the Azores now lie. On the art of consonance and dissonance Kircher wrote ten books in which are treated the whole doctrine and philosophy of sound, especially as applicable to philosophy, mathematics, physics, mechanics, medicine, politics, metaphysics, and theology. He gave numerous accounts of the curative powers of music, such as a melody to cure the bite of the tarantula and a tune to calm the frenzy of the mentally disturbed.

Frontispiece of *Ars magna lucis,* showing the light of the sun (depicted as Apollo) shining onto earth reflected by the moon (Diana), all emanating from *IHVH* surrounded by angels

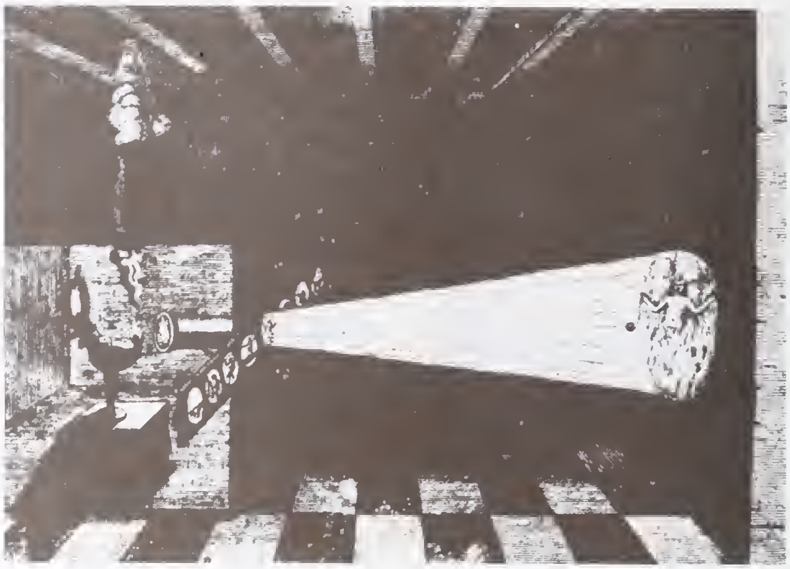


Illustration of a magic lantern as described by Kircher in his *Ars magna lucis*

In his *Ars magna lucis et umbrae,* a thousand-page analysis of the phenomena of light and shadow, Kircher included methods for designing and constructing sundials. He even built a great pyramidal sundial, and designed an *horologium catholicum,* or universal clock, ostensibly to mark the different time of day in the various Jesuit colleges scattered around the globe, but more specifically to help establish longitude. The idea was a development of Galileo's suggestion that the moment of some astronomical event, such as an eclipse of one of Jupiter's moons, could be predicted with the help of tables in some standard time related to a fixed degree of longitude, and that a person in some other part of the world, observing the same event in terms of local time, could readily calculate the longitude of the place from which the observation was being made. Kircher even devised a sort of calculating machine which he claimed provided practical results to various mathematical and scientific problems.

When he was shown the remains of the obelisk found in a cellar in the area of the old Campus Martius, Kircher suggested to Alexander VII that it be raised on the spot

That obelisks were involved with magnetic phenomena in the solar system was prophetically illustrated by Kircher in this sketch showing a large magnet in the central obelisk (symbolic of the sun) variously affecting magnets in the different-sized globes surrounding it.

where Augustus had used it as a great gnomon, or sundial. In his report to the pontiff, Kircher further suggested that the Vatican obelisk, which had been reraised by Fontana for Sixtus V, be similarly used as a sundial by the insertion of markers in the pavement of Saint Peter's Square. Both projects were more than Alexander VII, in a frail state of health, could face; but just before the death of the pope, Kircher found a way to repay his beloved patron by organizing for him an Hermetic monument in the form of a small but extraordinary obelisk raised by his old friend Bernini.

Some Dominican friars digging a new wall around their garden in the convent of Santa Maria Sopra Minerva, the ancient Roman dromos of Isis, had struck a pink granite obelisk buried about 15 palms beneath the surface. Alexander immediately appointed Kircher to head a committee to supervise the excavation of what turned out to be a short (5.5-meter) obelisk with remarkably well preserved hieroglyphs carved on all four of its sides.

Kircher's homage to the Hermeticist Pope Alexander VII

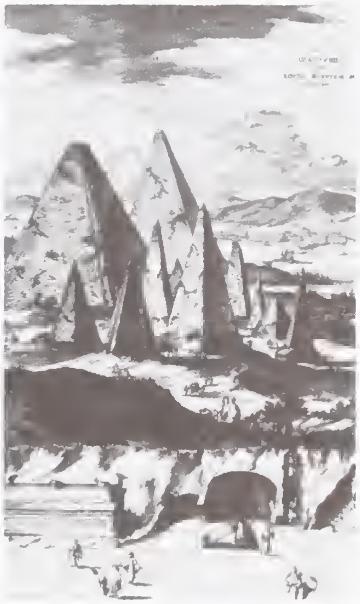
Kircher's reconstruction of the ancient Roman Iseum

Ironically, this monument to Isis (the Pallade Egizia of the Romans), erected on the site later dedicated to the pagan goddess of wisdom, Minerva (upon whom the Christians superimposed their Virgin Mary), was quickly seized by the Dominican fathers as their rightful property. They wished, they said, to raise it in the square before their church, on a base of six hillocks (symbols of the incumbent Chigi pope) surrounded by four dogs with torches in their mouths, a play on the words *domini cani,* or "hounds of the Lord," to indicate the bird-dog qualities of their order in ferreting out heresy. Alexander VII reluctantly gave in to the Dominicans' desire to have the trophy placed before their church, but vetoed their self-serving design, assigning Kirchner to see that this thoroughly Egyptian relic was more sensitively raised according to the old and clearly Hermetic design of the cavalier Bernini: that of an elephant with the obelisk on its back.

Just before the pope died, Kircher was further able to repay his beloved patron by underlining the Hermetic thought chiseled onto the base of the obelisk: "Oh you who here see transported by an elephant, the strongest of animals, the hieroglyphs of the wise Egyptians, heed this monument: to sustain solid wisdom, a robust mind is needed." All through the Middle Ages the elephant had been considered a wise and intelligent animal. In the works of Horapollo it was the glyph for a strong man in search of what is beneficial and essential. It was plain that the monument was specifically designed for Alexander VII, whose mind, despite his physical frailness, was considered strong enough to handle the Hermetic wisdom of Egypt. But the satirist Segardi, taking the symbolism one step further, used the fact that the elephant's rear end is turned toward the monastery of the Dominicans to compose the epigram *"Vertit terga elephas vertague proboscide clamat Kyriaci Frates Heid Vos Habeo"* or, in short, "Dominicans, you may kiss my arse!"

The Minervan obelisk facing away from the Dominican monastery

The Society of Jesus, founded in 1541 by Ignatius Loyola, adept, through the device of the spiritual retreat at conjuring visions to convince susceptible heretics to return to the Church, was to carry the standard of the Counter-Reformation. In a virtual state of war, Jesuits served as the military light horse of the church under the absolute orders of a general known as the "black pope," who was elected for life. Individual Jesuits were bound by a vow of personal obedience to both the "black" and "white" popes, ready to follow orders anywhere at any time, "manageable as a stick in his hand . . . unaffected as a corpse." A sacrifice of intellect to total obedience was considered "pleasing to God." Aware that the cause of the Reformation was the "ignorance, neglect and vicious lives of so many priests, especially in the higher ranks," Jesuits devoted their efforts to better education; and for three centuries were the best schoolmasters in Europe. By 1620 there were 20,000 Jesuits traveling to the ends of the earth, often suffering cruel martyrdom, dragging with them to death thousands of Christian converts. In Japan, when the Christianized women of the Shogun refused to perform in his harem, 250 churches were burned and 200,000 converts killed. Cardinal Bellarmine argued that since all authority derives from God, any Christian price forfeits his right to authority if his government contravenes the wishes of the Church. Subjects have no obligation to such a prince, and can take steps to remove him. The argument led to accusations of assassination against the Jesuits, including that of Henry IV. A spurious document, *Monita Secreta Societas Jesu,* purported to give secret instructions for acquiring power over princes and rich widows, and how to poison. Accused of becoming "the apostles of the rich and influential," Jesuits soon incurred universal hostility, especially from other members of the Church. In the course of the next century, the works of 27 Jesuits, including Bellarmine, were ordered burned by the common hangman. Another decree declared that Jesuit doctrines "contained the errors of Arius, Nestorius, Calvin, Luther, Wycliffe and Pelagius; that they were blasphemous, outrageous, and insulting to the Blessed Virgin and the saints; destructive to the divinity of Christ; favorable to Epicureans and Deists; encouraged murder and patricide, usury, vengeance and cruelty; threatened the safety of princes, and were in contradiction to the decisions of the Church, to the divine will, to peace and good order." The good fathers were accused of pederasty. In France, they gained the enmity of Madame de Pompadour by refusing her absolution while she remained the king's mistress, so she got Louis XV to expel them from France, and requested the pope to suppress the society. From Portugal they were expelled for purported complicity in the attempted assassination of King Joseph I. Clement XIII, in his eighty-second year, is said to have died of shock when requested by France, Portugal and Spain to dissolve the society. In a brief, *Dominus ac Redemptor,* in which he referred to the suppression of the Templars, Cardinal Ganganelli as Clement XIV declared the Society of Jesus extinguished, abolished, and abrogated forever, with all its houses, colleges, schools and hospitals. Its general, Lorenzo Ricci, was thrown into Castel Sant' Angelo where he died two years later. Many of the 22,000 disbanded Jesuits took refuge in Prussia and Russia where they were used by Frederick II and Catherine II as teachers for pupils whom they considered illiterate bores.



From the frontispiece of his *Sphinx mystagoga* it was clear that Kircher believe the wisdom of the world to have come from Egypt and to have been incorporated in its tombs, pyramids, and obelisks.

Times grew rougher for supporters of the Hermetic tradition. In England, Jesuits took advantage of the civil disorders which broke out after the death of Cromwell to intrude themselves among the Rosicrucians to pervert the order and cause its apparent disappearance. No longer protected by Alexander VII, Kircher gave up his jobs at the Collegio Romano, determined quietly to devote the rest of his life to archaeology and the solution of the riddle of the obelisks and their mysterious glyphs.

In an epoch when it was the fashion to search for unicorns and mermaids, and the Rosicrucian Elias Ashmole was organizing his antiquarian's museum at Oxford, one of Kircher's main interests became his own museum of rarities and oddities which he had collected to go along with his Egyptological curios. To these he added geological specimens, preserved birds, skeletons, mechanical models, as well as his own inventions, which included a variety of musical instruments, alchemical glassware, and microscopes. From all over the world Jesuits sent him donations such as rhinoceros horns, gold embroidered vests, girdles studded with rubies, idols, icons, and strange drugs. Soon he had an exhibition hall in the Collegio Romano 300 feet long with side galleries of curios such as the skeleton of a bird with three legs, and a monstrous 10-ounce stone removed from the bladder of his comrade Father Leo Sanctius. But the principal attraction remained his central exhibit of a range of Egyptian obelisks.

As Kircher's early work had dealt with the crucial but still mysterious force of magnetism, his last book describes his experiments with a microscope which could "amplify a fly into an elephant and a flea into a camel." In vinegar and milk he found innumerable "worms," which led him, well ahead of his time, to guess that the plague, of which no one knew the cause, might be propagated by tiny living organisms.

In November 1680, almost on the same day as his old friend Bernini, Kircher died in his seventy-ninth year, to be derided, ridiculed, and even questioned in his honesty. Ever since, he has been the whipping boy of Egyptology, though as Iversen says, "His devotion, his untiring enthusiasm, and his positive contributions have been disregarded by the science he sacrificed his life to further and to serve . . . an easy prey to egyptologists who have sacrificed his reputation for a witticism, mostly without having opened his books." A fair criticism, as the volumes are hard to come by, even in the very best libraries, and their thousands of Latin pages are still judiciously untranslated into any vernacular.

As Maristang notes, Kircher's life work, in its scope, went far beyond the limits of Egyptology, representing one of the last efforts to combine the totality of human knowledge in religion, philosophy, history, and science into a theological system, a universal cosmology based on the concepts and ideas of a Neoplatonized Christianity. Iversen, in sum, wonders if Kircher's conceptions of Egyptian religion and mythology, though undoubtedly fantastic and unhistorical, "are very much further from the truth than the sterile and lifeless waxworks to which the more sober, unmetaphysical methods of modern egyptology have reduced the Egyptian pantheon." From a humanistic as well as an intellectual point of view, he adds, "egyptology may very well be proud of having Kircher as its founder." Yet three hundred years were to pass before this remarkable scholar was given the credit he justly deserved for keeping alive the torch handed down to him from ancient Egypt.

Nothing, says Kircher, on the frontispiece of his *Ars magna sciendi,* is more beautiful than to know all.

Summoning a spirit

6. EGYPTIAN RITES OF MASONRY

Pius VI was lampooned for his vanity. When he added an eagle and a *fleur-de-lis* to his escutcheon of "two winds," the people of Rome suggested he restore the eagle to the empire and the lilies to the king of France, keeping for himself the "winds." Historian Jean François de Bourgoing said of him: "his prodigality and his taste for brilliant but expensive enterprises rendered him more odious than many princes who were really wicked." When an enormously expensive sacristy was added to Saint Peter's (at a cost to the people of 200,000 crowns) Pius added a plaque which read "What the public voice demanded, Pius VI completed." To which some Roman added: "You lie. The public was never consulted. Only your vanity."

The century which followed Kircher's, the so-called Age of Enlightenment, was to see a reversal in the fortunes of the religious contestants, bringing into play the destruction of the Society of Jesus and a flourishing of the Hermetic tradition in the ranks of all manner of Freemasonic orders, including their more secret organizers—the Rosicrucians and the Illuminati.

Two revolutions, one in America and one in France, ended the dogma of the divine rule of kings in favor of republican governments with the political and religious freedoms propagandized by Freemasons and eventually protected by the Bill of Rights. But despite the banishment of the Jesuits from most European countries, the popes, especially Pius VI, who was to reign longer than any previous pontiff, fought back. Opening his pontificate with an encyclical which forbade individual freedom of conscience, Pius VI, by the intransigence of his stand against political progress in France—which he was able to enforce by threatening with excommunication a weak and believing Louis XVI—became responsible, though perhaps unwittingly, for the abortion of an orderly evolution to constitutional government, bringing on instead a grossly radical revolution in which almost every value was drowned in the blood of the Terror.

The year before the American Declaration of Independence, the elevation to the seat of Saint Peter of Giovanni Braschi was greeted by the poor of Rome with foreboding and caustic pasquinades—those satirical notes clandestinely attached by wits to two mutilated statues known as Pasquino and Marforio, whose salty dialogue constituted an outlet for the pent-up misery of citizens. Ominously, Romans pointed out that any ruler with a six in his title had always brought disaster to the city. *"Semper sub sextis perdita Roma fuit,"* they lamented, thinking of Shakespeare's villainous and bloody Tarquinus Sextus, who deprived the city's poor of their arms and set them to slave work building great monuments, and of Urban VI, an intractable nepotist responsible for executing several cardinals and initiating the Great Schism which divided the Western Church for forty years, and of that unforgettable Spaniard, Alexander VI, the Borgia tyrant.

Nor were the poor of Rome happy with a pope who seemed determined not only to wage a war on "bad" books, but to revive the ostentatious splendor of the reign of Lorenzo the Magnificent's son, Leo X, at their expense, by diminishing their ration of bread—especially when he chose to rub salt in the wound by having engraved on the monuments he raised with their slave labor MUNIFICENTIA PII VI P.M., a practice which gave rise to such satires as the insertion of a reduced loaf of bread, engraved with the same papal inscription, into the hands of Pasquino.

Surrender at Yorktown

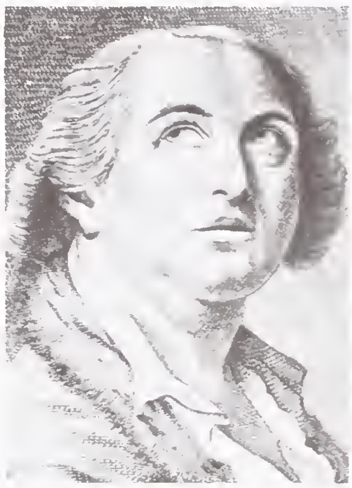
In the fall of 1781, as Freemason George Washington defeated Freemason Charles Cornwallis at Yorktown, and Freemason Frederich Baron von Steuben received the Englishman's sword, in Rome, lowlier masons, digging foundations for a small house by the hospital of San Rocco, struck the point of an obelisk. Further probing revealed two more pieces, plus the base, which had been broken in two. It was the same relic, the soutaned observers realized, which had been disinterred two centuries earlier in 1549, on the land of Monsignor Francesco Soderini, and quickly reburied because Pope Paul III had died before anything could be done about it.

To Pius VI the hospital of San Rocco, which specialized in caring for unwed mothers and illegitimate children, now raised a cry for compensation to remedy the damage caused by digging around their buildings. The new pope, though as profligate a nepotist as any of his predecessors—his nephew Romualdo Onesti, speculating on property sequestered from Jews soon made such a fortune he was able to acquire title to the dukedom of Nemi and have himself named both prince of the empire and grandee of Spain—continued to refuse the hospital any compensation until someone suggested raising the required 1,200 scudi to indemnify the monks through the sale of lottery tickets to the poor.

With that problem so economically settled, Pius ordered his papal architect, Giovanni Antinori, to repair the broken pieces of the San Rocco obelisk, no matter what the cost, and have it raised on the Quirinal Hill opposite his great palace, already expansively decorated by Fontana and Borromini, which served him, because of its finer air, as a summer residence. The obelisk was to stand in the Square of the Horsemen, so known because of two enormous Roman equestrian statues placed there by Pius V in the mistaken notion they represented Castor and Pollux, mythological twin sons of Leda by Zeus.

Classical horses in the Quirinal Square before the raising of the obelisk brought from Augustus's mausoleum

How much Pius wished to raise the obelisk as yet another antipagan symbol against the wave of revolutionary ideas spreading through America and Europe, and how much he merely wished to beautify Rome, remains moot. But the times were electric with the reforming ideas of Mason, Rosicrucian, and Illuminatus. The execution of victims for supposed offenses against the Church and its tenets, though diminished, had not ceased. In the Pas-de-Calais town of Abbeville, two young Frenchmen had just been sentenced to have their tongues torn out by the roots with pincers and their severed right hands nailed to the door of the church, before being burned to death by slow fire, simply because a wooden cross on a country bridge had been found whittled away with a knife—a crime of which the boys had been accused. One of them, named d'Etallode, succeeded in fleeing. The other, La Barre, was duly executed on July 1, 1776, in the manner prescribed, thus becoming one of five million such victims estimated by Victor Hugo to have succumbed to the Churches, apart from those killed in religious wars.



Alessandro Cagliostro

It was then, just as the American Continental Congress was meeting in Philadelphia to announce the Declaration of Independence, that there appeared on the European scene a new and extraordinary young man, determined to raise even higher than Pius's obelisk the torch of freedom by reviving the Egyptian tradition of Bruno. At the very time La Barre's body was being consumed by the flames, and the last Englishwoman to be burned alive was given to the flames in Horsham, a medium-sized man of thirty, with dark curly hair and large magnetic eyes, arrived in London in the company of a stunningly beautiful wife of twenty-one. The newcomer, elegantly but soberly attired, handsomely coiffed, with a sword at his side, cut a noble figure, followed by a retinue of servants, who addressed him as Count Cagliostro.

Serafina Cagliostro

In Whitcombe Street, Leicester Fields, where the couple took rooms, black smoke was seen to pour from the chimneys as the mysterious stranger practiced the art of alchemy over ovens and retorts, surrounded by books on the Cabala, the tables of Pythagoras, the calculations of Agrippa, and the computations of the abbé Trithenius, whose astrological magic was considered not only a form of telepathy, but a means of acquiring universal knowledge "of everything that is happening in the world." With these interests, it was only natural that Cagliostro should gravitate toward the Order of Freemasons which considered itself the repository of alchemical secrets going back to the Temple of Solomon.

Masonic procession in eighteenth-century London. The Esperance Lodge 369 is said to have been frequented mainly by French and Italian residents in London, and to have been attached to the Continental Masonic Order of Strict Observance, supposedly a continuation of the Knights Templar.

On April 17, 1777, at the King's Tavern on Gerard Street, in Soho, Alexander Count Cagliostro was initiated into the Lodge of Esperance 369, with the grade of Master Mason, accorded him because of his membership in the Knights of Saint John of Jerusalem, a sovereign order recognized by the Scottish Observance, formed in the 1750s by a baron von Hund, which claimed to possess secret documents of the Knights Templar dating back to the fourteenth century, and which operated under the orders of mysterious Unknown Superiors with the object of regenerating Freemasonry in an aristocratic sense.

Ever since 1646, when Elias Ashmole had been the first gentleman "accepted" into the order of Masonry, the operative guilds had taken in more and more mystics and occultists with no relation to the actual building trade. By the beginning of the eighteenth century, these "accepted" Masons, mostly aristocrats, humanists, and rationalists, outnumbered the "operatives," who withdrew to form their own trade unions. The last Grand Master of the actual builders had been Christopher Wren, obliged to leave his post in 1702 because of his religious opinions. The new "accepted" Masons, though they considered themselves the perpetuators of the ancient mysteries of Egypt, with its higher science and deeper understanding of the secrets of nature, passed down to Gnostic, Neoplatonist, and Templar, were yet a living order, tolerant of all religions, with the fundamental tenet that "there is only one Supreme Being; He is all, the one and only."

The reason for the papal anathema, according to Freemasons, was their assertion that every man is himself the living, slain, and rearisen Christ in his own person. To which a twentieth-century 33° Mason has appended: "Well may Catholic and freemason alike stand appalled at the stupendous blasphemy which is implied, as they ignorantly think, not knowing themselves of the stuff and substance of the Supreme Self, each for himself alike no less than Very God of Very God."

Politically, it was the Mason's prime desire to spread knowledge, confident that once understanding and tolerance gained an ascendancy in men's minds, they would condemn and reject narrowly enslaving dogma. Believing that only in free debate, without censorship, could society develop, Masons aimed at the establishment of complete freedom of worship, freedom of speech and association, freedom of the press, and freedom from arbitrary arrest and imprisonment without trial. They wanted every man to have the right to choose his type of employment and place of residence—entailing the abolition of the serfdom still binding in Europe—and envisaged an eventual government controlled by public opinion, subject to a representative parliament. They believed that humanity, if it so desired, could attain to a social order, such as that of the ancient Egyptians, reflecting the order of the cosmos.

But the Church thought otherwise. When the Encyclopedists, a group of Masons in France, tried to bring out a translation of Chambers Encyclopedia edited by Denis Diderot, with the collaboration of Voltaire, Rousseau, Montesquieu, d'Holbach, and d'Alembert, it was banned by the Church, placed on the Index of forbidden books, and copies were burned wherever possible. Clement XII issued a bull forbidding Catholics, on pain of excommunication and the threat of hellfire, from joining or supporting Freemasons, because they allowed persons of all religions into their order, were "depraved and perverted," and for "other just and reasonable motives known to Us," which, not being specified, were presumed to be sexual.

In London, introduced into society by his brother Masons, Cagliostro was appreciated not only as an alchemist, but as a natural healer and producer of marvelous elixirs and rejuvenating pomades, sought after by the ladies, who were much attracted to this man of mystery. But because neither Cagliostro nor his wife could speak English well they were obliged to rely on a Portuguese housekeeper to interpret for them. This woman soon introduced into the household friends and relations who complained so pitifully of poverty, they induced Cagliostro to use his clairvoyant powers to foretell for them one set of winning numbers in the national lottery. When Cagliostro refused to continue this unconventional form of welfare, from which the beneficiaries had earned several hundred pounds, they organized a plot to denounce their benefactor to the police for theft in order to gain entry to his house with a warrant and seize the notebook in which he kept his secret computations for foretelling the outcome of the lottery.

Cagliostro with the upcoming numbers in the royal lottery

Unjustly arrested, Cagliostro was kept four months in the King's Bench jail before the beneficiaries, common London swindlers, could be brought to justice; at which point, lest one of them be hanged for theft, Cagliostro chose to withdraw charges. But the charm had gone out of residence in England. Admitting he too was perhaps unjust in attributing to the whole nation the faults of a few individuals, he nevertheless "determined to leave a place in which I found neither laws, justice nor hospitality."

The Comte de Saint-Germain—a transparent pseudonym for "holy brother"—moves in the twilight between history and legend, using many names: Baron Gualdi, Comte de Gabalis, Lord Welldone, Count Orloff. Biographer Marie-Remonde Delorme believes him to have been Prince Leopold Racoczy, one of three sons of Francis II of Transylvania, born in 1696. Paul Chacornac, another biographer, thinks him more likely to have been the son of Queen Marie-Anne de Neubourg, who had been married without issue to Charles II of Spain but had a child by her lover John Thomas de Cabrera, Duke of Rioseco, Grand Admiral of Castille, exiled with the arrival of the Bourbons. Marie-Anne's de Medici uncle appears to have fostered the exiled child in Florence. In Paris, where Saint-Germain appeared in 1744 he looked about fifty, but Madame de Gergi, daughter of the French Ambassador to Venice, remembered seeing him there in 1710, when he looked no older than forty-five. Like Cagliostro, he was said to have discovered the elixir or life. His rejuvenating pomades were much in demand by the ladies. Described as aristocratic, with large dark eyes, powerful but full of tenderness and humor, he was elegant but soberly dressed, displaying a wealth of diamonds said to have been alchemically produced. An accomplished musician, he played and composed with equal ease, and was renowned for a stock of tales he told in almost every European language. He could write a love letter with his left hand while composing a poem with the other, or compose the same text with both hands so alike they appeared identical when superimposed. He could tame bees and charm snakes. After falling into a cataleptic sleep for hours or days, he would descibe having visited the remotest corners of the planet, or even the stars. He described his past lives, including that of Menkh-Kheperseneb, son of Hatshepsut, recounting historical events as if eyewitnessed. He was as great an alchemist as

On the Continent, the Cagliostros traveled to the Hague, Brussels, Liege, Nüremberg, Leipzig, and Sarrebourg, everywhere welcomed from one Masonic lodge to the next. In Prussia they were cordially received by King Frederick II, a Mason, who, influenced by his close adviser, the comte de Saint-Germain, had become not only tolerant of all forms of religion, but intolerant of the use of torture, which was banned from his kingdom. And it was from meeting Saint-Germain that Cagliostro appears to have discovered his real mission in life: to act as a catalyst to bring Masonry—which, on the Continent, seemed to be divided into divergent strains, some no more than a vain pursuit of high-sounding titles and exotic costuming—back to the esoteric principles of ancient Egypt with a purified and regenerated ritual. For this, Cagliostro decided to organize an Egyptian rite, no longer merely speculative, but "transcendental, at once Christian, yet reviving the early rites of initiation into the Osirian myths of death and resurrection, of communion with the dead."

The grandiose goal was "to restore to man the powers which had been his in Eden before the fall, before having been obliged to struggle by the sweat of his brow"—a state in which Catholic dogma appeared to wish him kept forever. Man, said Cagliostro, following the Hermetic tradition, was fundamentally of an archangelic nature, a demigod, with power to command spiritual beings and to reign on earth. But to do so, to become once more the happy intermediary between the divine and its counterparts in nature, man must first reacquire his love and understanding of nature.

From various books on magic, but chiefly from an Egyptian papyrus discovered in the Upper Nile Valley, Cagliostro developed a rite designed to regenerate Masonry by regenerating each individual Mason.

In a castle in Holstein placed at Saint-Germain's disposal by Prince Charles of Hesse, Cagliostro and his wife were initiated into the Order of the Knights Templar. Jean Pierre de Luchet has described the scene as taking place in the fantastic setting of candle-lit dungeon with Saint-Germain seated on a golden throne; but as Luchet's object was to denigrate Masonry by concocting spurious "memoires" of Cagliostro, and as he could hardly have attended in person, the description is doubtful.

But it was from this point on that Cagliostro began to display his colors as a Rosicrucian adept, claiming to be not only capable of transmuting baser metals into gold, but of transmuting his "non-self" into his "real self"—the object of the Great Work of "spiritual alchemy."

chemist, and a series of impressive laboratories were placed at his disposal by the aristocracy and royalty of Europe. Without means of support, he was free with money, generous to those in need, arousing the suspicion he had access to the hidden assets of the Rosicrucians, perhaps the remnants of the Templar's treasure. A personal counselor to kings and princes, Saint-Germain served as intermediary between prime ministers in England, France, Austria, Prussia, and Russia. In London in 1745, he was confined to the Tower in the company of Emmanuel Swedenborg and the Marshal of France de Belle Isle, *habeas corpus* having been suspended by the landing in Scotland of the Jacobite son of James III. Known as a member of the Jacobite pro-Catholic Scottish Rite Masonry, to which the majority belonged who had gone into exile with James II, Saint-Germain's predicament was increased by the discovery on his person of a letter of thanks from the Pretender. This led to the presumption of his being on a spying mission for Louis XV, who had mounted a fleet to help the Pretender. When the aspirant James IV was defeated at Culloden, Saint-Germain was allowed to leave England, presumably thanks to his connections in the British aristocracy and his high standing in Masonic circles. From 1746 to 1758, Saint-Germain disappeared from Europe, and, according to biographer Pierre Laermier, was in the Far East with Hindu gurus to develop a deeper understanding of reincarnation, hypnosis, pharmacology, clairvoyance, levitation, telekinesis, and the secret practice of the Tantric arts already familiar to his brothers of the Rosy Cross. Back in Paris in 1758, with his old friend Marshal de Belle Isle as Minister of War, Saint-Germain was befriended by Madame de Pompadour and frequently invited to dine with Louis XV, who spoke of him as a person of illustrious birth. In her diaries she relates how he fascinated the king with his ability to eliminate flaws from gems, ren-

Exactly how much Cagliostro learned from Saint-Germain is difficult from the record to establish, but it was after seeing him that the younger man began to formulate his new Egyptian Rite of Masonry based on the ancient Hermetic wisdom as well as on the later Alexandrine Rites of Memphis.

In Berlin, Cagliostro appears to have read the *Crata Repoa,* published in Germany in 1770, a book giving details of initiation into the ancient mysteries of the priests of Egypt. A French translation had been edited by Freemason Anton Bailleul in 1778, and that same year the Abbé Rodin, a member of the Parisian Lodge of the Nine Sisters, published a description of the initiatory mysteries of ancient Egypt in his *Researches on Ancient and Modern Initiation.*

Manly P. Hall, in his *Freemasonry and the Ancient Egyptians,* has reprinted an English version of the *Crata Repoa* made at the end of the nineteenth century by a high Mason of the Rite of Memphis, Dr. John Yarker, and Hall claims that a comparison "leaves no doubt that they are from a common source and are maintained by a common inspiration."

The *Crata Repoa* is a reconstruction of the rituals of initiation into the ancient mysteries put together from hints and allusions contained in the writings of such classical authors as Porphyry, Herodotus, Iamblichus, Apuleius, Cicero, Plutarch, Eusebius, Arnobius, Diodorus Siculus, Tertullian, Heliodorus, Lucian Rufinus, and others. From these fragments insight can be gained into the degrees of initiation undergone between neophyte and adept. According to Hall, a high Mason in his own right, the third degree of the *Crata Repoa* corresponds closely to the third degree of the Blue Lodge of Modern Freemasonry.

Crata Repoa initiatory scene from Manly P. Hall's *Freemasonry and the Ancient Egyptians*

dering them more valuable, or to conjure visions of the future, frightening the king with a vision of his grandson, Louis XVI, decapitated. The object of such seances, according to Saint-Germain, was to convince the monarch that reform was essential not only in the Church but in his government if he wished to avoid revolution, urging him to move toward a constitutional monarchy such as in England, and a federated Christian Europe for which peace between France and England was the key. By 1760, Louis agreed to send Saint-Germain to England on a secret mission to negotiate with George III an end to the Seven Years War, which was ruining France. The mission was aborted because of an encounter in the Hague with the adventurer Casanova. Casanova informed French Foreign Minister de Choiseul, who was against the scheme. Forewarned of imminent arrest, Saint-Germain moved quickly to asylum with his friend Frederick II of Prussia, and from there to Russia to help Catherine II seize the throne from her impotent husband Paul III, by summoning—as one historian tells the story—the ghost of Peter the Great to give her instructions how to act. After many adventures, Saint-Germain found in the Duchy of Schleswig-Holstein the ideal prince to help him develop his Rosicrucian projects—

As reconstructed in the *Crata Repoa,* the ancient rite began with circumcision as a permanent sign of belonging, followed by several months' imprisonment in a subterranean vault where the neophyte underwent a severe fast to symbolize that in this life the body is the sepulcher of the soul and can only be released from the serfdom of darkness through the light of initiation. Bound and hoodwinked, to symbolize the limitations of the mortal state, the neophyte was shown that the evils which petrify him when blindfolded lose their power once his eyes are uncovered. Binding the eyes was also a symbol for the necessity of binding the physical senses if the superphysical world is to be perceived.

In the first grade of the ancient Egyptian rite, the neophyte was shown a ladder to climb as the symbol of metempsychosis, his foot placed on the lowest rung to indicate that the ladder of the mysteries extends from the mundane sphere to the empyrian of the wise, and that each disciple as he ascends the grades must become teacher to those directly below him in attainment. The ladder likewise symbolized seven psychic centers of the human body, a ladder to be climbed by mastery of the secrets of yoga. In the first degree, according to Hall, the robes and garments were designed to represent the changes in the auric colors of the disciple resulting from his newly directed spiritual purpose, the conical hat being a symbol of aspiration toward the light, while an apron was a sign of purification. Robed in purity, the disciple was groomed to become "a guardian at the gates of truth," and given the secret password *Amoun,* meaning, says Hall, to be discreet.

How much of this ritual Cagliostro was able to apply to his adepts presumably depended on their desire for advancement, but mostly Cagliostro appears to have used his talents as a thaumaturge and magus to attract followers to at least embark on the way.

According to Cagliostro there had been three important Egyptian practices performed in the Holy of Holies of the Great Pyramid: the convocation of disembodied entities, either of "gods" or of spirits of the dead; divination through a child medium; and, finally, some form of spiritual and physical regeneration.

From the various esoteric doctrines practiced in the temples along the Valley of Nile, Cagliostro took the idea of reestablishing "an intimacy with the ancient 'gods' of Egypt and of enticing their participation into the life of Man." In this he was following the lead, spelled out in Hermes's *Asclepius,* of Ficino, Paracelsus, Agrippa, Dee, Charles of Hesse, son-in-law of the King of Denmark and Grandson of George II of England, who became the magus' truest friend and admirer. A student of alchemy and the magic of evoking spirits, Charles of Hesse was convinced of the existence on the planet of illuminated men, who had penetrated the secret teachings of the ancient Egyptians, Brothers of the Rosy Cross, who received precise, clear revelations from superior beings. Hesse, who was reputed to have mastered the method of intercourse with ghosts and supernatural beings that would appear at his call, was also able to describe his own past lives, which he said included one as King Josias of the Old Testament, another as Joseph of Arimathea, and most recently as the Protestant preacher Zwingli.

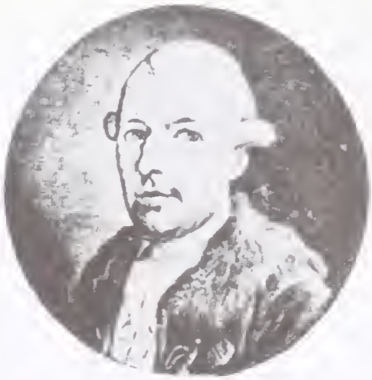
Baroque representation of the archangel Michael

Bacon, and Saint-Germain; and Cagliostro appears to have learned from the Rosicrucian manual *Enchiridon,* the actual steps by which adepts could be put in touch with "angels and the spirits of the dead."

In Leipzig, at the Lodge of Minerva of the Three Palms, Cagliostro learned from Dom Permety, a Benedictine alchemist who had developed a *Hermetic Rite of Perfection,* to convoke "the entities that revolve in heaven." Permety was later made a member of the Academy of Berlin by Frederick the Great, then curator of his Royal Library; eventually he formed the lodge of Illuminés of Avignon.

On the basis of these various techniques, and what he claimed to have learned in his travels in Egypt, Cagliostro fashioned his rite for summoning angels: it amounted to hypnotizing a child, usually a young girl whom he called a dove, or a boy whom he called a *pupille,* to scry in a crystal bowl, illumined by candles, wherein the child could see visions and make prophecies. The officiating magus could then tell people about their own past, including their past lives, with the hoped-for effect of waking them up to the fact that they were indeed immortal spirits, occupying different bodies, and that they were on the planet with some goal to achieve. By communicating with what he claimed to be disembodied entities, and even sometimes by succeeding in materializing some sort of visible form for those present, Cagliostro was better able to convince the participants in his rituals of the Hermetic tenets that the material world they lived in was but one level of reality, interconnected with other more rarefied dimensions, leading up through a spirit world to the divine, where, eventually, all was One.

Several of those who joined the rite brought their own children to act as mediums. In Wittau, Count von Howen brought his son, who turned out to be an expert, going into trance and immediately seeing visions, among which he described the archangel Michael, leader of the planetary spirits, as a shadowy figure robed in white, followed by other archangelic entities such as Anael, Raphael, Zodiachel, Uriel, Anachiel, and Zachariel, appearing in various guises. More instantly convincing were descriptions given to individuals of their own immediate family lives, often amazingly correct. Cagliostro also made more general prophecies. In November 1780 he declared that the empress Maria Theresa of Austria had died. Five days later, the news was confirmed. He then prophesied that the empress's daughter, Marie Antoinette, would give birth without trouble to a healthy dauphin, which she did a few weeks later.



When the chair of Canon Law at the University of Ingelstadt in the Catholic stronghold of the Southern German monarchy of Bavaria became vacant in 1774, after being held for ninety years by the Jesuits (the order was dissolved by Pope Clement XIV), the Curator of the University, Baron Johann Adam Ickstatt, a liberal member of the Privy Council of the Elector who had begun to liberalize the University, appointed to the chair his twenty-six-year-old godson, Adam Weishaupt. Adam's father, also a professor at the University, had died when the boy had been only seven, leaving him to the Baron's care. Brilliant, and well trained by the Jesuits in the conspiratorial methods of access to power, young Weishaupt decided to organize a body of conspirators, determined to free the world from the Jesuitical rule of Rome and help humanity back to the pristine Christian faith of the hermetic martyrs. He is reputed to have been initiated by a German merchant named Kölmer, who had spent many years in Egypt, into a secret doctrine based on Manichaeism. Mayday of 1776, Weishaupt founded his own sect of the *Very Perfectibles*—better known as Illuminati—with five original members, self-described as reformist libertarians, partisans of absolute equality. It was Weishaupt's contention that all that was needed to recover man's original nature was "to create the good society," a goal, he maintained, which demanded only that "men should understand the weight of prejudice and error encumbering them." Universal happiness, complete and rapid, could be achieved, he declaimed, by dis-

In Ingolstadt, Cagliostro is believed to have met Adam Weishaupt, professor of philosophy and canon law at the university, who, in 1776, had founded the sect of Illuminati. Calling themselves heirs to the Knights Templar, they declared their interest in using celestial intervention as achieved by Cagliostro for the furtherance of a program of worldwide religious reform, but one more radical than Cagliostro's, "committed to avenging the death of the Templar's Grand Master Molay by reducing to dust the triple crown of the popes and disposing of the last of the Capet Kings."

Cagliostro obliged, and described in prophetic detail the decapitation of Louis XVI, an event hardly to be envisaged at that time as anything but improbable.

posing of hierarchy, rank, and riches. "Princes and nations," said Weishaupt, "will disappear without violence from the earth; the human race will become one family; the world will be the abode of reasonable men. Mortality alone will bring about this change imperceptibily." Unable in Catholic Bavaria to achieve this utopian goal by direct means, Weishaupt determined to work from within an existing organization: the Masonic order. In 1777, just a year after Cagliostro had joined a lodge of the same Strict Observance, Weishaupt was initiated in Munich into the lodge of *Theodore of Good Counsel.* Within two years he was in control of the lodge. Further to expand membership in his Illuminati, Weishaupt recruited a youthful but effective Masonic organizer, Adolf Francis, Baron Knigge. By 1779, there were 54 members of the Illuminati, mostly young noblemen and clergymen, established in four Bavarian cities. Thereafter, with the help of a Masonic bookseller, Johann Bode, the order branched out through Southern Germany and Austria, and down into France and Northern Italy. Intellectuals, such as Goethe, Schiller, Mozart, and Herder were attracted. Bode even managed to recruit Saint Germain's friend and protector Prince Charles of Hesse, then director in Germany of the Strict Observance Ritual, though he soon withdrew, influenced apparently by Frederick Wilhelm, heir to the throne of Prussia. By the end of the 1780's, "no one could be sure how many Masons shared the Illuminati views." Already Bavarian Jesuits were preparing a massive counterattack. As with Luther, they first attacked Weishaupt on his personal life, accusing him of having fathered an illegitimate child and of having tried to perform an abortion for his sister-in-law while awaiting dispensation to marry her. Thanks to a bolt of

On the physical level, what the aspirant initiate found appealing in the Egyptian rite was a means, probably learned from Saint-Germain, of regenerating the body every fifty years. As described by Cagliostro, the method, starting with the full moon of May, required forty days of the strictest dieting and consumption of elixirs designed to eliminate all toxins from the body. At the end of the ordeal, in a climax of convulsive fever, the body was to shed hair and teeth, which with all the other cells of the body, were to regenerate and last another fifty years.

For the postulant to recover knowledge of his own immortality, Cagliostro developed a spiritual retreat of forty days leading to initiation and enlightenment.

For spiritual regeneration, the psychic objective involved the search within the male for his female counterpart, and for females the male, so that, mated, they could "flower, through the miracle of love, and give birth to a whole new self on a higher plane."

For women, Cagliostro founded the Egyptian Lodge of Adoption, with Serafina as Grand Mistress. Robed in a white-and-gold gown embroidered with the words *Virtue, Wisdom, Union,* she officiated with the symbol of will in her hand: the sword. On her apron of white leather, trimmed with blue roses, symbols of regeneration, were the words *Love* and *Charity.*

lightning which struck the house of one Illuminatus, the police seized a cache of incriminating papers. The Elector issued an edict outlawing all secret societies in the provinces. Another edict of March 2, 1785, specifically condemned Freemasons and Illuminati, offering rewards for those who would reveal what they knew of the organization. Numerous documents seized in a police raid provided the government with what were considered sensational revelations, showing prescriptions for inducing abortions, for making secret inks, and indications that the order claimed the power of life and death over its members. The Illuminati were accused by the Jesuits of seeking ingredients for abortions to be "free to debauch women, or indulge in all manner of licentiousness." Dismissed from his post at the University, Weishaupt fled to a neighboring province. The order went underground; but the Jesuits continue to pursue it to this day.

As a place to settle, Cagliostro chose the Rhineland city of Strasbourg. There he arrived with a special rose powder which he said enabled him to soften hard marbles, and with formulas he claimed allowed him to transmute metals and precious stones; he also brought elixirs for health and long life. He is described as entering the city in a coach covered with magical symbols, preceded by six servants riding black horses. As news spread that the great miracle healer had taken a house in town, rich and poor flocked to his door, on crutches, on stretchers, in every state of disease. In all of these Cagliostro took a benevolent interest, soothing, restoring confidence, healing. The record is abundant, precise, and incontrovertible. Hundreds of cures were attested to by official statements and reports, including those of several physicians and priests.

But when asked how he performed his miraculous cures without orthodox training, Cagliostro replied that a spiritual healer had no need for what passed as "medical science," that his was a more ancient therapeutic art he had learned in the East. Through his gift of clairvoyance, he said, he could analyze the mind as well as the body of his patients, urging them to purify their souls. The power to heal, he insisted, came not from him, but from the

Marie Antoinette of Austria passing an obelisk at the entrance to Strasbourg, on her way to her wedding night with the dauphin of France, later Louis XVI.

patient; it was largely a question of finding the equilibrium of the forces that flowed from the greater cosmos through the smaller cosmos of the human body, an equilibrium which could sometimes be reestablished, as he had learned from Egyptian and Chinese medicine, with no more than a single word or a gesture.

He extolled the sublimity of nature and the limitless possibilities for spiritually regenerated man in a state of "pre-Adamic" grace. "He who is illumined by the light of Nature," he quoted Paracelsus, "will succeed in penetrating the whole structure of man, and will find the right remedy." Like a good Rosicrucian, Cagliostro not only refused to accept money for his cures, but was constantly distributing largesse to those of his patients who were too poor to feed themselves or take care of their needs in order to get well. And though the source of Cagliostro's money remains a mystery—unless he somehow had access to the remaining treasury of the Templars—he was never in any financial trouble involving the law.

Cardinal de Rohan

News of Cagliostro's fabulous cures reached the ears of the bishop of Strasbourg, Louis René Édouard, Cardinal de Rohan, Prince of the Empire, Landgrave of Alsace, Headmaster of the Sorbonne, Grand Almoner of France, a descendant of the ancient kings of Brittany. As scion of one of the most important families of France, he held vast lands, and resided at his sumptuous Château de Saverne, where he was attended by fourteen butlers and twenty-five valets. The cardinal, who, like Cagliostro, cherished a passion for alchemy, sent word that he was eager to meet the magus. "If the cardinal is ill," replied Cagliostro, "let him come to me and I will cure him. If he is in good health he has no need for me, nor I for him."

The rebuff, instead of infuriating or insulting the cardinal, aroused his curiosity. In his luxurious coach, he drove off to visit Cagliostro on the excuse that he wished to be cured of his asthma. Cagliostro obliged, explaining that he saw no conflict between holy religion and celestial magic, the latter being sanctified by the Bible under the laws of Saint John. "Magic," said Cagliostro, "is an art due to divine goodness, dedicated to the fullfilment of the divine will." Rohan invited Cagliostro to stay at his château, where he put a laboratory at the magus's disposal and where the cardinal attested to seeing Cagliostro produce before his eyes not only gold, but diamonds. "In my place, in my presence," said the cardinal, "he has made five or six thousand pounds worth of gold."

When the cardinal's elder brother, Charles de Rohan, prince of Soubise, became seriously ill in Paris, Cagliostro

Mesmer's baquet

A French lodge of Freemasons at the reception of a Master

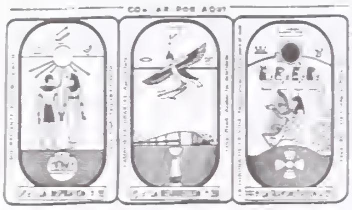
agreed to travel with the cardinal by coach to the capital to effect a cure. It was the summer of 1781, just when Pius VI and Antinori were preparing to raise the obelisk in front of the Quirinal. In Paris, Cagliostro found the prince of Soubise wasting away as the result of an attack of scarlet fever. In three days the magus had the old man on his feet, and in two weeks he was back at court, where Louis XVI was so impressed he ordered special protection extended to Cagliostro.

Letters of recommendation from Louis's minister for foreign affairs, count de Vergennes, from the keeper of the Royal See, the marquis de Miromesnil, and from the minister of war, Marshal de Ségur, charged the authorities in Strasbourg in the king's name to extend every consideration to Cagliostro. But the fact that the magus performed his cures without charge, and often on patients whom the orthodox medical profession declared to be incurable, roused the enmity of the organized doctors of Strasbourg. What most irritated the faculty members of the university was his overtly authoritarian manner in matters of curing. The physicians of Strasbourg, outraged at Cagliostro, did to him what their compeers in Vienna were then doing to Franz Anton Mesmer for the very same reason: they launched a monstrous campaign of calumny, including public posters, anonymously labeling Cagliostro a quack and a charlatan, so poisoning the atmosphere that he decided to leave.

In Lyons, center of Illuminism, and of interest in the occult, lived numerous followers of the clairvoyant philosopher who explored the spirit world in vision—Emanuel Swedenborg. There were also the followers of the so-called "unknown philosopher," Claude de St. Martin, and of Martinez de Pasqually's Elus Cohens who had returned to the Gnostic concept of the universe as a living divine organism in which man could rise through the cabalistic spheres to his true and divine self. Received with great enthusiasm by the Masons of Lyons, Cagliostro believed he had found the true setting for building a Central Masonic Lodge devoted to his Egyptian Rite. The Lyonnais were happy to contribute to the creation of a *Lodge of Triumphant Wisdom* of which Cagliostro would be Grand Cophte. Started in 1784, the splendid temple was ready in 1785, complete with huge pillars of Jakin and Boaz, red and white, as in the Temple of Solomon, symbols of the two forces which, in equilibrium, sustain the universe, represented in the temple by a great vault decorated in the image of the infinite. As in Egypt, the walls were carved with hieroglyphs, and there were statues of Isis, Anubis, and Apis, the sacred Egyptian bull.

Anubis, jackal-headed "god of the dead," is called "guardian of the secret of transformation and leads the deceased toward a state of bliss or to grievous trials." According to myth, Anubis was the son of Nephthys, who had tricked her brother Osiris into having intercourse with her. Abandoned by Nephthys, Anubis was raised by Isis. He helped find and embalm the body of murdered Osiris, through whose kingdom he then guided the dead.

From all sides, says Cagliostro's biographer François Ribadeau Dumas, adherents flocked to Cagliostro's Egyptian rite, "drawn by the beauty of its sentiments, the loftiness of its ideals, its central rule of love." In the lodge, the neophyte was to be put through the grades of initiation, applying himself to the problems of living in the world while remaining pure to spiritual law.



De Gébelin suggested that the Tarot cards were leaves of a sacred book which had descended from ancient Egypt, representing symbols of philosophical and metaphysical importance. Tarot was understood to mean the innermost nature of something, its principle, or the law of its being, one which could act as the key to ultimate reality.

In the second grade more symbolic hazards were applied, and the neophyte was taught to withstand bodily terror by being covered with snakes. Removal of the snakes meant liberation from the illusions of this world. By breath control the neophyte was to learn to master the serpent power within his own body. Instructed in the secrets of geometry, he was to measure the universe by the rule of living. As a symbol of the fall of the human race from the Golden Age of Saturn he was given the caduceus of Toth and told it was an emblem of the movement of the sun around the ecliptic.

In the third degree of the *Crata Repoa,* which Hall corresponds to the third degree of the Blue Lodge, the neophyte descended into the abode of the dead where lay in effigy the murdered Osiris, slain by Set, the animal nature in man, the mummy bonds emblems of the hampering agencies of ignorance, superstition, and fear. Here the sword of karma was placed against the neophyte's throat to remind him that if he broke the law, he would destroy only himself, that the law of society represents the law of the universe.

Hall believes that in this ritual the neophyte was actually knocked out by a blow on the head to experience seeming death in order to learn that he could exist outside his body. Alternatively he was given a drug from a goblet made from a human skull to lead him to the world of spirit.

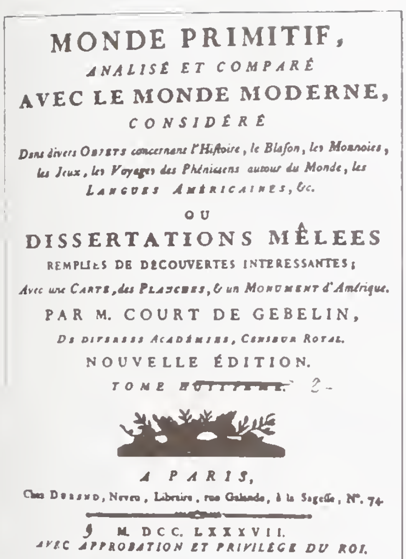
As Kenneth Grant points out in his *The Magical Revival,* the Egyptians distilled the juice of the sycamore, the sacred fig tree, because it was noticed that mortals who drank it "were transformed into immortal spirits, able to penetrate the spirit world and hold commerce with disembodied spirits and other subtle entities." The liquor was then mythified as nectar, ambrosia, or the drink of the gods. In India the juice of the *peepul* was said to "place men on an equal footing with the gods, enabling them to see into the past and into the future, to transcend space and time, to know the secrets hidden in the regions of the universe."

After this stage came the greater mysteries in which the initiate was shown the "elemental potentates, archangels, angels and tutelary spirits and the various orders of the upper world," to demonstrate, as Yarker puts it, "the great perfection to which the Egyptians had reduced the science of theology."

In the next grade the initiate was taught the secrets of alchemy, or how to direct the power of fire to decompose substances and combine others, in order to acquire metaphysical knowledge and superphysical powers by means of which to transmute the evil in human nature into perfect "gold" or "light."

In the sixth, or penultimate, grade, the initiate was shown that the "gods" of the Egyptians were "the principles of life and the workings of universal law . . . vast beings rooted in eternal principles sustaining the universe by their emanations." Here the initiate was shown the bodies of the dishonored dead who had betrayed the secrets of the Society indicative of the occult truth that the spiritual powers of the universe cannot be perverted without fearful compensation, and that broken vows will destroy the body and unseat the reason. In the seventh grade, say Yarker and Hall, all the great mysteries were explained.

But Cagliostro could not tarry with his adepts in Lyons. He was summoned to Paris by his friend Cardinal Rohan, who, anxious to return to royal favor, and hopeful of becoming the king's first minister, pleaded with Cagliostro to use his wonder-working powers to help him regain the favor of Marie Antoinette. The queen had been displeased with Rohan ever since he had returned from being French Ambassador to the Viennese court of her mother, the Empress Maria Theresa, who disliked the cardinal for his lavish style of living and his penchant for pretty young ladies.



MONDE PRIMITIF,
ANALISÉ ET COMPARÉ
AVEC LE MONDE MODERNE,
CONSIDÉRÉ
Dans divers Objets concernant l'Histoire, le Blason, les Monnoies, les Jeux, les Voyages des Phéniciens autour du Monde, les Langues Américaines, &c.
OU
DISSERTATIONS MÊLEES
REMPLIES DE DÉCOUVERTES INTERESSANTES;
Avec une Carte, des Planches, & un Monument d'Amérique.
PAR M. COURT DE GEBELIN,
De diverses Académies, Censeur Royal.
NOUVELLE ÉDITION.
TOME ~~HUITIEME~~. 2-
A PARIS,
Chez Durand, Neveu, Libraire, rue Galande, à la Sagesse, N°. 74.
M. DCC. LXXXVII.
AVEC APPROBATION ET PRIVILEGE DU ROI.

Collection of the author

Grand Master Court de Gebelin

Cagliostro and Serafina arrived in Paris in January of 1785 as guests of the Cardinal, and were put up in his sumptuous palace, the Hotel de Strasbourg. But Cagliostro, seeking privacy, soon moved to a smaller house of his own not far away in the rue Saint Claude, now the Boulevard Beaumarchais.

French Masons were quick to welcome Cagliostro, inviting him to join the Lodge of the Nine Sisters, that "most mystical and esoteric of the French Lodges," also described as "a university of world political philosophy," grand-mastered by Benjamin Franklin, then the main link between the secret societies of Europe and America, to whom Cagliostro is reported to have prophesied that a New Atlantis would be rising in America. Among the other distinguished members of the Nine Sisters were Voltaire, Helvetius, and Thomas Jefferson. Another brother was Franz Anton Mesmer. And one of Mesmer's patients, who attested to having been cured by him, was a former Grand Master, Antoine Court de Gébelin, France's leading orientalist, first to identify the pack of Tarot cards as a reservoir of ancient Egyptian wisdom, the secret teachings of the Egyptian priests, who, he asserted, had thus disguised their arcane knowledge, their symbolic depic-

The duc de Chartres, shortly to inherit his father's title of Duc d'Orléans, was one of the richest men in France, but popular in Paris because of his gifts to the poor. Known as a liberal, with aspirations to becoming a constitutional monarch, he is described by contemporaries as "possessing the charming manners of a *grand seigneur,* never rude or cruel, full of gentle consideration for all about him, though selfish in his pursuit of pleasure." Accused during the Revolution of aspiring to replace Louis XVI, he adopted the title of Citoyen Egalité and was elected deputy from Paris to the Convention. When faced by the terrorists' guillotine, he was accused of arguing that he was not truly of noble extraction, but the son of a coachman who had been his mother's lover. Shocked by such behavior, surviving Masons are said to have celebrated his defection with a ritual degradation and breaking of his sword.

tions of the structure of the universe, received from Hermes Trismegistus so that it might survive through the ordeal of Christianity after the collapse of the pagan world.

Asked by a committee from the leading Masonic lodges of Paris to interrogate Cagliostro on ancient Egyptian philosophy, de Gébelin was struck by Cagliostro's amazing replies, as were all those present, who admitted they had met their master in such matters. Urged by fellow Masons to open an Egyptian-rite lodge in Paris, Cagliostro installed himself as Grand Cophte of the Temple of Isis in the rue de la Sourdière. There he admitted women to "the mysteries of the pyramids," attracting such high-ranking ladies as the queen's favorite, Madame de Lamballe, who was initiated at the vernal equinox of 1785. Cagliostro then formed a supreme council with the duc de Montmorency as Grand Protector, Jean-Benjamin de Laborde, farmer-general of France as Grand Inspector, and Beaudard de Saint-James, wealthy treasurer general of the French navy as Grand Chancellor. His Royal Highness the duc de Chartres, Grand Master of French Masonry, attended an Egyptian-rite ceremony, declared his confidence in Cagliostro, and announced his official recognition of the rite. Another *grand seigneur* with equally liberal tendencies, fresh from aiding the Americans in forming a republic, also joined Cagliostro's Egyptian rite and proclaimed his absolute confidence in the powers of its Grand Cophte; Marie Joseph Paul Ives Roch Gilbert Motier, Marquis de Lafayette.

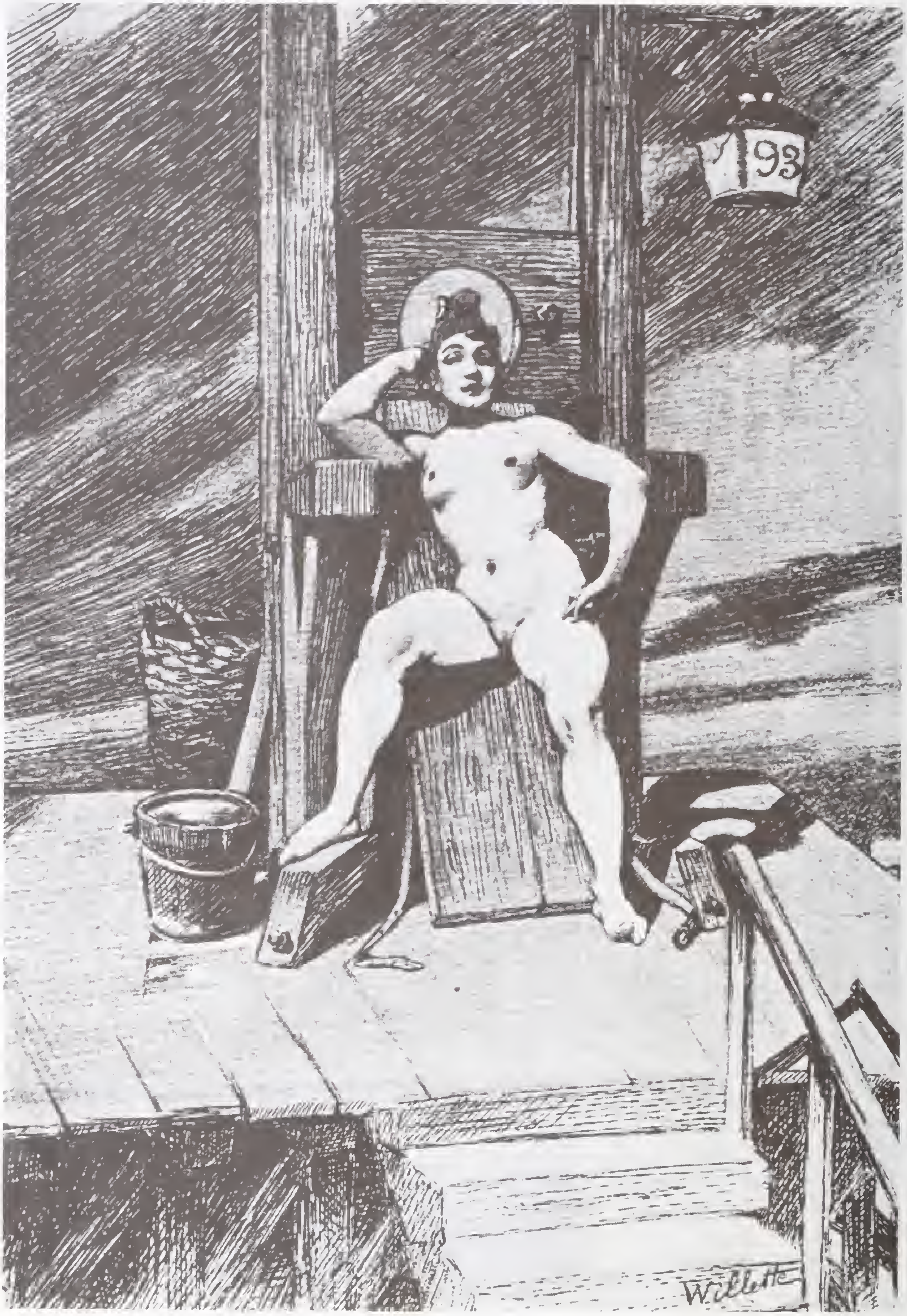
The Duc de Richelieu, under an assumed name, and wearing a disguise, came to consult Cagliostro and was shown a past life as Ruggieri before Catherine de Médicis. And just as clearly as he described the past lives of the duke, Cagliostro declared he could see the rot behind the apparent splendor of Louis's police state, which was causing misery and degradation among the masses. But although Cagliostro called for greater social justice for the poor, the sick, and the underprivileged, his political principles were oriented more toward "regenerating the Christ in man," as a means of achieving a peaceful transition to a constitutional monarchy. In the more liberal forces of Masonry, and especially among the followers of his own rite—whom he confidently estimated to amount to a million souls—Cagliostro saw a determined desire to search for a better system of life, without recourse to bloody revolution.

In France, where the papal bulls against Masonry had never been promulgated, twenty-six Masonic lodges were presided over by priests, and members of the clergy of all ranks constantly frequented Masonic rituals. Catholic lodges had been founded in Paris under the protection of the marquises de Girardin and de Bouillé, both royalists and friends of Saint-Germain, whose goal was to "establish communication between God and man by means of intermediary beings." Soon so many priests were attending the Egyptian ceremonies, declaring themselves highly satisfied with the rite, that Cagliostro, whose dream was to effect a union of his Egyptian science of magic with the fundamental beliefs of Christianity, was moved to hope his order might at last be recognized by the pope, as had been the order of the Knights of Saint John.

Cardinal de Rohan promised Cagliostro his support and appealed to the archbishop of Bourges, to whom Cagliostro explained his rite. A favorable report was apparently sent to Rome, and the dossier seems to have been presented to Pius VI under promising auspices.

Pius was just then admiring from the windows of his summer palace on the Quirinal the San Rocco obelisk at last being raised by his architect Antinori between the two great horses placed in the square by Sixtus V. The delay of four years in handling the needle had been caused by Antinori's failure to find a way to turn the great rampant beasts so the pope would not have to face their rear ends. Prodded by Pius, Antinori at last found a way; and the operation, in the end, required no more than ten minutes per horse.

But the Romans did not think much of the monument, nor of the expense it had entailed, and some wit changed the inscription on the base of the equestrian statues—which had been mistakenly attributed to the Greek sculptor Phidias—from OPUS PHIDIAE to OPUS PERPHIDIAE PII SEX II. And the obdurate and purblind reaction of Pius to Cagliostro's ecumenical suggestions was to dash the magus's hopes for a peaceful solution to the revolutionary fervor in France. Instead, an unexpected Parisian scandal was to pit the pope's dutiful acolyte Louis XVI against the forces of Freemasonry and accelerate the French Revolution.


93
Willette

7. PIOUS TERROR

Jeanne de la Motte managed to live at Versailles by boasting royal blood as a descendant of an illegitimate scion of the Valois family who had committed forgery under Louis XIII. Her husband, a gentleman soldier in the gendarmerie, was a rake and a gambler.

The day Calgiostro arrived in Paris, Cardinal de Rohan, in his haste to get back into the good graces of Marie Antoinette, had fallen for the ploy of a scheming female, Jeanne de Saint-Remy de Valois, who called herself Countess de la Motte. The impoverished descendant of a bastard son of Henry II, the woman used a tenuous position at court to convince Rohan she had access to the queen whose favors she could obtain for the cardinal, if, with his large fortune, he would guarantee a financial transaction. The queen, said de la Motte, wanted a fabulously expensive diamond necklace which the king, considering the economic condition of the country, thought impolitic to buy for her. But if the cardinal would merely act as guarantor to the bankers who owned the necklace, the queen could acquire it immediately and pay for it in installments from her private funds. In return she would grant the cardinal her "favor," and even meet him clandestinely in the park of Versailles.

None of this had the cardinal told Cagliostro, though the latter had repeatedly warned him to beware of de la Motte as an unreliable fraud. The cardinal, already infatuated by the schemer's sexual attractions, was even more delighted by the prospect of becoming a lover of the reputedly sensuous queen. But the scheme went wrong; and when Louis XVI was informed of his wife's involvement, the la Motte woman, in a desperate attempt to save herself, tried to shift the blame onto Cagliostro whom she accused of being the Cardinal's own *eminence grise*. By chance, or good fortune, one of the financial backers of the jewelry firm which had delivered the necklace was Monsieur Beaudard de Saint-James, Grand Chancellor of Cagliostro's Egyptian-rite lodge. Promptly he informed Cagliostro of the charges brought against him by the countess, who accused him of having purloined the necklace and selling the stones in England—which was just what she had done, with the complicity of her husband, a disreputable minor guard's officer.

Foolishly, Louis XVI ordered an investigation by parliament, and by *lettre de cachet* had Cardinal Rohan arrested just as he was about to celebrate mass on the Feast of the Assumption in the royal Chapel. Into the lurid dungeons of the Bastille the unhappy cardinal was followed by Cagliostro and Serafina, all placed incommunicado.

As the months wore by, without news of his wife, or of the outside world, Cagliostro kept himself sane by writing his memoirs. Outraged at the horrible injustice of a system which allowed a king by simple *lettre de cachet* to imprison in the Bastille anyone he chose, for as long as he chose, even for a lifetime, without access to a lawyer, to be tortured at the pleasure of his jailers, Cagliostro prophesied the brutal death of the Bastille's governor, the Marquis de Launay, and the transformation of the fortress into a Temple of Freedom, property of the people of France.

Brought to trial before a parliamentary court, and asked who he was, where he was from, what he did, and by what right, Cagliostro replied: "I do in God's name all the good I can. It is a right that requires neither a name, nor a country, neither proofs, nor caution. . . . Am I not a free man? Judge me by my habits, by my actions. Tell me if they are good, tell me if you have seen any that are more effective. Then do not occupy yourselves with my nationality, my rank, or my religion."

When, on the witness stand, Madame de la Motte accused Cagliostro of all sorts of crimes, saying she "only regretted not living in those blessed times when a charge of sorcery would have led Cagliostro to the stake," Cagliostro calmly replied that he forgave her, and

Jeanne de la Motte conspiring with Marie-Nicole Leguay, alias Baroness d'Oliva, who bore a remarkable resemblance to Marie Antoinette, as they arrange a meeting with Cardinal Rohan. The girl agreed to impersonate the queen at night in the rose garden of Versailles to induce Rohan to act as security for the diamond necklace. She gave him a rose and a note signed "Antoinette de France," hopeful harbingers of a sexual assignation.

Jeanne de la Motte being branded on the shoulder by the hangman with red-hot V for *voleuse,* or thief, before being exposed naked to the crowd in front of the Conciergerie with a rope around her neck. She later died in London from a fall from the window of her lodgings. The jewels she stole from the necklace, small and very blue, were bought by John Frederick Sackville, third duke of Dorset, ambassador to the court of Louis XVI, and are in the possession of the family at Knole in Kent.

that he assumed her calumnies must be inspired more by the desire to clear herself than of actual hatred against him. The parliamentary court, after due deliberation, found Madame de la Motte to be the guilty party, condemning her to be publicly whipped, naked, by the executioner, and to be branded with a hot iron on both shoulders, forfeiting all her properties. Cagliostro, Serafina, and Rohan were found guiltless and released. But the governor of the Bastille, fearing a daylight demonstration in favor of Cagliostro by the people of Paris, only let the Cagliostros out close to midnight. But a tumultuous crowd of almost ten thousand Parisians who considered Cagliostro a hero against whom the king had been arbitrary and unjust, was there to greet them and carry them on their shoulders to their house, acclaiming Cagliostro for his liberalism, his powers as a healer, his generosity to the poor, and his innocence as a victim of the hated Austrian, Marie Antoinette, whom the Parisians believed to have been guiltily involved in the affair of the necklace.

As for the queen, incensed by the release of Cagliostro, she forced the vacillating Louis to order him out of Paris in twenty-four hours and out of the country in twenty-one days. As the Cagliostros' ship sailed from Boulogne, an estimated five thousand French well-wishers waved farewell to the man they considered the greatest living benefactor of mankind.

From London, Cagliostro addressed a letter to the people of France in which he attacked Louis XVI's absolutist regime, prophesying the advent of a new constitutional monarchy in which *lettres de cachet* would be abolished, and predicting that stone by stone the Bastille would be demolished till the people of Paris could dance on its site.

Romantic cliché of the demolition of the hated Bastille

In his memoirs, written in the Bastille, Cagliostro described a childhood in Medina, under the name of Acharat, where he was tutored by an elderly Greek occultist, Althotas, confidential adviser to Grand Master Pinto, who took him to live in the palace of the Grand Mufti Salahyn, high priest of the Moslem religion. There, said Cagliostro, he was taught botany and medicinal physics while being exposed to the wisdom of Islam, eventually traveling to Mecca to be initiated into Chaldean magic and the wisdom of the Assyrian sect of the Old Man of the Mountain—the Hashishin. A further pilgrimage, similar to that of the legendary Rosenkreutz, took him to Egypt to be initiated into the secrets of the Great Pyramid, and be told of the great underground halls where the ancient priests protected a precious store of human knowledge. In Fez, said Cagliostro, while in a trance, he was further initiated into the contents of the Rosicrucian secret books of *T* and *M*.

The widespread publication of this letter in France aroused Louis and Marie Antoinette to further vengeance. Ambassadors and agents of the king were ordered to make life, wherever the Cagliostros might try to enjoy it, impossible.

Grounds for such an action were to be fabricated with the expertise of a professional blackmailer and libelist, Theveneau de Morande, a police informant who for some years had spied on the French community in London, and who lived on a yearly pension of 4,000 francs blackmailed out of Louis XV's mistress, Madame du Barry, by threatening to divulge details of her private life as a prostitute, which, in the end, he did anyway. Morande, as the editor in London of a scandal sheet called *Courrier de L'Europe*, was hired to launch a scurrilous campaign of defamation against Cagliostro and his wife. In a series of articles paid for by Louis, he set to libeling Cagliostro as a charlatan, an imposter, and a petty crook, using for ammunition the evidence fabricated by Madame de la Motte, ordered destroyed by parliament, a surviving copy of which was

Marie Jeanne Bécu, countess du Barry, known as "la sultana," the all-powerful courtesan mistress of Louis XV for whom the diamond necklace was originally designed, before the king suddenly died. In her ghosted memoires she tells how Cardinal Rohan brought Cagliostro to her house to show her her future in a "metallic glass and ebony frame, ornamented with a variety of magical characters," warning her she might not like what she saw. When du Barry looked she fainted—presumably at the sight of her own head rolling from the guillotine on December 7, 1793.

furnished to Morande by Louis's minister of state, Baron de Breteuil. Morande also managed to collect stories from those of Cagliostro's former servants who had stolen from him, or betrayed his confidence, and were now happy to defame him for money. Added to this anecdotal padding were attacks from one of the most dangerous of all sources: those women, such as Baroness von der Ecke, whose favors Cagliostro had declined.

Cunningly, Morande hit upon an assured method for defaming Cagliostro: he attributed to his victim the crimes of a pimp and petty crook, the Sicilian Giuseppe Balsamo, who was known to have been repeatedly arrested for minor crimes and for selling the favors of his pretty wife, Lorenza, to prospective victims. For Morande, it was nothing to charge that Cagliostro and Balsamo were one and the same. For Cagliostro, there was nothing to be done but deny the allegation, which he vehemently did: "It is not I who under the name of Giuseppe Balsamo was driven ignominiously from Paris in 1772. And, it is not my wife, who under the name of Lorenza Feliciani was imprisoned. No police register, no testimony, no investigation by the Bastille authorities, no notice of information, no proof at all has been able to establish that I am Balsamo. I deny that I am Balsamo."

But the libel spread, and as each lurid article, concocted in the best style of red-herring journalism, followed the other, the appetite of readers grew with what it fed on. Using false and anonymous letters to the police, Morande was able to print details so circumstantially lascivious that the public began to wonder if indeed it might not have been duped, if Cagliostro, at least in his early life, might have been the crook Balsamo. As Morande's *Courrier* went the rounds of Europe, Catherine the Great of Russia, turned by her Jesuit friends against Masons, used Morande's material to lampoon all of Masonry through Cagliostro in a series of plays which drew ridicule on the magus as a charlatan and mountebank. Even Goethe, a brother Mason, fell for the *canard*. In disguise he traveled to Palermo to investigate the identity of Balsamo by interviewing his family, and though Goethe obtained not a shred of evidence to support the contention that Cagliostro was Balsamo, he decided to protect his own flank by waffling.

All over Europe, such is the nature of man, people too closely associated with Cagliostro thought it best to dump their former hero. Some of the charges were wild: such as

Gillray's caricature of Cagliostro at a convivial gathering of the Lodge of Antiquity in London in November 1786, where, instead of the sympathy he expected from fellow Freemasons, the magus was ridiculed by one called Mash, an optician, who gave a burlesque imitation of the Grand Cophte of Egyptian Masonry as a quack doctor vending a spurious balsam to cure every malady. Cagliostro was so mortified he withdrew, and left the country.

those of the comte de Mirabeau—never averse to changing coats—who voiced the opinion in a pamphlet that Cagliostro had all along been an emissary of the Jesuits "hatching secret plots in Protestant countries."

In London, whereas the Lodge of Antiquity of the Scottish rite had honored Cagliostro with a magnificent reception on his arrival in November 1786, Masonic friends began to avoid him for fear of being tarred by Morande, especially when his journal accused the membership of the London lodge which had initiated Cagliostro of being composed of "valets and barbers." The atmosphere necessary for Cagliostro to create a lodge of his Egyptian rite in London no longer existed. To avoid trouble with Louis's agents, Cagliostro left for the Continent, alone and incognito.

In Switzerland he was greeted and cared for by staunch Masonic friends, but the atmosphere was no better suited for a prolonged residence. From Switzerland, where Serafina had joined him, the Cagliostros traveled to Turin; but the king of Sardinia, on instructions from Paris, ordered the refugees out of town within twenty-four hours. At Rovereto, in the Austrian Tyrol, where Dante had sought refuge in exile from Florence, Cagliostro was welcomed by old and trusted Masons, who helped him open a lodge of the Egyptian rite by the shores of the Adige. There he set about curing the sick, as usual, gratis, until the doctors, priests, and magistrates joined to force him out of town.

Friends advised him to try Trent, where the bishop, Monsignor Pier Vigilio Thun, an Austrian prince, was much taken with alchemy and occultism. The bishop welcomed Cagliostro and even accepted the possibility that his rite might be accepted by the Church, if only Cagliostro could, as he had done for him, lay out its content to Pius VI, directly, person to person. To facilitate matters, the bishop addressed a letter to the Vatican secretary of state, Cardinal Boncompagni, asking for a safe-conduct for Cagliostro to travel in the Papal States. The cardinal answered that "Cagliostro, being under no prohibition in the Pontifical States, has no need for the safeconduct you request."

Further to aid Cagliostro in his venture, the bishop of Trent addressed letters of recommendation for him to cardinals Boncompagni, Zelada, Colonna, and Albini. After a great banquet in the bishop's palace, on May 17, 1789, just as Mirabeau in Paris was challenging the will of Louis XVI in the States General, precipitating events toward a break with the monarchy, the Cagliostros set off by carriage for Rome to obtain from Pius VI approval for his

When asked to be more specific about his nationality, Cagliostro replied: "All countries are dear to me. All men are my brothers. I am a wanderer. On my way I do what good I can; but I do not tarry. As I pass I leave a little light, a little warmth, a little of myself until all shall be spent at the end of my career, when the rose will flower on the cross. I am Cagliostro. Need I say more? If only you realized that you are, as you are, the sons of God, if you were not so vain, you would have already understood." Asked to explain the secret of his nature, he replied without pomp or vanity: "I am of no time and no place. As a spiritual being I exist eternally, and if I immerse myself in my thoughts going back over the years, if I project myself towards a way of life quite far from that which you may perceive, I can become whomsoever I please. Participating consciously in the absolute being, I best regulate my actions with that which surrounds me. My name is that of my function; and I choose it, as I choose my function, because I am free. My country is the one in which I momentarily pause. Date it yesterday, or tomorrow, if it suits you, and that illusory pride of a grandeur that may never be yours. I am he who is."

Architect Antinori showing Pius VI the newly raised fifty-foot obelisk believed to have been part of Sallustius's circus dedicated to the festival of the goddess Flora. It was now adorned with a spherical star containing a piece of wood reputed to have come from the Most Holy Cross of the Crucifixion, with relics of saints Paul, Andrew, Gregory the Great,

Egyptian rite of Masonry, a move intended to reunite Christian and Mason in the Hermetic dream of a new and progressive order.

And so the trap was set.

Arriving in Rome at the end of May, Cagliostro and Serafina, who was happy to return to her native city and visit her aging parents, were just in time, as they put up at the small hotel della Scalinata on the Spanish Steps, to witness the inauguration of another obelisk raised by Antinori for Pius VI at the top of the steps, facing the Church of the Trinità dei Monti. Placed so that a person standing at the exit of the pope's summer palace could admire from a single spot the perspective of three separate obelisks at the end of the via Quattro Fontane, the via Sistina, and the via XX Settembre, the new monument was clearly an adornment to Rome. But its symbolic function was the more apparent in the face of political trouble in France. Like its predecessors, this obelisk was being raised as an overt symbol of the Church's determination to squash the Hermetic tradition from Egypt manifesting as it was in France through efforts of French Masons, 477 of whom were members of the States General.

Pius's plot was Jesuitical in the extreme. On the pope's direct orders, Cagliostro, from the minute he arrived in Rome, had been placed under surveillance by agents of the Inquisition, not only in the hope that they might ferret

and Pius V. Broken pieces of the obelisk had lain opposite the Lateran Palace ever since Pope Clement XII had stolen them from the garden of the duke of Sora (where they had surfaced among the flowerbeds in 1734), on the excuse that *all* the antiquities in Rome belonged to the Reverend Household. Then came the French connection. In 1765 France's minister of finance tried to buy the needle for 25,000 francs to place in front of Nôtre Dame de Paris. And on the grounds that the entire Pincian Hill had belonged to the kings of France since Charles VIII, the Minimi Friars of the Trinità, afraid the work would undermine their church, appealed to the French ambassador, Cardinal de Bernis, to have the project stopped. Pius VI remained obdurate; the needle went up just as Cagliostro arrived in town, in time to hear the complaints of the populace, who joked about its shortness. Goethe, also in Rome, described a hat at carnival made of a tiny red obelisk atop an enormous white pedestal.

Cardinal François Joachim de Bernis, French ambassador to the Vatican, whose poetry had so pleased Madame de Pompadour he was named minister of foreign affairs under Louis XV. The marquis de Sade, in *Justine,* renders one of the most pornographic poems in the French language, attributing its authorship to the cardinal.

from their secret hideouts the Masons of Rome, but in the hope that Cagliostro might be used as a scapegoat for discrediting Masonry throughout the world. A pirated copy of de la Motte's memoirs, including the false letters she had fabricated as having passed between Rohan to Marie Antoinette, had been delivered to Pius, along with the libelous articles produced by Morande.

Unaware of the trap, and secure in the protection of his letter from the secretary of state, Cagliostro first drew up a petition to Pius, laying before him the regulations and constitution of his Egyptian rite. He then called on the Vatican and left his credentials, declaring that the rise of Masonry in the heart of Catholic countries could not fail to deserve the benevolence of the Vicar of Christ, especially as the ritual had as its preamble: "Love and worship the Lord God with all your heart, cherish and serve your neighbor by doing all the good to him of which you are capable, let your conscience be your guide in all your actions."

Masonic circles in Rome, mostly in the aristocracy, and among foreign diplomats, welcomed Cagliostro, especially at Villa Malta, near Porta Pinciana, the Roman residence of the Knights of Saint John of Jerusalem, a great many of whom were initiate Masons, as was their Roman Master, the Bailly de Loras. There Cagliostro organized Masonic séances, and initiated members of Roman society into his Egyptian rite. In Malta House he was safe, since its grounds were covered by diplomatic immunity. There he performed one séance in the presence of the French ambassador, Cardinal de Bernis, and several members of Rome's nobility, which was later described by an eyewitness, the abbot Lucantonio Benedetti, as taking place in a large hall adorned with Egyptian, Assyrian, and Chinese idols.

When a young female medium described seeing a crowd surging toward Versailles, demanding the overthrow of the king, the French ambassador became much perturbed. And even more so shortly thereafter, when he heard that the revolution had actually started in France, that the scene described by the young medium had actually taken place in real life, conveyed by some occult means. On July 14, as Cagliostro had predicted, the people of Paris seized the Bastille, and slaughtered his old jailer, the Marquis de Launay.

On August 4, ecclesiastical privileges were overthrown in France, there were riots in churches, convents were sacked and burned; the clergy made plans for a civil constitution, separating themselves from Rome. A decree

Caricature of Louis XVI, overwhelmed by the gross burden of both the nobility and the clergy of France

was issued by the National Assembly declaring that all men have a right to think as they choose in matters of religion, and express their opinions on the subject, that man is accountable for his actions, not his beliefs, which are his own business. Man, said the decree, is bound to obey only laws to which he has consented.

In reaction, Pius VI issued a contract to Antinori to raise a third obelisk, in Piazza Montecitorio, before the papal Palace of Justice—ironically the seat of Italy's future parliament, and took immediate security measures to prevent the entrance into the Papal States of potential subversives. Watch was redoubled against a possible uprising among an estimated five thousand armed Masons within the Papal States, who were believed to be only waiting for a signal to rise up with the help of more groups in such Masonic strongholds as Bologna and Ancona. In Rome it was suspected by the Inquisition that Cagliostro had come as a secret agent or commissar of Weishaupt's radical Illuminati to perform just such an action.

Meanwhile, urged by Roman Masons to organize a lodge of his Egyptian rite, Cagliostro chose to do so almost within the shadow of Antinori's Trinità dei Monti obelisk, in the studios of a French painter, a fellow of the adjacent French Academy, Augustin Louis Belle, in whose quarters Masons had been secretly meeting for more than two years. One room, known as the room of "reflection," was draped in black, with a small table holding a skull. A larger room, known as the "Temple," adorned with the usual two columns and various emblems of Masonry, held a throne for the Master.

There, Cagliostro initiated a Capucin monk, a professor of theology in Paris, Father François Joseph Roulier, who said he was attracted to Christian occultism and the symbolism of the Masons, and whom Cagliostro believed might be useful in Rome in furthering acceptance of his rite by the Vatican, or, in the words of Ribadeau Dumas, "uniting the Children of Hiram with the sons of St. Peter." Far from being of help, the Capucin is believed by several historians to have been an agent of the Inquisition. The first documentary piece of evidence against Cagliostro, produced after the Capucin became his secretary, was a letter addressed by Cagliostro to the French States General, over which Cardinal Rohan was then presiding, in which he asked to be allowed to return to live in France; it was passed straight into the hands of the Inquisition. The letter, evidence enough of revolutionary leanings, prompted the Inquisition's first move, which was to put pressure on the family of Serafina, obliging her father, by who knows what sinister methods, to sign a complaint against Cagliostro for practicing Masonry—a crime forbidden by law in the Papal States.

Immediately Cagliostro was warned by a fellow Mason, Giuseppe Ferretti, that trouble was at hand. Other Masons secreted their incriminating emblems and went into hiding. Cagliostro, confident of his own good faith, and of his letter from the secretary of state, did nothing to protect himself, other than send out an appeal to other Masons in Rome to come to his rescue in case he was taken prisoner. What Cagliostro did not know was that Cardinal Boncompagni was no longer secretary of state, having just been opportunely replaced by Cardinal Zelada.

Cardinal Francisco Zelada, Vatican secretary of state, a Spanish Jesuit, who spent many years in charge of the secret Vatican archives

On December 3, 1789, Pius VI turned over his dossier on Cagliostro to the supreme tribunal of the Holy Office. The assessor requested the arrest of Cagliostro. On Sunday, December 27, though it was the Feast of Saint John, and a holy day, on which one did not arrest, the pope, for fear that Cagliostro might flee the trap, granted the special request. Monsignor Rinuccini, governor of Rome, ordered Cagliostro seized, and Belle's studio searched.

About 10:00 P.M. a squad of papal grenadiers broke into

Cagliostro's lodgings and carted him off to Castel Sant'-Angelo. Serafina was taken to a convent. All of Cagliostro's papers and correspondence, all of his Masonic impedimenta, were seized; no effort had been made by him to hide any of this material, sufficient to incriminate any man as a Mason. Hardly the precaution of a Weishaupt agent of subversion.

Some prominent Masons were arrested in the city, including the duke of San Demetrio. The marquis Vivaldi managed to disappear in time, and his wife, dressed as a man, fled to Venice. Loras, master of the Knights of Saint John, escaped to Malta. Yet, from the documents found in Cagliostro's house, and from the contents of Belle's "Temple," the Inquisition was able to reconstruct only the secret Masonic ceremonial, and the dress of the officers, but not the inner meaning of the ritual, the mystery of which had to be revealed from initiate to initiate, as Cagliostro had hoped to do in person to Pope Pius VI.

For fear that someone might attempt to liberate Cagliostro, the guard was doubled at Castel Sant'Angelo. No one without a special pass was permitted within. So serious was the threat considered that Carnival festivities were canceled in Rome lest Masons take advantage of fireworks to pull some trick.

From his dungeon Cagliostro was brought before a group of top Inquisitors, including Cardinal Zelada and Cardinal Antonelli, head of the Church's Propaganda Office. The governor of Rome was present, as was the state treasurer, Monsignor Giovanni Barberi, acting as Inquisitorial secretary. Hardly the talent required to interrogate the petty crook Balsamo, whom the Inquisition, using Morande's Jesuitical device, now claimed to have in their hands. Forty-three times, over a period of almost a year,

Interrogation by the Inquisition at the end of the eighteenth century

Grilled by the Inquisition

Cagliostro was grilled by various Inquisitors. No record is available of what transpired at his so-called trial, carried on in absolute secrecy. All documents relating to it have disappeared or been suppressed.

It is even difficult to reconstruct what happened to Cagliostro during his imprisonment in Castel Sant'Angelo, or the degree to which he was tortured. It was rumored he had been strangled so that Balsamo could be put on trial in his place to show that the law was dealing not with a personage of importance, but with a mean delinquent. Though how popes, cardinals, archbishops, ministers, and the crowned heads of Europe, could, for twenty years, have had social intercourse with a creature so mean and so villainous as Balsamo was painted, was never explained; nor was the fact that everywhere Cagliostro had been in Europe he was idolized by those he met and cured and by them was considered to be a great and enlightened benefactor of humanity.

All that came out of the trial was the judgment, passed by the tribunal of the Holy Office on March 21, 1791. A week later, in chains, his head veiled in black, in the presence of Pius VI, the prisoner was forced to kneel and hear his sentence. Giuseppe Balsamo was condemned to the penalty established by Clement XII and Benedict XIV against heretics, dogmatizers, heresiarchs, masters of superstitious magic: death by burning.

Pius, with the excuse that he wished to allow the prisoner more time to repent—but clearly not wishing to create another martyr by blood—piously commuted the sentence to perpetual imprisonment in a fortress, without hope of pardon. Posted on the streets of Rome, between the holy figures of Saint Peter and Saint Paul, the decree stood for all to read and take warning that to be a Mason in the Eternal City was a capital crime, one the Church intended to proscribe forever. Using the occasion as pretext for a general denigration of Masons, Pius issued an apostolic edict confirming and reinforcing previous pontifical edicts against Masonry, invoking the severest corporal punishment of death against anyone practicing the rituals, especially those of the Egyptian rite.

The same day, there appeared for sale on the streets of Rome a pamphlet printed by the Pope's Reverend Household anonymously written, which purported to be a compendium of the life and deeds of G. Balsamo known as Count Cagliostro. Its author was the Inquisitorial secretary, Giovanni Barberi, not a Jesuit as most historians aver, but a lay monsignor, who chose this method—one of the grossest injustices— to defame and vilify a prisoner with no means whatsoever of defense.

What Cagliostro may or may not have said under torture is moot; the top secret dossier of the minutes of his trial has not been made available from the Vatican archives. Barberi's compendium is the sole known source for Cagliostro's supposed revelation of a secret meeting with the heads of Weishaupt's Illuminati during which he is said to have received large sums of money to spread their propaganda and "illuminize French Masonry." To this charge the French translator of the compendium arbitrarily added a preface associating Cagliostro with "the gloomy follies of the German Illuminati," accusing the German sect of "surrounding thrones, blindfolding sovereigns in error and keeping from them men of talent and vision," a charge repeated to this day by right-wing propagandists. The hero of Barberi's compendium is described as "short, dark-skinned, plump, surly-eyed, speaking a Sicilian dialect mixed with an ultramontane vernacular, without cognition, science, void of any resource that might make it beloved. . . ."

This of the Cagliostro who had constantly frequented the highest society and the greatest minds in Europe, described by those who knew him as "intelligent, sympathetic, gay, temperate, active, at ease with princes and all the great, whom he considered he could help but from whom he required nothing in return," and, by Maurice

Among Cagliostro's effects confiscated by the Inquisition was a seal consisting of a serpent pierced by an arrow and holding an apple in its mouth. This serpent has been interpreted as the green dragon of Hermetic philosophy, or the Hebrew letter *Aleph*, symbolizing equilibrated unity. Another source has interpreted it as a sigil of the three celebrated emblems carried in the Greek mysteries: the phallus *I;* the egg, *O;* and the serpent, Φ—the first being the emblem of the sun, the second of the female, the third of the destroyer and reformer, eternally renewing itself.

Magre, in his *Return of the Magi,* as having had "a broader view of events and human nature than any other man in history." It is easy to understand, says Magre, why his followers called him the "Divine Cagliostro." "A marvelous spirit had descended into him."

Is this the same person of whom Barberi asks: "How could such a man have had access to gracious women whom he managed to deviate from the path of virtue?" To which he replies: "The women he was able to conquer were all so old and so ugly they could find no other mate than Balsamo." The magus's famous cures, says the compendium, were all the result of pure chance, or not cures at all. His Egyptian elixir "was nothing but cheap wine with some aromas capable only of exciting the vertigo of sensuality." Balsamo-Cagliostro was labeled a thief, a pimp, a counterfeiter, a syphilitic, a criminal wanted by the police of several countries.

No mention whatsoever was made in the compendium of the role of Cardinal Rohan, nor of his description of Cagliostro as "the most extraordinary man, the most sublime, whose knowledge is equalled in the world only by his goodness."

Yet this libel by Barberi is what became the prime source for future historians. Thomas Carlyle, in a vicious attack on Cagliostro, whom he never met, admitted having based his entire work on Barberi's compendium.

W. R. H. Trowbridge, another major biographer of Cagliostro, sums up the case: no proof was, or ever has been, brought forth in support of the libels. Not a word of testimony was heard in support of the list of crimes of which Cagliostro was accused. No witness in court or elsewhere ever identified Cagliostro as Balsamo. The family of neither was summoned to Rome to give evidence. No proof was formulated.

Dr. Marc Haven (whose real name was Emanuel Lalande), a member of the cabalistic order of the Holy Cross, in his earlier biography of Cagliostro, calls the magus "a human being as sublime in love as in wisdom," and concludes: "No one every proved Balsamo and Cagliostro were the same person." As Henry d'Almeras puts it in his *Cagliostro and Freemasonry in the Eighteenth Century:* "From his whole life they were able to substantiate only one single crime, that he had been a Free Mason, a crime which the pontifical bulls punished with death."

By striking down a petty Balsamo, the Church hoped to discredit all of Masonry as a phony font of religious tolerance, of liberty, equality, and fraternity, a slogan attributed to Cagliostro, as terrifying to established institutions as it was appealing to their victims. Now every last Mason in Europe who had known or frequented Cagliostro would be made to feel the shame of having been deluded by a quack and a charlatan, a pimp and a snake-oil peddler. Masonry and its officials would be made the laughingstock of Europe for having fallen for such "garbage" as Cagliostro had conveyed in his "spurious" Egyptian rite. All liberal ideas would be as discredited as the Masonic leaders who had supported them.

Further to demean Cagliostro, he was forced, barefoot, in penitent's garb, with a candle in his hand, to walk between two lines of monks from Castel Sant'Angelo to Santa Maria Sopra Minerva, the ancient temple of Isis, where he was obliged to kneel before the altar and abjure his errors. In the same piazza, in the shadow of the obelisk raised by Kircher in memory of one Hermetic pope, Cagliostro's manuscript on Egyptian Masonry, declared "seditious, heretical, blasphemous, and tending to destroy the Christian religion," was given to the flames by the hand of the public executioner. With it were burned all of Cagliostro's Masonic emblems. Lost to the world, as the crowd clapped and shouted, were his *The Ritual Rules of Egyptian Masonry, Concerning the Beatific Vision, Concerning the Evocation of Higher Spirits, Physical and Moral Regeneration, The Art of Prolonging Life, The Art of Making Gold, The Divine Cabala,* and *Astrological Calculus*. Masons tried to defend Cagliostro's position, but the reaction was ruthless, and their pamphlets were bought up and destroyed by Church and police.

Of the homages paid to Cagliostro shortly after his condemnation, perhaps the most tender and lasting came from his fellow Mason Wolfgang Amadeus Mozart. In *The Magic Flute,* first produced in Vienna on September 30, 1791, Mozart portrayed the Grand Cophte of the Egyptian rite as Sarastro, the high priest of Isis and Osiris, central figure of the opera, venerated by his followers.

From Rome, Cagliostro was taken in chains by forced night marches to the fortified bastion of San Leo, atop a peak in the Montefeltro Mountains near San Marino, the most feared prison in Italy, whose inmates were known to have been driven mad in a matter of weeks. The marches across the Apennines took place in the dark for fear that someone might recognize the prisoner and make an attempt to free him. At San Leo, Cagliostro was placed in a dungeon which had served as a water cistern, deep underground, and when it was rumored that a group of French Masons might be preparing to land around the fortress from balloons, the jailers, warned by Cardinal

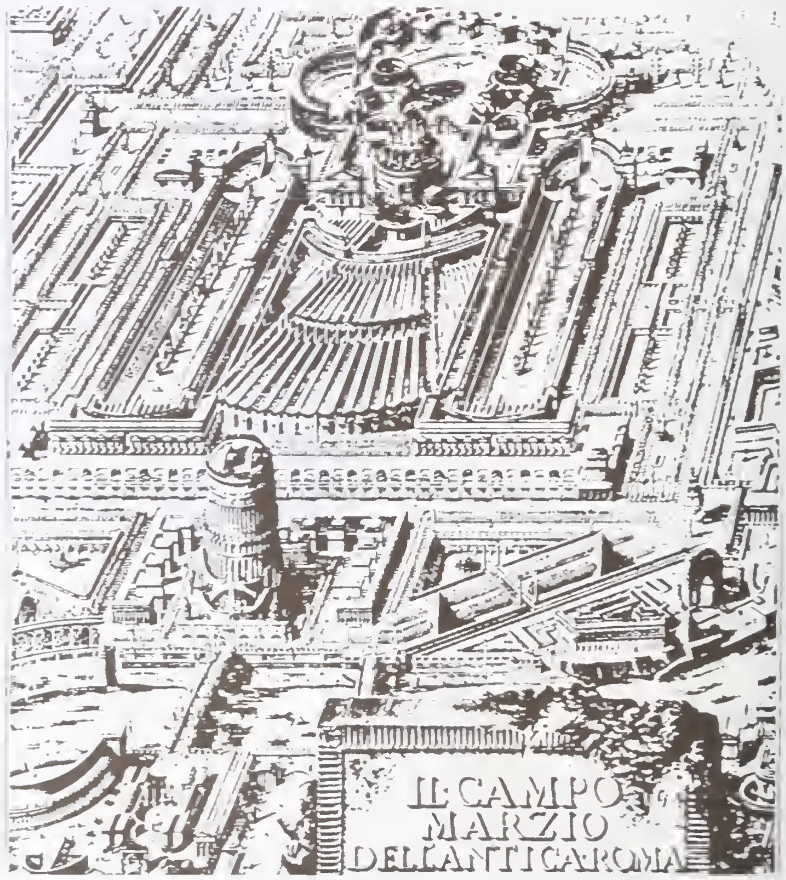
The reputedly impregnable Castle of San Leo, where Cagliostro was immured

Zelada that they would pay with their heads for Cagliostro's escape, walled the prisoner up alive, leaving only a small hole through which to spy on him, pass him his gruel, and torment him with the same question posed to Christ on the Cross: "If you are really the Son of God, why don't you call on your angels to set you free?"

Still hoping for a pardon from Pius, that he might seek refuge in revolutionary France, Cagliostro had a message sent to the pope warning him that a girl dressed as a page would try to stab him, that eventually he would lose his temporal powers and be taken a prisoner from Italy. The girl was apprehended; but it did nothing for Cagliostro, other than validate his clairvoyant powers. Pius was too busy unveiling his last obelisk in the Piazza Montecitorio before a great throng in the presence of Mesdames

The obelisk raised by Pius VI on Montecitorio—opposite the papal court of justice and future seat of Italy's Parliament—was his most important venture, if only because at last some attention was paid to the original point and purpose of such monuments. First raised in Heliopolis by Psamometitos II of the Saite dynasty, the obelisk is described by Pliny the Elder as having been brought from Alexandria to Rome by Augustus in 10 B.C. and set in a marble pavement in the Campus Martius marked out with bronze stripes and decorated with mosaics representing wind roses and the constellations of the zodiac; its purpose was to serve as a great gnomon, or sundial. The pavement, says

Pliny, was laid out for an appropriate distance so that the shadow of the obelisk at noon on the shortest day of the year exactly coincided with its height. Bronze rods let into the pavement measured the shadow day by day, as it gradually became shorter and lengthened again. According to Pliny the device had been engineered by the mathematician Novius Facundus, though others attributed it to Manlius. Unfortunately, Pliny was not explicit enough to make it clear whether the monument served only as a *solarium,* to indicate the length of the meridian shadow, or also as an *horologium,* to indicate the hours of the day. In any case, something went wrong with the device, for Pliny reports that after thirty years its astronomical indications no longer corresponded. This he attributed to a change in the path of the sun, or to some other heavenly change, or because the earth had shifted its axis, or because of earthquakes which could have tilted the needle. Pliny even considered that the foundations could have been affected by inundations of the Tiber, though he discounted this explanation, "as the obelisk's foundations are as deep as it is tall." The needle was reported still standing in the eighth century A.D., and Iversen believes it to have been knocked down by the Norman Duke Robert Guiscard who put Rome to



the sack in 1084 while freeing the tyrranical pope Gregory VII from imprisonment in Castel Sant'Angelo. It disappeared again until discovered by a barber in his cellar, where Fontana took Sixtus V to see it in 1587, though they buried it again as too burned and damaged to raise. In 1666 Kircher suggested to Alexander VII it would be easy to dig up the broken pieces, but his patron died too soon. A few years later, Cornelius Meijer, a Dutch inventor living in Rome, suggested raising the obelisk to serve as a solar gnomon, adding that because of the narrow vertical slit in the bronze ball atop the needle it might be used not only to note the passage of the sun's rays but also for sighting the north star and thus counting off the hours of the night. But Innocent XI was too weak for the job, which was left to Benedict XIV who jovially agreed to inspect the needle through a wall dug through the cellar of the Lottery. To extricate the five broken pieces without destroying the economically essential Lottery, the pope had recourse to an extraordinary old man called Niccoló Zabablia, a very rough fellow, who could neither read not write, and could barely express himself in words, but was renowned for the invention of simple machines to move great weights in restricted areas. Between May and August 1748, Zabablia brought out the five pieces and lay them in the filthy courtyard of the Palace of the Lotto. Benedict came in a carriage to admire, but as no architect dared raise the fragments they lay in a courtyard until Pius VI dragooned Antinori into accepting the challenge. Six days before the storming of the bastille he had it raised as a symbol against revolution. When the obelisk had first been discovered, Romans digging wine cellars and latrines had found beautifully wrought bronze constellations and a sundial clock with seven gilded degrees. This led to a dispute between what d'Onofrio calls the *eruditi* and the *matematici* as to whether the obelisk could function as a clock for Romans or merely as a rough gnomon to observe the sun's shadow from solstice to solstice. Pius's papal treasurer, Cardinal Ruffo, convinced that it could do both, hired a quarryman to carve out a series of marks in the cobbles of the piazza to indicate the hours of the day by means of the shaddow cast by the ball atop the obelisk, as well as along a meridian to mark the solstices. An immediate cry was raised by Rome's professors who argued against the "vain design" of having an obelisk serve as a sundial. d'Onofrio quotes two illustrious opponents. One, Giacomo Pessuti, ridiculed the idea of an *horologium* "for reasons . . . obvious to anyone with the slightest tincture of optics or astronomy." Obelisks, he argued, had naturally fallen into disuse as gnomons because of "the advent of wheeled clocks." He also claimed that heavy traffic of pedestrians and carriages would render the venture useless. Another opponent, the abbot Giuseppe Calandrelli, noted ironically "that the project would make the papal states ridiculous, as if they were without an elementary knowledge of astronomy, reduced to establishing noon with the use of a gnomon." He compared the situation to "a poor lay Capucin who, in his miserable kitchen garden, has to stick a nail in the wall to indicate to his bretheren when it is noon." But Ruffo had his way, and onto the base went an inscription in Latin: "Royally raised as a pyramid marking the time on its dial, long in a dunghill it rested, broken, disdained, and forgotten. Now to new splendour and dignity called by Pius VI, proudly it counts with its shadow each of his glorious hours."

de France, Adélaïde and Victoire, the two maiden great-aunts of Louis XVI, living daughters of Louis XV, who had managed to escape to Rome from the Revolution. As an overt display of the antirevolutionary feelings rife at the papal court, the ceremony was, like the puffed-cheek Aeoli of the papal arms which adorned the obelisk's pyramidion, whistling in the wind. Two weeks later Antinori was dead. Shortly thereafter the Mesdames de France died miserably in Trieste; as for the pope, he was burned in effigy in Paris, a foretaste of what was in store for him.

In San Leo, unable to take his rejuvenating elixir, Cagliostro realized he was doomed, and made his last prophetic announcement: "I will be the last victim of the Inquisition; for when I come to eternity I will pray so hard there will come a new order upon this earth."

It was June 8, 1795.

On August 23, according to the prison record, Cagliostro suffered an apoplectic stroke. A Capucin monk, Cristoforo Cicerchia, ran to his side, imploring him to make peace with the Church: "You still have a few moments in which to buy yourself a good place in heaven," he pleaded. But Cagliostro refused. He would neither repent nor confess. On August 26, as recorded in the parish register, Cagliostro expired. As a heretic, his body was ordered by the local bishop to be buried in unhallowed ground with no religious rite.

The daughter of one of the jailers reported, some years later, that in his cell Cagliostro had painted a full-length portrait of himself using a brush made from the hairs of his beard and color from the rust on the cell bars; it showed Cagliostro dressed in pontifical robes pointing to the image of a Masonic temple on his bared chest; beneath his feet were the emblems of the Catholic Church.

An eyewitness described four men bearing his body on an old broken door. At the bottom of the hill, sweating because of the August heat, the bearers deposited their load by a well to have a drink in a nearby wineshop. Sufficiently inebriated, they dug a hole on the promontory, into which they placed a brick as a pillow for the corpse's head. Its features covered by an old used handkerchief were buried in earth.

Two years later, on December 8, 1797, as Napoleon returned to Paris to capitalize on his Italian victories, the castle of San Leo surrendered to General G. E. Dambrowski of the Polish Legion of Napoleon's Cisalpine Republic, and its inmates were released, so the story goes, to dig up Cagliostro's grave and use his skull to swill wine as a toast to their liberation. Ironically, the

French troops entering Rome from the Flaminia to congregate in Piazza del Popolo around the obelisk of Augustus, reerected by Sixtus V

presence of the French troops in the Papal States was precipitated by the murder in the streets of Rome of the French agent Hugo de Basseville by a group of conspirators headed by Cagliostro's inquisitors Giovanni Barberi and the Cardinals Zelada and Albini.

When General Duphot of the French embassy, who was engaged to Joseph Bonaparte's sister, was also murdered, Napoleon's General Louis Alescanshe Berthier, later Prince of Wagrom, captured Rome, set himself up in Pius's Quirinal Palace, and declared the Papal States a republic. Barberi was condemned to death for this second overt act of murder, done presumably on orders from, or with the consent of, the pope. Particular severity was exercised against Barberi, says historian Jean François de Bourgoing, because he was "deservedly hated on account of the influence he acquired, and of the persecutions by which he had harassed all the inhabitants of Rome—whether natives or foreigners." According to Bourgoing, Barberi's exceptional actions arose from his prejudices and his ignorance, "Being exclusively versed in criminal jurisprudence, he was unacquainted either with political affairs or with mankind." But whereas Barberi managed to escape and hide out in what was then the inaccessible wilderness of Monte Argentario, beyond the lagoon of Orbetello, Pius VI, in his eighties, his legs

Pius VI taken prisoner by Napoleon's troops in Rome. In one day the pontiff's nephews, Cardinal Braschi and the duke of Nemi, sank from opulence to beggary.

paralyzed and unable to flee, was forced to cede to France the papal lands of Avignon, Ferrara, and Romagna. Taken prisoner, first to Siena, then to Florence, then to Turin, and eventually to Grenoble, Pius VI was never again to see the Rome he had adorned, nor the obelisks with which he had adorned it.

What remained of Pius's fame was an enormous folio volume of nearly seven hundred pages, *De origine et usu obeliscorum,* commissioned by him from the Danish scholar Jorgen Zoëga, who had settled in Italy in 1783, which came off the presses as Napoleon's troops invaded Rome. The volume, greeted as the most comprehensive and dispassionate survey of Egyptology that had yet appeared, contained in the first two chapters the accumulated material from classical authors on which what was known of Egypt was based. There followed an archaeological and historical description of all the known obelisks in Europe and Egypt, taken mostly from Mercati, Bandini, and Kircher, to which Zoëga added an excursus on pyramids.

Jorgen Zoëga at work on his obelisk book

Though Zoëga declared his purpose to be the collection and exhumation of all the evidence from authors ancient and modern which had any bearing at all on the obelisks of Egypt, he found the data to be "absurd," thus missing the whole point of what he was studying. He did show, by detailed measurements, that most of those proposed by his predecessors were not even consistent and he did attack the problem of the hieroglyphs. The volume contains the most extensive and carefully reproduced collection of original hieroglyphical inscriptions published till then. What is more he stressed the distinction between the hieroglyphic script and the large-scale drawings which often accompanied them, showing that the direction of hieroglyphic writing was indicated by the figures facing the start of each line.

In his attempt to classify the number of separate glyphs, Zoëga reached a total of 270 on the obelisks themselves, and 958 including all the inscriptions in European museums. From this he deduced that the total was not nearly large enough for an entirely ideographic script in which each word of the language has its own separate sign. This led him to suggest that certain figures of animals, birds, or plants used in the hieroglyphs might represent letters that could be read as sounds. This suggestion constituted the first ideational breakthrough in the decipherment of hieroglyphs; it also contributed the first modern European usage of the words *phonetic signs,* or *notae phoneticae.*

On the negative side, Zoëga concluded that there were no esoteric or symbolic secrets whatsoever involved in the shape of the great obelisks: that their slender pyramidal shape arose solely from considerations of aptness, beauty, and durability, "so that there was no mystery about it." A mystery there was: but he had missed it, as had Pius. And all the time the evidence had been within their grasp.

As General André Massena's troops went through the liberated Castel Sant'Angelo, they discovered an anonymous manuscript which had been seized in Cagliostro's lodgings on the day of his arrest. Entitled *La Très Sainte Trisophonie,* or *The Most Holy Threefold Wisdom,* it was a beautifully handwritten work with a score of colored illustrations and many glyphs. That it survived the fires of the Inquisition is due, most probably, to the apparently totally innocuous allegorical language in which it is written.

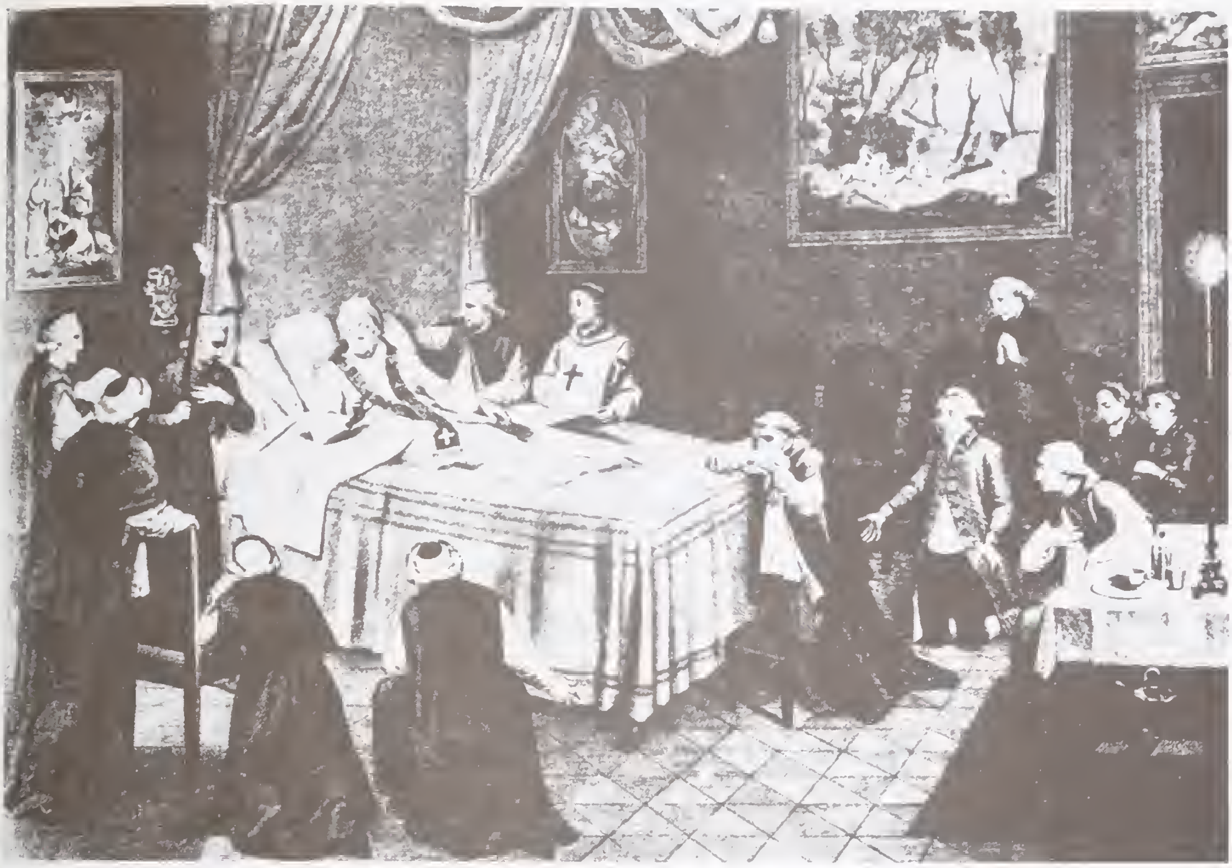
Grillot de Givry, who first commented on the discovery in his *Musée des Sorciers,* just over a hundred years later, interpreted the text as cabalized alchemy, presumably from the pen of Saint-Germain, one of the sole remaining documents attributable to this timeless sage of the eighteenth century.

Manly P. Hall's reprint of the only remaining text of this rarest of occult works

Illustration in *La très sainte trisonophie* of a couple scrying. Theodore Bersterman, in his treatise on crystal-gazing published in 1924, says: "Scrying is a method of bringing into the consciousness of the scryer by means of a speculum (or mirroring surface) through one or more of his senses the content of his subconscious, or rendering him more susceptible to the reception of telepathically transmitted concepts, and of bringing into operation a latent and unknown faculty of perception."

But it was not until the middle of the twentieth century, when the Californian philosopher Manly P. Hall reproduced the book in its entirety from the original and only example, now in the library of Troyes, adding copious notes and a prefatory text, that it was shown to be "in every respect an authentic ritual of the Society of the Rosicrucians, possibly the actual record of Saint-Germain's own acceptance into the mystical brotherhood of which he finally became the Grand Master." The early sections, says Hall, seem to derive their inspiration directly from the neo-Egyptian ritual called the rite of Memphis.

That Pius and his cohorts missed the mystery, unable to decipher the Hermetic meaning behind the overtly blameless story, is explained by Edward C. Getsinger, an authority on deciphering ancient texts, who found that the volume contained the most ingenious codes and methods of concealment he had ever encountered; "a perfect example of how symbolism is used to intimate truths too dangerous to reveal."



Pius VI on his deathbed in captivity

It is clearly, says Hall, a threefold enigma. "From its symbolism, it seems that one of the keys is alchemy, or soul-chemistry; another Essenian Cabbalism; the third Alexandrian Hermetism, the mysticism of the later Egyptians." Those who wish to consult Manly Hall's notes may come as close as it is possible in an overt document to learn the truths for which Cagliostro laid down his life, truths which were only to reappear in the next century with the discovery of the Egyptian so-called *Book of the Dead*.

But none of this was for Pius. By the time he was taken from Rome, Saint-Germain had vanished from the scene. And, in condemning Cagliostro, the poor pontiff had managed to bury the one clairvoyant who might have given him a clue to the mysterious meaning of the obelisks and their glyphs, just as, in patronizing Zoëga, he had managed to bury in a tome of pluperfectly pedantic Latin, the whole subject of obelisk and glyph.

And there it lay, requiescent, but not in peace. Sadly, Zoëga admitted his failure: "When Egypt is better known to scholars, and when the numerous ancient remains still to be seen there have been accurately explored and published, it will perhaps be possible to understand the meaning of the Egyptian monuments."


GAZA
ABOUKIR
N

8. NAPOLEON REDISCOVERS EGYPT

Jean Jacques Champollion (Figeac)

Jean François Champollion (le Jeune)

Frontispiece of the *Description de l'Égypte* with Napoleon's imperial *N*

As Pope Pius VI lay on his deathbed in August 1799, a young French professor of history at the university of Genoble, Champollion-Figeac, had been pulling strings to get himself named to a group of savants being selected by the twenty-nine-year-old General Bonaparte to accompany him on his conquest of Egypt.

Jean Jacques Champollion had already added to his surname the appellation of his native town of Figeac in order to distinguish himself from his eight-year-old brother, Jean-François, for whom he anticipated a great future, and whose limelight he did not wish in any way to shade. Convinced that the boy had a truly remarkable mind and deep devotion to scholarship—at four he had learned to read and write by comparing a written missal with the prayers he had learned by heart—the elder Champollion had taken the youngster into his home to give him special tutoring in advanced studies. To repay his elder brother's courtesy in calling himself Figeac, the younger Champollion added to his own name that of Le Jeune, or Junior. But because of his olive complexion, curly black hair, and slightly slanted eyes with yellow irises, which gave him an oriental appearance, his sister-in-law called him Sagir, the Arabic word for "junior," a nickname which stuck to him for life.

Despite strong recommendation, Champollion-Figeac was not selected to go to Egypt. But the Paris Directorate was only too happy to be rid of Napoleon, whom they considered an irritating and formidable rival. His overt object was to cut off Britain's route to India. A stronger motivation was his driving search for fame. "I must seek it in the East; all great fame comes from that quarter." In the footsteps of Alexander the Great, Napoleon wished to conquer the world, but first he had to conquer the East, overthrow the Turks, seize Constantinople, take Europe in the rear, paving the way for the fall of India, China, and the world.

The idea was not original. It had already been envisaged by Sixtus V in 1587 when he outlined the scheme to the Venetian ambassador, Giovanni Gritti, in his lamentably vernacular Italian: "A little money, a little money, Mr. Ambassador, and I could send an army into Egypt. Seven-

General Napoleon Bonaparte

Obelisk raised at Rouen in honor of Napoleon's victories in the Italian Campaign

ty or eighty galleons, well armed, would do the trick. I could seize and fortify Alexandria and be master of Egypt. It would buy off the inhabitants and make them into Christians, perhaps even with the help of Arabs who are against the Turks." Sixtus even had the genial notion of cutting a canal to Suez, but was afraid the difference in water level in the Red Sea might cause a dangerous flood in the delta.

An occupation of Egypt by the French had also been envisaged by another student of hieroglyphs, the German philosopher and mathematician Gottfried Wilhelm von Leibnitz, discoverer of differential and integral calculus, who had suggested the idea to Louis XIV. Leibnitz (who had been offered custodianship of the Vatican Library but had turned it down because he would have had to join the Catholic Church), like Zoëga, did not agree with Kircher's belief that the hieroglyphs contained esoteric wisdom. He considered the inscriptions on the obelisks to be merely "historical texts commemorating events and victories."

Napoleon, as a freethinker, was more sanguine about cracking the riddle, which his Masonic friends in Paris convinced him was essential to a proper understanding of political history. To do the job, he had deliberately collected some 150 scientists and artists, many of them Masons, recruited from the Académie des Inscriptions, including scholars of the highest distinction, such as Gaspard Monge, Étienne Geoffroy Saint-Hilaire, Edmé François Jomard, Claude Louis Berthollet, and Jean Baptiste Joseph Fourier. That obelisks were on Napoleon's mind is evident from the story that his wife Josephine, also a Freemason, came to see him off at Toulon, and asked him, as she kissed him good-bye, to bring her back one from Thebes, even if it were only a small one.

On May 19, 1798, Napoleon's armada sailed with thirteen ships of the line, fourteen frigates, seventy-two corvettes, and nearly four hundred transports carrying forty thousand troops. In his cabin, Napoleon carried with him the Bible, the Koran, the Vedas, a book on ancient mythology, Montesquieu's *Spirit of the Laws*, translations of Thucidides, Plutarch, Tacitus, Livy, and several books on such military commanders as Turenne, Condé, Luxembourg, and Marlborough. For lighter reading, he took along Cook's *Voyages* and forty English novels.

His archrival, Horatio Nelson, somewhere at sea in the Mediterranean, was cruising with his squadron in the hope of intercepting and destroying the French armada. But the two great fleets, each commanded by a Freemason, silently passed in the night, narrowly missing an encounter.

Six weeks later—after stopping in Malta to loot the treasure of its Knights—the French squadron reached Alexandria on July 1. Napoleon's troops quickly seized the town, once a sophisticated metropolis of half a million souls, with 4,000 public baths and 400 theaters, which had been reduced under the Ottoman Turks to no more than a village of four thousand souls. A miserable march through the desert took the expedition to the Giza plateau. There, at the great Battle of the Pyramids, Napoleon defeated sixty thousand Mameluke warriors by letting their intrepid horsemen shatter their silk-and-gold-laden bodies against the firepower of his classic infantry squares.

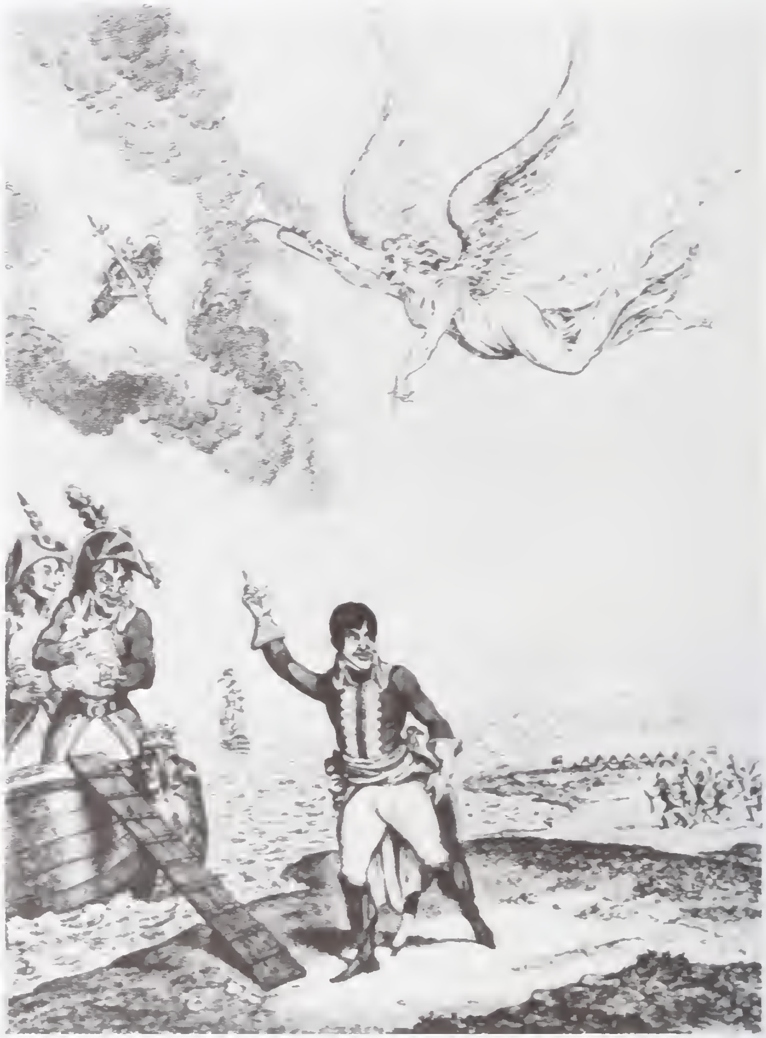
In three weeks, Bonaparte's generals chased the remnants of the Mamelukes up the Nile as far as the Aswan cataract. With the entire country subdued, Napoleon declared Egypt a French protectorate. Promising to treat local citizens with restraint and respect, he set up in Cairo a government which included prominent Egyptians. It was then safe for his savants to be let loose to loot the country of its ancient treasures as they unearthed temples, dug into pyramids, and measured obelisks for transfer to Paris. Soon they had collected antiquities from all over the country, housing them in a special collection in Cairo. Thus came to light a slab of black basalt found by a detachment of French soldiers working on fortifications near the village of Rashid or Rosetta. From this discovery it looked at last as if the key to the unravelment of the secrets of Egypt was at hand. The stone was covered with inscriptions in three distinct scripts: one hieroglyphic, one mysterious, one clearly Greek.

But the French had counted without Albion. A short distance from Rosetta, in the Bay of Aboukir, Nelson caught the French fleet by surprise. As brilliant at sea as Napoleon was on land, the young admiral trapped the French between two fires and sank all but one of their ships of the line, leaving the French army stranded in Egypt in the midst of a population rapidly growing hostile.

Nelson wounded during the Battle of the Nile

From this victorious Battle of the Nile there mushroomed a coalition of British, Turks, and Arabs, determined to expel the French from Egypt. When an uprising in Cairo caused the death of several hundred French soldiers, Bonaparte retaliated by shooting and beheading the insurgents, rolling their heads in the squares. En route to attack the pasha of Acre, who had raised an army, Napoleon captured Jaffa, but unable to feed or guard three thousand prisoners, he had them shot to a man, wiping out the male population of the city, an act of cruelty so heinous it put marrow into the defenders of Acre. Thus this last stronghold of the Templars, which had fallen to the Moslems in 1290, now cost Napoleon an empire. When the town would not surrender, blocking the would-be world conqueror's way to the East, Napoleon bitterly remarked: *"J'ai manqué ma fortune à Saint Jean d'Acre,"* and began his first retreat.

To save his reputation at home, this general of the French stole secretly from his troops, sailing on the sole frigate that had survived the British attack. Once more slipping past Nelson's fleet, Napoleon reached Corsica well before the news of his defeats, to be greeted as a hero, a welcome which paved his way to the coup of 18 Brumaire and his being named consul of France, then first consul.

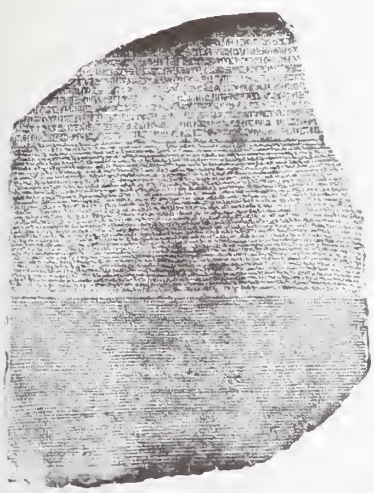


Cartoon lampooning Napoleon's clandestine flight from Egypt

Meanwhile, the British general Sir Ralph Abercromby had landed an army at Aboukir Bay, 14 miles northeast of Alexandria, and attacked Napoleon's abandoned forces.

General Abercromby dueling with French dragoons

So stalwart was the conduct of the foot soldiers of the Twenty-eighth Gloucestershire Regiment, heavily engaged by the French *par devant et par derrière,* that they gained the unique distinction thereafter of wearing their badges both at the front and back of their headdress. Even Sir Ralph distinguished himself by engaging in personal combat with some French dragoons, until the French, facing capitulation, fired a few volleys and quit. From one of these last volleys a spent ball struck Abercromby in the head. Succumbing in the moment of victory, he left to his number two, General Hely Hutchinson, the honor of receiving the surrender of the French. Gallantly, the Englishman gave the debris of Napoleon's army free passage back to France.



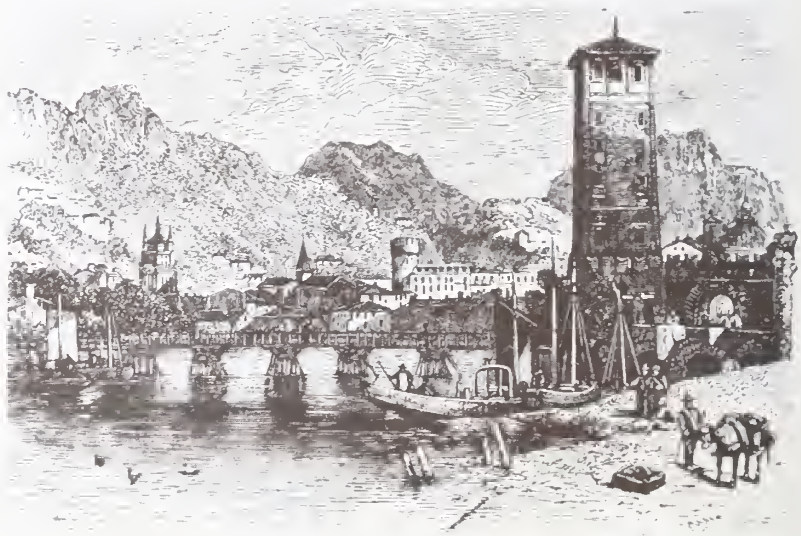
The Rosetta Stone, described in the *Courrier d'Égypte* as of very fine-grained black granite, found by Pierre François Xavier Bouchard, an officer in the French engineers, at Fort Jullien, Rosetta

But all the antiquities collected by the French, including the Rosetta Stone, were claimed by the British as spoils of war. Hearing the terms, the savants rose in rebellion and refused to part with their trophies. Saint-Hilaire did not mince his words: "You are taking from us our collections, our drawings, our copies of hieroglyphs; but who will give you the key to all that? . . . Without us this material is a dead language that neither you nor your scientists can understand. . . . Sooner than permit this iniquitous and vandalous spoilation we will destroy our property, we will scatter it amid the Libyan sands and throw it into the sea. We shall burn our riches ourselves. If it is celebrity you are aiming for, very well, you can count on the long memory of history: you too will have burnt a library in Alexandria." General Hutchinson, a man of vision, was sufficiently impressed to allow the French to keep their collection. But he insisted on retaining the Rosetta Stone. Lost to France, it went to reside in the British Museum, where no one, as Saint-Hilaire had warned, could make head or tail of its glyphs.

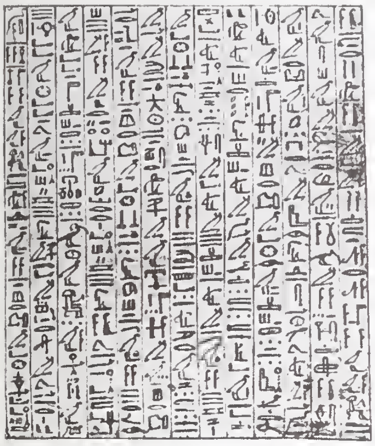
In a Grenoble bookstore, the younger Champollion, then nine years old, came across a copy of the *Courrier de* *l'Égypte* with a description of the discovery of the Rosetta Stone. Spurred by the suggestion that a decipherment of the hieroglyphs might eventually open up the whole of Egyptian history, he plunged into the study of Latin and Greek so as to be able to read for references to Egypt in the classics. It was to take him several months.

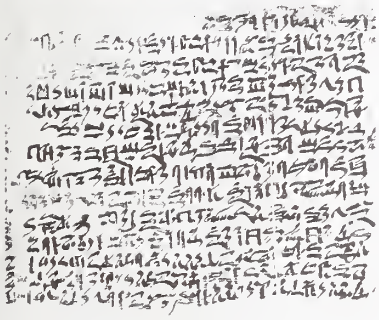
By this time the senate in Paris had proclaimed Napoleon emperor of the French. Abandoning for the moment his dream of conquest in the East, he decided instead to concentrate on reorganizing his empire at home. One of his first moves was to establish the University of France, which he linked administratively to all the regional universities and to all the public *lycées*. As a result, Champolloion-Figeac, a good Bonapartist, managed to obtain for his younger brother a scholarship to the Grenoble *lycée*. Fourteen years old, Champollion-le-Jeune was not tall but had a firm, slender body full of strength. According to his major biographer, Hermine Hartleben, the boy's handsome features, fine-boned and full of magnetism, caught people's attention; and when he talked on matters he liked, such as Egyptian history, he seemed to vibrate with an intense desire to be understood. Adults, startled by his self-assured manner and the ease with which he conversed, were drawn to him and indulged him.

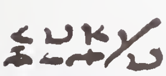
Grenoble was then a university town of twenty-five thousand inhabitants, standing on the left bank of the river Isère in a lovely fertile plain with hills and mountains that swept up steeply toward the distant peak of Mont Blanc. The seat of the bishopric, with fortifications dating back to the Roman emperor Diocletian, its people were nonetheless independent *dauphinois,* strongly democratic, intellectual, boasting of many learned societies.



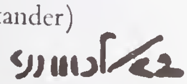
The town of Grenoble in the Piedmont of Dauphiné Alps







ALKSANTRS
(Alexander)



PTLOMÊS
(Ptolemy)

When a new prefect was appointed to the district by Napoleon, it turned out to be Jean Baptiste Joseph Fourier, the engineer-historian who had been to Egypt with Napoleon and served as secretary to the French Institute in Cairo. In Grenoble, when Fourier was asked to become a member of the learned Académie Delphinate, its secretary, Champollion-Figeac, asked if he could introduce his younger brother. Amazed at how much the boy already knew about Egypt, Fourier showed him the small museum of Egyptian antiquities he had collected, including stelae, amphorae, statues, stone tablets, and fragments of papyri covered with hieroglyphs. Most exciting to young Champollion was a rough parchment copy of the three texts of the Rosetta Stone. When told that no one could either read or understand the glyphs, the boy replied firmly: "Then I will."

From the Greek text, which he could readily translate, Champollion saw that the stone carried a decree issued in Memphis in 196 B.C. by an assembly of Egyptian priests in honor of King Ptolemy V Epiphanes, to commemorate his benefactions to the indigenous priesthood. More interesting was a colophon which decreed that the stone be engraved in three different characters: hieroglyphs, native letters, and Greek. From this it seemed clear that the stone carried three versions of the same text. Unfortunately, the top and both sides of the Rosetta tablet had been broken away, so that only half of the hieroglyphs were left, not one line of which was complete.

Fourier explained that so far the best efforts at deciphering the tablet had been achieved by working on the nonhieroglyphic text, the so-called demotic script, to see if any relation, letter to letter, could be found between it and the Greek text. Sylvestre de Sacy, Europe's leading orientalist, had tried his hand at the problem by picking out the proper names which appeared in the Greek text and then searching for the equivalent letters in the demotic. In this way he had managed to locate the names of Alexander and Ptolemy.

A Swedish diplomat, John David Akerblad, widely traveled in Egypt, to whom de Sacy had lent a prepublication copy of the inscription, had identified Arsinoë, Verenice, and Aetos, establishing that such words as *Greek, Egyptian, temple, love,* and *abundance* were written with the same alphabet, of which he identified twenty-nine letters. Fourier explained to the boy that the demotic words deciphered by Akerblad were almost identical with Coptic words for the same concepts, which seemed to vindicate Father Kircher's notion that ancient Coptic had been the language of Egypt.

Thanks to Fourier, Champollion was now able to obtain rare material that would otherwise have been impossible for him to consult, including the works of Kircher. Promptly the boy launched into a study of Coptic, and produced a map of Egypt following the Coptic names, disregarding the Greek and Roman ones, which he considered suspect. He also began to study Arabic, Chaldean, Syriac, Ethiopian, Sanskrit, Send, Pehlevi, Parsee, and Persian, hoping to find other clues to the langauge in which the hieroglyphs might have been written. He even launched into Old Chinese, because some authorities maintained the ancient Egyptians had come from China to settle on the Nile.

By the time he was seventeen, Champollion had made his first table of the succession of Egyptian pharaohs, based on data culled from the Old Testament, and from ancient works in Greek, Latin, Arabic, and Coptic. Shortly thereafter, he was invited, despite the opposition and hostility of several members of the faculty, because of his youth and his intolerance of ignorance and prejudice, to read a paper to the faculty of Grenoble University. Trembling slightly, agitated by some inner emotion, the slim, dark-skinned youth stood erect before the gathering of professors, then announced that he proposed to regale them with an encyclopedic view of ancient Egypt in all its aspects. As the young scholar spoke, brushing a hand through his dark curly hair, the audience became enthralled. Never had they heard anything like it. There were gasps of amazement as he mentioned rare sources he had consulted, ancient Coptic scripts, Hebrew and Arabic sources, sources which represented hundreds of hours of concentrated reading in many ancient languages, mostly from obscure books that the professors had not even heard of. He described the country as if he had lived there, creating the illusion he had stepped out of ancient Egypt into the nineteenth century. As one historian put it, he had so thoroughly absorbed the ancient Egyptian culture, he gave the uncanny feeling to those in his presence that he was an ancient Egyptian reincarnated.

When Champollion finished, there was a hush, followed by a buzz of excitement. His conviction and sincerity had carried all before him. The president of his lyceum jumped up and embraced him. Professor Renauldon told him he could immediately join the faculty of the university. Unanimously he was accepted as a corresponding member of the Academy of Grenoble. From humble student he found himself a highly regarded teacher, but not for long. Such precocity could only engender jealousy. To escape it, and the antagonistic atmosphere of academia, Champollion wanted more than anything to be allowed to go to Paris to pursue his study of the Rosetta Stone and its hieroglyphs, admitting to his brother that he had the weird feeling he had been present in Memphis in 196 B.C. when the stone had been raised.

Napoleon's victory at Austerlitz

It was 1808. Napoleon had defeated the Austrians at Austerlitz, and by taking Berlin replaced what was left of the Holy Roman Empire with a French-controlled Confederation of the Rhine. In Paris, he set up a court as precise and rigid in its etiquette as that of the *ancien régime,* rivaling the splendor of Louis XIV, though it could be said for the empire that it did not restore the feudalism, privileges, and exactness of the Bourbons.

In Paris, Champollion became a student of Sylvestre de Sacy, the head of the Académie des Inscriptions, who had finally managed to obtain a plaster cast of the Rosetta Stone. Champollion was soon lost in the dusty archives of the Paris libraries, only coming out to wander into another institute or museum, searching constantly for anything to do with ancient Egyptian or with Coptic. In the Bibliothèque Nationale, he found and annotated Kircher's *Lingua Aegyptiaca restituta* and was able to work on the Coptic manuscripts stolen by the revolutionaries from the Vatican.

In the Louvre Museum, Louis XVI's former palace, which had been opened to the public in 1793, he could admire the works of art accumulated by a series of French monarchs, or more recently looted by Napoleon from the churches, galleries, and museums of Italy, the Netherlands, and Germany. There, Baron Dominique Vivant Denon, named by Napoleon director of the museum, had formed the Egyptian collection from the enormous quantity

Silvestre de Sacy, head of the Academy of Inscriptions, founded to supply Louis XIV (the Sun King) with "learned ornamentations for his pleasure."

of antiquities brought back by Napoleon's savants, to which he continued to add.

Convinced that Coptic was to Egyptian what modern Italian is to Latin, Champollion tried to find someone in Paris who could teach him to speak the language. There was no one, other than a Coptic priest who said mass at the church of Saint Roch, by the rue de Rivoli; from him he was able to learn something of the pronunciation of contemporary Coptic, but little more. For practice, Champollion spoke Coptic to himself whenever he was alone, which was most of the time.

With no money other than what his brother sent him from his own small earnings, the young man found a room next to the Louvre, cheap, shabby, with an iron bed, rickety sofa, and two chairs. It was damp and cold. His meals consisted of bread, cheese, and onion, with an occasional bowl of stew, eaten rapidly and sparingly. His coat was threadbare, and his shoes were stuffed with paper. The gray dampness which hung over Paris induced a cough with spasms which developed into a severe pain in the chest.

In 1809, when Napoleon began drafting recruits for military service in his new campaigns, the young Champollion only just managed to be exempted through the intervention of Fourier and de Sacy. But his money ran out, and his landlady, catching him speaking to himself in Coptic, threw him out as a lunatic, leaving him no choice but to go home without having solved the riddle of the glyphs.

In Grenoble, his brother managed to get him the post of assistant to the octogenarian professor of history at the university, but a jealous group of professors soon banded against him, determined to force the young savant from the faculty. They could not tolerate his pointing out the errors in their instruction. "I do not like to compromise with truth," he insisted, "it is shameful to play politics with education." Believing that teachers had to be intellectually free and immune from pressure, Champollion began to write satirical sketches attacking both the royalists and the Bonapartists, which endeared him to neither.

By this time Napoleon had divorced his childless Josephine to marry the archduchess Maria Luisa of Austria, thus allying France with Austro-Hungary. As the ersatz Holy Roman Emperor he decided to emulate his predecessor caesars and pontiffs, and in a decree issued from Schoenbrün, ordered the erection of an obelisk made of Cherbourg granite in memory of the campaigns of Iena and the Vistula, bearing the inscription "From the Emperor Napoleon to the People of France."

Napoleon, whose Arch of Triumph stands at the top of the Champs-Élysée, planned an even bolder and grander monument to outdo the glory of Thebes and Rome—a 180-foot obelisk to replace the statue of Henri IV on the Pont Neuf near where de Molay was burned. This colossal needle was to be formed of six superimposed granite monoliths, the lowest of which was to weigh a million pounds. The sculptured faces were to cover more than 10 million square feet (or about 24 acres). Calculations were made and plans drawn by Charles Le Père, who had accompanied Napoleon to Egypt, where he had been responsible for *mis*-measuring the Great Pyramid of Cheops. No more than the foundations were laid for Napoleon's needle before the plans collapsed along with the empire.

Louis XVIII caricatured as interested mostly in the problems of his mistresses

Ten projects were submitted, in one of which two elephants on either side of an Egyptian colonnade rendered homage to the "new Alexander." But the jury chose a more sober design by the architect Jean François Chalguin. The foundations were laid, but Napoleon, retreating from Moscow, was badly defeated at Leipzig. Pursued by his enemies into France, the depressed dreamer was forced to abdicate on April 11, 1814, and go into exile to Elba. The obelisk was stillborn.

As the Bourbons reclaimed the French throne upon which to seat a fat, lazy, and inept Louis Xavier Stanislas, comte de Provence, brother of Louis XVI, as Louis XVIII, Champollion buried himself in his work. That year he published his *Egypt Under the Pharaohs* in two volumes; it was dismissed as fanciful. Stung by the critics, Champollion realized the only way to prove his point would be to decipher the hieroglyphs and show a truer history and chronology of Egypt.

Then came the "hundred days," not only to reprieve Napoleon, but by chance to bring Champollion and the emperor together. Tired of his island prison, the ex-emperor slipped past his guards on Elba and landed unopposed at Antibes in the south of France. "I shall reach Paris without firing a shot," he predicted. To avoid the royalist towns of Provence, he headed toward Savoy and republican Grenoble, where an old friend was in command. Just before Grenoble, a body of royalist troops barred his way. Stepping forward, Napoleon threw open his coat to reveal his well-worn uniform and the ribbon of the Legion of Honor. "Soldiers, if any among you wishes

Napoleon's return from Elba

to kill his Emperor, here I am!" An officer gave the order to fire, but the soldiers refused, crying *"Viva l'Empereur!"* Crowding around him, they tore off their white Bourbon cockades.

In Grenoble, Napoleon put up at the Auberge des Trois Dauphins and asked for a competent man with a clear mind and lucid style to translate his verbal instructions into written orders. The mayor suggested Champollion-Figeac, then head of the faculty of letters at the university.

The elder Champollion, who had now legally changed his name to Figeac, arrived at Napoleon's quarters in the inn with his younger brother, whom the emperor began to cross-examine about Egypt, becoming so impressed that he kept the youth in his small room while a crowd fidgeted anxiously outside.

Napoleon in Grenoble. Leaning against the still-barred gates, he is said to have taken a pinch of snuff and then tapped with his silver snuff box until the gates were opened by a welcoming crowd.

The next day, to pursue the conversation, Napoleon sought out Champollion in his quarters at the university library to tell him he admired the courage with which he imposed his views: "I would never have taken Toulon in 1793 if I had not done the same," said the emperor. "I was just your age." Champollion talked to Napoleon in Coptic, which enthralled the emperor, who agreed it was the key to understanding ancient Egyptian, and said he intended to restore Coptic as the national language of Egypt. He promised to have Champollion's dictionary printed at government expense as soon as he got to Paris. "I will do it by decree," said Napoleon, "just as I ordered the publication of Ptolemy's *Almagest* translated by de Sacy, and the great Chinese dictionary which had been languishing for a hundred years."

Wanting to know more about Egypt for his future plans, which involved a great irrigation project to make the country bloom, Napoleon spent several hours with Champollion, pumping him on every facet of the subject. When Napoleon set off to reconquer Paris, he took with him Figeac as an aide, leaving young Champollion to edit the Bonapartist newspaper started by his brother, the *Journal de Isère,* the first number of which described Napoleon's triumphant march from Elba toward Paris, emphasizing the democratic ideals of liberty on which the new regime was to be founded, rather than the former imperial pomp.

299. Serment de Ney — Serrement de nez

Cartoon playing on the French word *nez* (pronounced "ney") for "nose."

By the time Napoleon reached Lyons, he was addressing everyone as "citizen" and promising a liberal constitution. Republican sympathizers disillusioned with the Bourbons who had shown themselves incapable of ruling, and had deliberately broken every stipulated agreement made with Napoleon at the time of his abdication, flocked to his tricolor banner with shouts of *"Vive l'empereur!"* Even Napoleon's old marshal, Michel Ney, Prince of Moskowou, who had suggested to the Bourbons bringing Napoleon back to Paris in a cage, took one look at the approaching tricolor and came over to the emperor's side, quickly imitated by his troops. Louis XVIII, hearing of the triumphant reception given the returning hero, slipped quietly out of Paris.

Napoleon welcomed back to his old quarters in Paris

At the Tuileries, officers and soldiers seized the emperor and carried him up to his old apartment on the second floor. Figeac, who was with Napoleon all the way to Paris, now became a member of several committees charged with projects of reform.

But the "hundred days" were soon over; the combined reactionary forces of Europe proved too strong. Figeac was with Lucien Bonaparte at the Palais Royale on the evening of June 20, 1815, when they received the news of Napoleon's defeat at Waterloo by a combination of English, Dutch, Belgian, and Hanoverian troops under the command of the duke of Wellington. Louis XVIII slipped back into the Tuileries just as quietly, this time protected by Scottish muskets. Everywhere in France, royalists were forcibly put back into power by foreign bayonets. In republican Grenoble, which held out against the royalists, raising barricades, Champollion rushed about to hide the rarest volumes and manuscripts of the library from a vicious royalist artillery bombardment.

As Napoleon abdicated at Fontainebleau, Austrian soldiers were installed in Grenoble. Champollion's paper was taken over by antirevolutionists who cried for Napoleon's accomplices to be shot. Blood flowed. Thousands, including Marshal Ney, were executed. Champollion got away with a mere dismissal from the university, and exile to his native town of Figeac. The Bourbons were back, having, as Talleyrand remarked, "learned nothing, and forgotten nothing."

Frontispiece of the *Description de l'Égypte* with the bust of Louis XVIII replacing the imperial *N* of Napoleon.

When Napoleon seized power as emperor he initiated the reestablishment of orthodox Catholicism in France, with Pius VII as pope, but kept him a virtual prisoner at Fontainebleau. When the new pontiff requested the suppression of Masonry, Napoleon decided instead to make use of it. The Grand Orient and the Grande Lodge were united, and the emperior's brothers, first Joseph, then Lucien, were named Grand Master of the joint body. Dignitaries of the new empire quickly followed suit. But it was a chastened Masonry, deprived of its Illuminist tendencies, anxious to integrate itself in the new structure of patronage. With the defeat of Napoleon, Pius VII was restored to the Papal States, so relieved, they say, that he levitated during the celebration of Mass. Masonry was once more forbidden. The Inquisition was revived along with the index of forbidden books. The church threw its support to absolute monarchs, while parliaments and democracies were termed "atheistic," and the Jesuits again sought to make every sovereign the vassal of Rome.

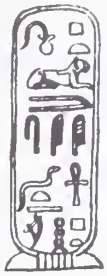
Cameo of Thomas Young

The Inquisition, abolished by Napoleon's brother Jérôme as King of Westphalia, was reestablished by Pius VII. In Paris, Figeac obtained the protection of the Masonic group which, under the leadership of Edme François Jomard, was allowed to continue to edit and bring out the remaining folio volumes of the *Description de l'Égypte* minus the imperial "N" which had decorated the earlier volumes.

To keep alive, young Champollion managed to give private lessons, slipping up to Paris on holidays to consult the copious and magnificent illustrations in the huge volumes of the *Description,* which were causing a sensation in Europe among those who could afford to read them, and were strong enough to lift them.

In Grenoble the new prefect was the baron d'Haussez, a former revolutionary from the Vendée who had rallied to the empire and then reverted to the royalists with the return of Louis XVIII. More royalist than the king, he now hated liberals, and especially Champollion, whom he accused of conspiring against the safety of the state. A cold, unpleasant man, who kept a guard at every window, he showed Champollion copies of his Bonapartist letters to Figeac intercepted by Fouché, the chief of police, who had survived every regime from the Terror to the Reaction. Unable to work in Grenoble, Champollion sought refuge with his brother in Paris. There, in a top-floor attic on the rue Mazarine, he survived the stagnation of the Bourbonic restoration by devoting himself entirely to cracking the secret of the hieroglyphs, working mostly with material provided by his brother, who had been collaborating with André Dacier, the permanent secretary of the Academy of Inscriptions, where thousands of reproductions of glyphs had been accumulated.

A competing researcher in England, Thomas Young, a physician by profession and a physicist by inclination, had found a direct relation between hieratic and demotic, and published his results in 1818. By noticing a collection of characters that occurred thirty times in the demotic script of the Rosetta Stone and comparing them with where their equivalent appeared in the Greek text, Young concluded that they stood for the word *king,* yet he could not tell which letter stood for which hieroglyph. Nevertheless the system enabled him to establish the correct significance of such words as *Osiris, immortal, victory, year,* and *likewise*. But he had no idea of how to read the individual letters, most of which he got wrong or transposed. He did correctly guess that a cartouche was a convention indicating a royal name; but otherwise, with the hieroglyphs, he



PTOLMÊS
(Ptolemy)

KLEOPATRA
(Cleopatra)

The island of Philae (now submerged by the Aswan Dam) lay about 5 miles south, or upriver, of Aswan, beyond the first cataract and before the second. The obelisk found by Bankes was 20 feet long and weighed 6 tons. It was inscribed with the names of Ptolemy IX (184(?)-116 B.C.) and his sister-wife Cleopatra. Bankes later found the lower half of its matching pair, which he had removed to England.

made no further headway, considering, as did everyone else at the time, that they were purely ideogramic—that is, standing for words or ideas, not sounds.

Champollion had at first thought likewise. But when he counted the number of words in the Greek text of the Rosetta Stone and the number of signs in the hieroglyphic text, he found there were three times too many of the glyphs; this led him to conclude that they *must* represent sounds, not words. By transcribing the Greek name *Ptolemaios* letter by letter from demotic to hieratic and then to cursive hieroglyphic, Champollion was finally able to find virtually the same hieroglyph in the Rosetta Stone. This meant that the proper names of Greeks, such as *Ptolemy* and *Cleopatra,* must be written phonetically, letter by letter, in all the hieroglyphs. Unfortunately, there was no *Cleopatra* in the Greek text of the Rosetta Stone; but in a text known as the Casati papyrus, he found the demotic form for this last of the Ptolemaic queens. What he needed now was another Rosetta Stone. And in 1891 he got it in the form of an obelisk.

Some years earlier, a French traveler, Frédéric Caillard,

had found an obelisk on the island of Philae above Aswan, between the Nile's first and second cataracts, smaller than most, only 22 feet long, but which weighed about 6 tons. Unable to move it, Caillard bequeathed it to the French consul, Bernardino Drovetti. But Drovetti's competitor in the racket of ravaging Egypt for treasures to sell to wealthy antiquarians, the British consul Henry Salt, also got wind of the find and hijacked it. With a wealthy young English antiquarian, William Bankes, an adventurous friend of Byron's, Salt arrived on the scene and arranged with the gigantic Italian explorer and adventurer Giovanni Battista Belzoni, to have the obelisk floated down the Nile so it could be shipped to Bankes's estate in England.

Giovanni Battista Belzoni

Belzoni's men had built a rough stone causeway from the bank but the weight of the obelisk sank the stones into the mud of the Nile until only the tip was visible above the swirling waters. In despair Belzoni had divers lay heavier stones underwater until the obelisk could be gently levered back onto land. With heavy ropes tied upstream a boat bearing the obelisk was delicately manuevered through the steepest part of the cataract until it shot out into clear water to be safely navigated downstream to Aswan and Alexandria for shipment to England as a successful coup for the British.

Henry Salt, British consul general in Egypt, considered himself an artist and a litterateur but spent his career selling antiquities for profit, though his first collection netted him a paltry £2,000 from the British Museum. Only after his death did his second collection fetch £7,000 at Sotheby's. With Belzoni, Salt quarreled over who should get credit for their joint discoveries, and in the end he declared: "I have but one wish: never to have my name coupled with his." Salt died having received neither a pension nor the recognition as a scholar he so assiduously longed for.

While Bankes continued up the Nile with an elderly Prussian nobleman, Baron Sack, Belzoni immediately ran into difficulties and nearly lost the obelisk when it got loose and slipped into the Nile, requiring enormous exertion and some sharp engineering to recover. Next he had to float it down the cataracts, a job so dangerous the boat captain buried his head rather than watch. Finally, he had to overcome Drovetti, who did everything in his power to recover the obelisk, including making threats to Belzoni's life. At one point Drovetti even tried to convince a native sharif that the obelisk was his property because the hieroglyphs on it said it had belonged to his family!

The French consul Bernardino Drovetti (seen here with his gang of trusties) was a Piedmontese born in Barbaria who accompanied Napoleon to Egypt as a colonel. Like his great rival Salt, he had difficulty selling his Egyptian loot to Catholic Charles X because it was feared it would show the Egyptian civilization to be older than the 4004 B.C. accepted by theological dogma. Eventually he disposed of it with the Berlin Museum and with the king of Sardinia for the monarch's Turin collection. After 27 years on the Nile, Drovetti ended his days in an asylum for the mad.

The Philae obelisk, which W. J. Bankes financed Salt to steal from Drovetti, as it stands in Kingston Lacy House in Dorset.

In the end Belzoni got the trophy safely to Cairo, where it was shipped to England, to be set up on Bankes's Dorset estate, Kingston Hall, in the presence of Arthur, duke of Wellington. On the base of the obelisk was an inscription in Greek in honor of Ptolemy Euergetes II and of Cleopatra, his wife. Of the two hieroglyphic cartouches, Ptolemy's was immediately recognizable. It was hoped that the other would bear the name of Cleopatra. In 1821 a lithograph was made of both the Greek and the hieroglyphic texts, a copy of which reached Champollion in January 1822. Immediately he recognized the second cartouche as that of Cleopatra, spelled nearly as in the transcript of the demotic name, only more fully. It confirmed for Champollion the value of the letters *polt,* which appear in both *Ptolemy* and *Cleopatra*.

Altogether this gave him fourteen recognized alphabetical signs among the hieroglyphs; but what puzzled Champollion, as it had puzzled Young, was that different signs appeared to express the same sounds, a fact for which neither expert could account. Some signs, like the egg at the end of the Cleopatra cartouche, Champollion realized from other research was simply a designation of the feminine. But he was now convinced that he was on the right track to decipher the lot, and that nothing could stop him. Locked up in what he called his "arsenal" attic studio, he began to apply the system to all the available texts on obelisks. A cartouche from a Karnak obelisk reproduced in the *Description de l'Égypte* quickly gave

ALKSANTRS
(Alexander)

him ALKSDR, for Alexander. The Barberini obelisk, which had first brought Kircher to Rome, gave him HADRIAN, and SABINA his wife. Furthermore, as the general inscription on the obelisk contained a repeated group of eight letters, obviously a proper name, and since Hadrian's favorite was the youth Antinoüs, Champollion deciphered the name as ANTEINS, proving the stone to have been carved in his memory.

Kircher's next obelisk, the Pamphilian, raised by Bernini in Piazza Novona, referred to VESPASIAN and his son TITUS. Other obelisks of the Roman period carved with hieroglyphs gave Champollion the names of LUCILIUS, SEXTUS, AFRICANUS, TIBERIUS, DOMITIAN, NIRVA, and such titles as CAESAR and AUTOKRATOR. It was now clear that late Egyptians had used phonetic glyphs to spell out foreign names and titles. If only there had been some Egyptian names of pharaohs in the Bible, Champollion mused, he could see if the principle also applied to native pharaohs; but there were none.

Like a caged beast, Champollion paced his arsenal, begging everyone to send him more texts. Then it happened. In September 1822 he received copies of some inscriptions from a French architect, Huyot, who had copied them from the famous rock temple of Abu Simbel between the first and the second cataracts. One of the

Temple of Ramses II at Abu Simbel

texts contained a cartouche with a royal name written with the picture of the sun, which Champollion recognized as the glyph for Ra, followed by an unknown sign, , like an *m*, and two . Champollion then found another cartouche with the same and glyphs preceded by the glyph for an ibis, which he knew to be the representation of the god Thoth. Thus he had the names of two pharaohs: Thoth () and Ra (), obviously Thothmes and Ramses.

It was a breakthrough. Unmistakably the ancient Egyptians used phonetic glyphs to spell out not only foreign names, but also Egyptian names. Could it be that all of the hieroglyphs were phonetic? It was a step Champollion dared not yet take, though he sensed that success was at hand.

In a fever of excitement, he rushed to the institute, where he threw the papers onto his brother's desk, pronouncing the now famous statement: *"Je tiens l'affaire!"* I've got it! Then his legs buckled and he fell into a coma which lasted three days.

When Champollion recovered, he was able to transcribe the names of a score of ancient Egyptian gods and pharaohs. From the next text given in Greek by Hermapion for the Piazza del Popolo obelisk, brought to Rome by Augustus, and raised by Sixtus V, Champollion deciphered the title *Whom Amon loves,* and established that the Egyptians gave their pharaohs a name and a title in two cartouches joined by the phrase *Child of the Sun*.

Soon he had read fifteen more glyphs of pharaohs going back as far as the eighteenth dynasty. From the Campus Martius obelisk raised by Antinori for Pius VI he got PSMTK for the pharaoh known to the Greeks as PSAMMETICHOS. He also discovered that proper names were followed or preceded by signs indicating a species, such as god or man.

He now had the alphabetical equivalent of twenty-four Egyptian glyphs. But knowing the letters of a language does not mean one can read the language. His only hope was the Coptic connection. Had Coptic not existed, Champollion would have seen no way to reconstruct any of the language other than its personal names and places. But if he could find a group of hieroglyphs that coincided with an ordinary word in Coptic, the meaning of which he knew, he might have a start on the language of ancient Egypt.

Before launching into this strange new world, he decided to announce his limited breakthrough to the Académie des Inscriptions, which he did in a letter, since famous, addressed to its permanent secretary, Dacier. On September 22, 1822, under the great cupola of the institute, Champollion gave the substance of his discovery to twenty-five academicians. Each was issued a leaflet with the names of the pharaohs Champollion had deciphered, along with their equivalents in Greek and Coptic, dramatically bringing home to his audience the fact that they were witnessing the beginnings of true Egyptology, a means of opening up the ancient civilization of Egypt.

De Sacy was quick to appreciate and approve Champollion's thesis. But neither Young nor Jomard, both jealous of Champollion, would accept his system of decipherment; they refused to attribute importance to his discovery. In England and Germany, Champollion's translations were rejected out of hand, though few of those who voiced their criticism bothered to test his method on other inscriptions. Only the brothers Humboldt, in Germany, gave Champollion credit for one of the great discoveries of mankind. Finally, Salt, who had helped with the seizure of the Bankes obelisk, admitted that Champollion's system had enabled him to decipher several words.


PRECIS

SYSTEME HIÉROGLYPHIQUE

RECHERCHES

By this time Champollion was analyzing and translating not only phrases but small inscriptions and whole sentences, proving that the system he had discovered was applicable to the entire body of Egyptian glyphs. These results he wrote up in his *Précis du système hieroglyphique,* dedicated to Louis XVIII, in which he showed in more than four hundred quarto pages with forty-six plates that the hieroglyphs were both phonetic and ideographic, that some could be read phonetically as letters, others as ideograms—in other words, that some could be used to indicate the object represented, such as a man, or bird, and at other times stand for the alphabetic value of the initial consonant of that Egyptian word. The précis has been called "one of the most important and original works of modern scholarship."

A short while later, a distinguished, well-dressed man called at 28 rue Mazarine and asked to see Champollion. When his sister-in-law asked whom she should announce, she was told: the duke of Blacas, first gentleman-in-waiting to Louis XVIII. Blacas said he had come on behalf of the king to present Champollion with a gold snuff box with his initials in diamonds and the inscription: "From King Louis XVIII to Monsieur Champollion, on the occasion of his discovery of the hieroglyphic alphabet." The king ordered Champollion's précis printed at state expense, and encouraged him to create an Egyptian grammar and a dictionary of hieroglyphs.

With this success Champollion was able to marry and have a daughter, Zoraide, who was born on March 1, 1824. A few weeks later he was received in private audience by Louis XVIII, who asked him to travel to Turin to consult and reorganize three hundred cases of Egyptian antiquities, including two hundred papyri with hieroglyphs and assorted stelae looted in Egypt by the French consul Drovetti and bought by the king of Sardinia for his Turin museum. Champollion was to copy the inscriptions so as to create a more correct version of Egyptian history, and at the same time negotiate in Leghorn for the acquisition for Louis XVIII of the valuable Egyptian antiquities "collected" by Henry Salt.

In September, Louis XVIII died and was succeeded by his reactionary younger brother, the count d'Artois, who came to the throne as Charles X, to set up what Wellington called "a government by priests, through priests, for priests." Luckily, the new king, though violently antirepublican, confirmed Champollion's commission to travel to Italy. In Turin, Champollion made a sensational discovery: the work of Clement of Alexandria, who had

Charles X, brother of Louis XVI, and chief of the ultra-royalist reactionaries at court, passed his youth "in scandalous dissipation" incurring a debt of 56 million francs. Claiming to reign by divine right he threw power into the hands of the extremist Jesuits and declared, "I would rather hew wood than be a king under the conditions of the king of England."

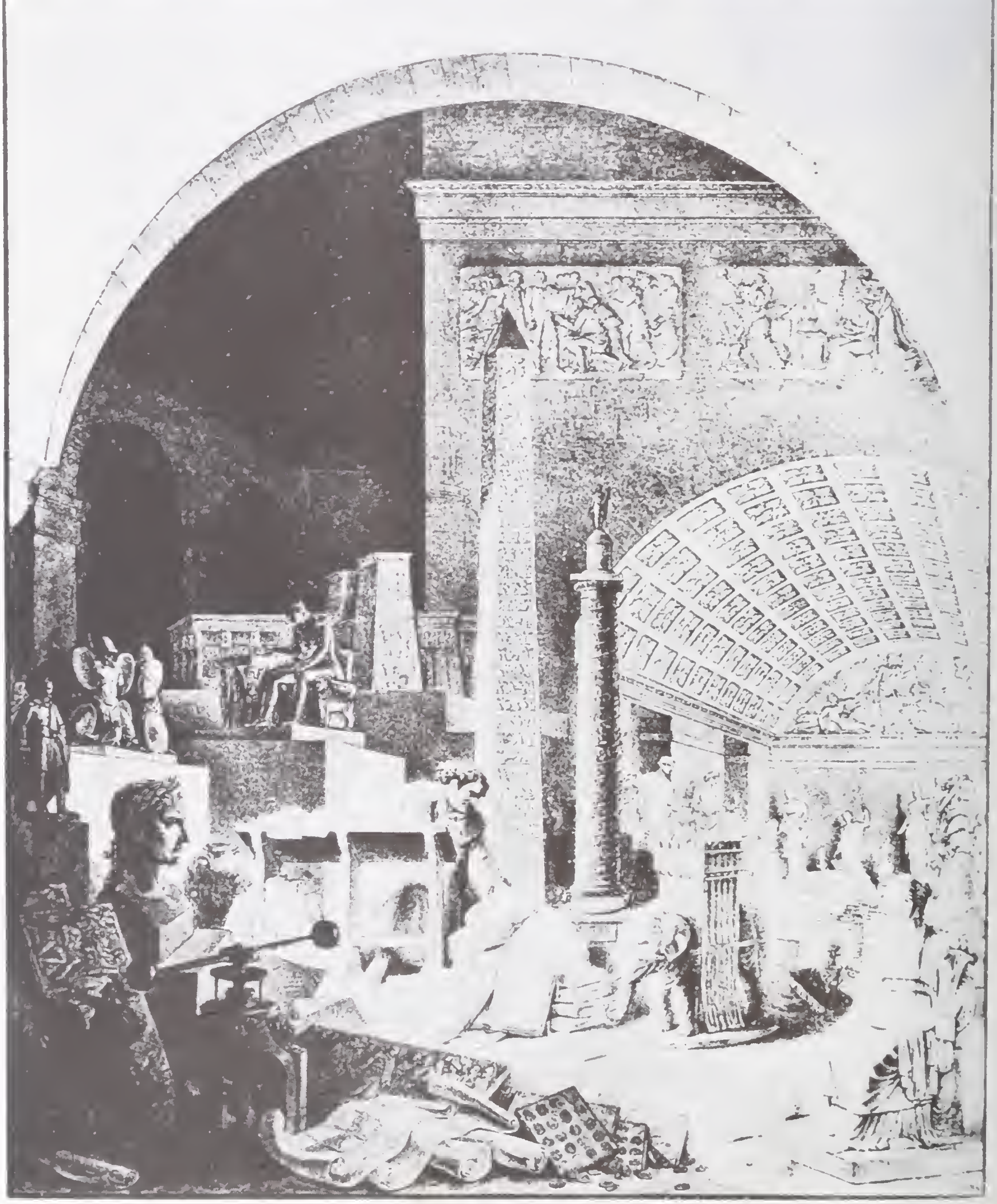
lived about A.D. 200, an expert on "heretics," who may have been an initiate into the "mysteries," and who, by his knowledge of the ancient Egyptians convinced Champollion that all of what passed for Egyptian history would have to be rewritten. He also found the only then known example of a great Egyptian literary work, transmitted directly from the time of the pharaohs: 165 chapters written in pure hieroglyphics. Eventually published as *The Book of the Dead,* it proved to be one of the most vital documents ever discovered in Egypt, and enabled Champollion to begin to tear away the veil from that country's past.

Champollion worked hard at transcribing the glyphs, but his notes for a book were stolen by a fellow researcher, Salvolini, and did not surface till long after Champollion's death. From Piedmont, Champollion went to Rome to study the hieroglyphs on the obelisks there and to make a catalogue of the Egyptian antiquities in the Vatican. Received by Pope Leo XII, he was told that with his discovery, he had done a great service to religion—though not to which.

Back in France, Champollion was awarded the Legion of Honor; he was also named curator of a special Egyptian collection at the Louvre which Charles X wished to form with the cases of antiquities bought from the king of Sardinia. On November 4, 1827, the collection was inaugurated in the presence of Charles X, and opened to the public on Christmas Day. To decorate the entrance of his new museum, the King decided to have an obelisk transported from Alexandria, where Champollion was to travel in order to check out the obelisks there, then mount an expedition to copy and bring back correct drawings of as many Egyptian antiquities as possible.

The young Sagir's dreams had at last come true.

Called *The Book of the Dead* by early Egyptologists, these ancient texts dealing with the awakening of the soul at death are more aptly called *The Book of Coming into Light.*



9. CHAMPOLLION PARTS THE VEIL OF ISIS

On July 31, 1828, Champollion sailed from Toulon on the frigate *l'Egle* with seven young French artists and one medical doctor, Pariset. At Civitavecchia they were joined by a group of five Italians sent by the duke of Tuscany under twenty-eight-year-old Ippolito Rosellini, an Egyptologist and professor of languages at Pisa. The Italians were to help Champollion transcribe inscriptions and make drawings of temples and monuments. As the group approached Alexandria, their ship was caught in a storm and several of the adventurers, fearing *l'Egle* would sink, put messages in bottles and tossed them overboard. Then the sea calmed, and early on the morning of August 18, they spotted the landmarks of Alexandria: Pompey's Pillar, and close by, the standing silhouette of Cleopatra's Needle. Champollion jumped ashore and kissed the soil of Egypt.

His first endeavor was to copy the inscriptions from the second of the obelisks raised by Augustus in front of the Caesarium which had fallen beside its still standing neighbor, Cleopatra's needles, and required excavation from the sand. From its inscriptions, Champollion concluded that both it and its companion had once stood before the Temple of Thothmes in Heliopolis. But why the obelisks had stood in pairs, he could not fathom.

Drovetti, who had done all he could to prevent Champollion from coming to Egypt because he was afraid the visitors might constitute a danger to his various looting schemes, now refused to take responsibility for their expedition. Nonetheless, he was obliged by orders from Paris to take them to see the khedive or viceroy of Egypt, Mohammed Ali.

When the British left Egypt in 1803, such chaos had followed, with rampant plundering and assassinations, that the religious leaders in Alexandria had appealed to Mohammed Ali, commander of the Turkish troops in Egypt, to restore law and order. A reliably cruel and unscrupulous tyrant from the hills of Albania, he did just that, seizing the opportunity to establish a certain independence from his Ottoman masters. By treacherously murdering the entire corps of the Sultan's Mameluke beys, he turned the Ottoman province of Egypt into what amounted to his own independent state, one in which foreigners could vie to

Denon, in the Louvre, among the treasures looted by the French in Egypt

Mohammed Ali, a converted Christian orphan from Macedonia, wished to bring Western technology to Egypt, harness the Nile for agriculture, and introduce industrial manufactures into Egypt. He was in no way interested in ancient temples except to use their beautifully hewn blocks to build factories that would never go into production. His prime addiction was to the pleasures of his harem of five hundred lovely women—two hundred in Alexandria, three hundred in Cairo.

On the eastern point of Phoros stood the great lighthouse, first of the Seven Wonders of the World, reputedly as high as the Washington Monument. Begun by the first Ptolemy, it was completed by the second. Originally an island, the point was later joined to the mainland by a half-mile mole called the *hepastadion,* six stadia long. At the head of the mole stood the Temple of Hephaestus, and behind the emporium the great Caesarium with its two guardian obelisks.

invest, and where their consuls as virtual ambassadors could collaborate with the autonomous viceroy in looting the country.

On August 24, in the very hottest days of summer, Consul Drovetti came with horse and carriage to fetch Champollion and the captain of *l'Egle* to meet Mohammed Ali. The rest of the party followed on donkeys. To Champollion the sumptuousness of the pasha's palace, on the peninsula of Pharos where the great Alexandrine lighthouse had stood, came as a shock because of its stunning contrast with the poverty of the people in the streets.

Mohammed Ali, then 60 years old, with a long white beard, received the Frenchmen in one of the cool rooms of the palace, seated between two windows, dressed in a simple robe. Of medium height and cheerful countenance, his eyes full of vivacity, the Pasha smoked a long pipe decorated with diamonds as he asked Champollion about the sort of voyage they planned. Champollion replied that all his life he had dreamed of visiting this most beautiful of countries, and that to read the hieroglyphs and rediscover the ancient history of Egypt, he wished to go as far up the Nile as the second cataract, studying the ancient sites along the way.

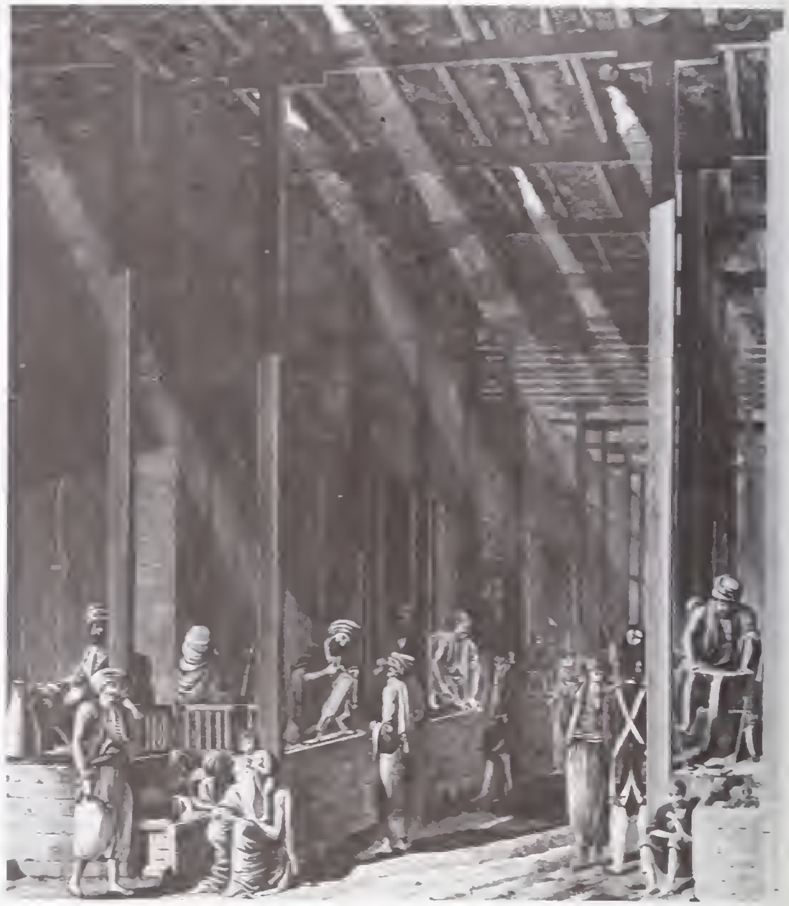
Mohammed Ali stroked his beard and offered them coffee. To show that he was privy to what was going on, he remarked that everyone seemed to be trying to prevent the voyage. "They don't want you to see too many antiquities too close," he said with a wry smile. "But don't worry, I'll give you a *firman* [a passport], and two of my personal body guards." All he asked in return was a translation of the inscriptions on the Alexandrine obelisks, which Champollion, working all through the night, delivered the following morning.

Palace of the khedive

Typical Nile boat

Thanks to the pasha's support, Champollion was able to bypass Drovetti and rent the largest and best equipped boat on the Nile, the *Isis*. As they set sail, Champollion felt he was reliving the dreams of his youth. "Everywhere I go," he wrote in his diary, "and everywhere I look, everything I touch is like renewing acquaintance with things I have known and loved all my life." Between Alexandria and Cairo he followed the map drawn by the editors of the *Description de l'Égypte,* carefully correcting the names of the towns which the members of Napoleon's expedition, in their ignorance of either the Egyptian or the Coptic language, had misnamed or misplaced.

In Cairo, as he wandered through the twisted streets, stopping from bazaar to bazaar, Champollion found himself back in the world of *A Thousand and One Nights*. He had grown a long handlebar moustache, and shaved his head, which he covered with an enormous brightly colored turban. At his side hung a large scimitar. With his dark skin and extraordinary command of the language, he passed easily for an Arab. Eyeing his companions, dressed in native pantaloons and bright brocade, with the yellow pointed boots much favored by rich Turks and Egyptians, Champollion said with satisfaction: "I am a completely new person! I don't feel tired as I did in Paris." Much taken with the beauty of the native females, he describes in detail the erotic dances of the ubiquitous *aalmas,* or dancing girls, but gives no details of his own amorous adventures.



Cairo bazaar

In October the group prepared to travel up the Nile aboard the *Isis*. At Memphis, where, according to the Rosetta Stone, King Ptolemy V Epiphanes had been deified, Champollion correctly classified architecture of different epochs by a mere glance at the ruins. As the group roamed about, sketching and measuring, or copying inscriptions, the natives who followed them laughed at these people "who could read stones."

Sakkara, with its ancient stepped pyramid, they found largely destroyed, plundered for building material for the pasha's palaces at El Difdjar. Everywhere they went, they saw that agents of antiquities dealers such as Salt and Drovetti had ruined the sites, rendering them impossible to study. Tombs had been devastated, pillaged, and refilied. Fragments of mummies had been scattered so profusely they made what Champollion called "a plain of mummies."

At Antinoe, rebuilt by Hadrian for his boyfriend, they found nothing left of the beautiful monuments described and drawn by the members of the Commission de l'Égypte: the inhabitants had destroyed and burned the limestone blocks to extract the lime. Little was left standing other than the indestructible granite columns.

Since the Renaissance, Egyptian graves had been systematically robbed to provide Italian cardinals with private collections. By the time Richard Pococke, a British traveler, visited Egypt in 1737, he complained, "They are every day destroying these fine morsels of Egyptian Antiquity; and I saw some of the pillars being hewn into millstones." Champollion saw that thousands of movable objects were being exported by collectors, dealers, tourists, and unscrupulous consular agents such as Salt and Drovetti, subjecting Egypt to an orgy of destruction. Not only amulets, scarabs, papyri and whole mummies were being taken, but entire rooms, freizes, and tombs were stripped and shipped.

Still, Champollion was able to buy a heavy granite head of Ramses II for one piastre, and make the owner drag it himself to the boat.

At the end of October they arrived at Esna, where they wanted to visit the temple on the west side of the river, greatly admired by the Commission de l'Égypte. Too late. Twelve days before their arrival, the temple had been pulled down by the pasha to strengthen a quay on the river. Luckily the temple of Esna has been spared as a

Temple of Esne

storehouse for government cotton; but Champollion found its decadent Ptolemeic sculpture quite detestable.

At Armant he described the temple, and copied many of its reliefs—which was lucky, for it was later in the century destroyed by the viceroy Said for stones to construct a sugar factory. Denderah they encountered by moonlight.

At Denderah they found six rooms within the thickness of the walls, and six more underground, access to which was very difficult as the passages were full of bats and there was little air. The walls and the colossal columns were covered with scenes in relief, including a great zodiac painted in two bands along the ceiling of the portico. The famous ceiling zodiac had already been blasted out with dynamite in a cops-and-robbers duel between Salt and Drovetti, and shortly thereafter a quarter of the temple was quarried away for a saltpeter factory.

Without native guards, but well provided with arms, they set off through the night, singing arias from the latest operas as they marched to find the temple, most likely from Rossini's *Semiramide* which had premiered a few years earlier.

When the temple loomed before them, bathed in soft moonlight, they saw that it was the best-preserved structure they had yet encountered. To enter its vast halls they lit torches, which revealed hundreds, even thousands, of inscriptions, from which Champollion deduced that the temple was not dedicated to Isis, as everyone maintained, but to Hathor, whom he identified with Venus or Aphrodite, the goddess of mirth and love. Champollion saw that two pharaohs of the New Kingdom, Thothmes III and Ramses II, had added to the original construction, as had succeeding monarchs down to the Ptolemites, followed by the Romans, the last deducible from the carved names of Augustus and Antonius.

At El Kab they went ashore to see the temple, but found it, too, had disappeared, destroyed by Mohammed Ali, as were the two temples of Amenophis III and Thothmes II, of which nothing was left but the drawing done by the commission. In November the party reached Karnak at Thebes, where they visited the Temple of Seti I, the

These seated colossi on the plain of Gournah, across from Luxor, were identified by Greeks with Memnon, a mythical king of Ethiopia, known as "Son of the Dawn." The statues were renowned for giving off harplike sounds at dawn (apparently caused by expansion of the stones in the morning sun); but the Persian troops of Cambyses, curious to know what made the giants howl, broke up the stones. They were further damaged by an earthquake in Roman times. Egyptologists saw in the statues representations of Amenophis III (or Menephtah), son and successor to Ramses II, which had once stood before his mortuary temple, already destroyed in Augustus's time. Champollion found their bases covered by 15 feet of accumulated dirt. Later measurements showed that the bases were linked by cubit and proportion to the king's chamber in the Pyramid of Cheops.

Memnon Colossi, and the Ramesseum; but Champollion, seeing that "it would take a lifetime to copy all the glyphs," decided to spend more time on his return.

Further up the Nile, at Edfu, he found an immense and magnificent temple also dedicated to Hathor and to her mate, Har-Hat, the personification of celestial science and light, whose son Hawsont-Tho Champollion considered the equivalent of Eros, or "love," in the Greek myths. Sculptured representations of the three divinities, with qualifications and titles, threw a new light for him on the Egyptians' theogonic system, or genealogy of gods. At Abydos, Champollion found dynastic sites mixed in whith those of the Greco-Roman period, all badly ravaged by vandals. Sliding almost naked on his belly to enter the buried interior passages of temples, he nearly stifled, but obtained some extraordinary drawings. Found lying in a dead faint in one of the tombs, he joked on reviving that he "needed complete silence in order to hear the voices of his ancestors." On the walls of an ancient tomb he found more than a hundred different kinds of birds carefully depicted, and more than a dozen different dogs, several not native to Egypt.

The Temple of Edfu with its two immense pylons half-buried in the sand, rebuilt in the Ptolemaic era at the end of the first millennium B.C. Champollion deciphered glyphs on its walls dating back to the third millenium B.C.

At the first cataract, the group had to abandon the *Isis* and proceed to the second cataract in three small barques lent them by the commander of the province of Esne. Champollion was excited to see Philae, the lovely island where the Bankes obelisk had been discovered. From the river it appeared unspoiled, with temples and colonnades overgrown with fragrant tropical plants, shaded by tall palm trees. But they soon found that Christians, with hammer and chisel, and in the name of God, had ruthlessly obliterated inscriptions and friezes on the porticos of the Temple of Isis, lopping off heads, hands, feet, and phalli.

In Nubia, in the Temple of Kalabschi, Champollion got a better insight into the basic religion of the ancient Egyptians. He saw that Amon-Ra, their supreme and primordial being, was not only his own father, but husband to his mother, the goddess Mouth—that is, the feminine portion contained within himself, at the same time male and female—and that all the other Egyptian gods were merely forms of these two principal constituents. Most important, Champollion found that no matter how far back he went into Egyptian history, the people had been highly civilized, possessing hieroglyphs, mathematics, music, and an understanding of embalming. There seemed to be no beginning. Only under the Ptolemites had they become decadent. By this time Champollion had the long black beard of a Capucin monk, and had assumed the dress of a desert Arab, eating pilaf with his fingers, smoking three pipes a day, and keeping healthy by drinking nothing but Nile

water, possibly on the advice of his predecessor up the river, that intrepid seventeenth-century traveler responsible with Francis Bacon for organizing a New Atlantis in Virginia, George Sandys, who recommended Nile water "for it procureth liberal urine, cureth the dolour of the reins, and is most sovereign against the windy melancholy arising from the shorter ribs, which so saddeth the mind of the diseased."

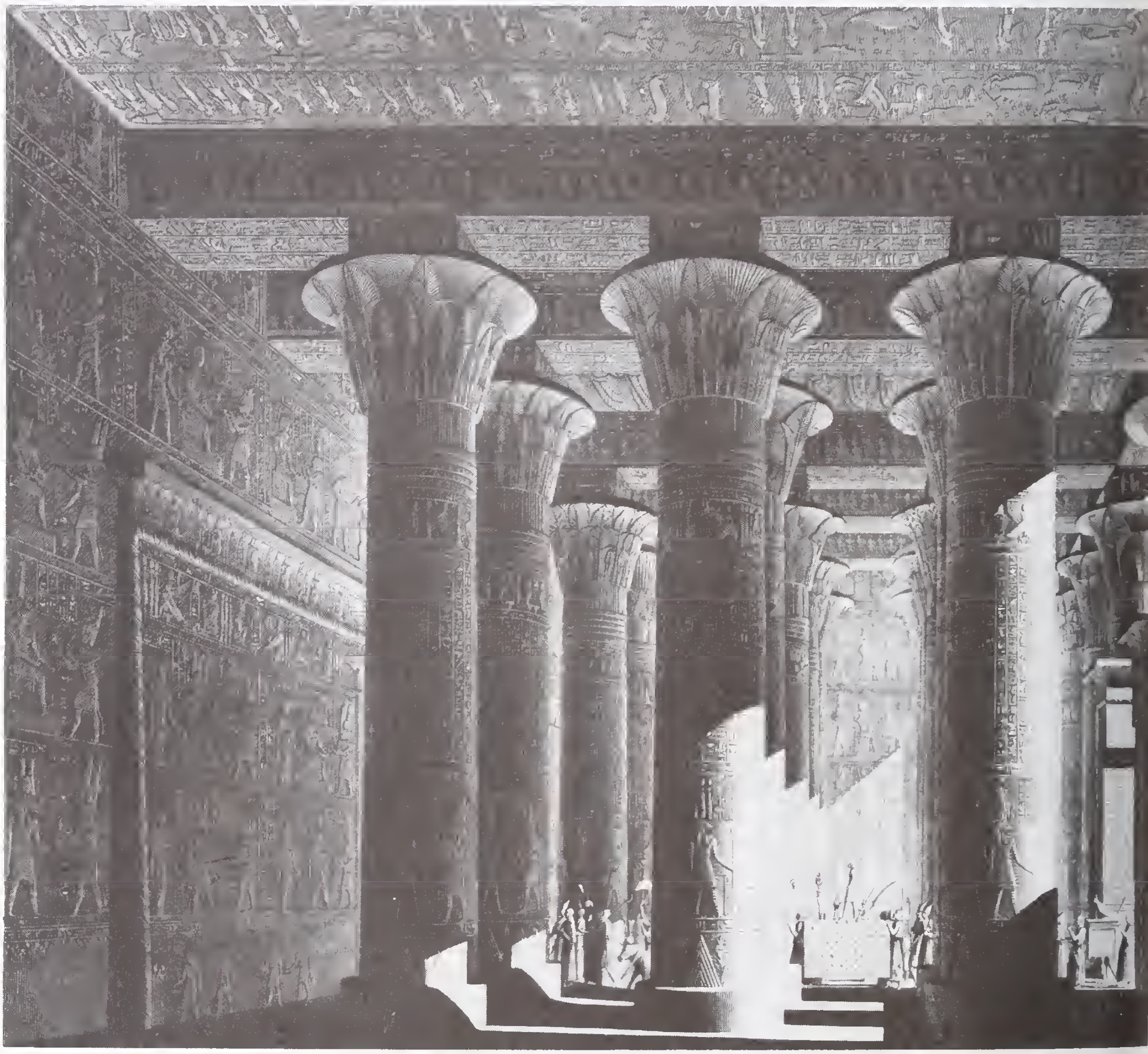
Nubia, for Champollion, grew desolate, with crocodiles asleep on the sandbars, and unexpectedly cold at night.

Reading the stones

Crossing the Tropic of Cancer in January 1829, Champollion complained that he almost froze. So they turned back, also because Drovetti had held up their mail and the money due Champollion.

Slowly coming back down the Nile, the party stopped and made careful drawings and notes of hieroglyphs on all the temples they could find, "hoping to bring back all of Egypt in our portfolios." This time they stayed seven months in Thebes, which Champollion described as the most magnificent work produced by the hand of man, the grandest and the most marvelous. No nation on earth, he concluded, either ancient or modern, had ever conceived architecture so noble, and on such a scale. "The Egyptians of old," he said to Rosellini, "thought like men a hundred feet tall. We in Europe are but Lilliputians."

Hypostyle temple of Esne



In Thebes, Champollion learned that a British engineer in Alexandria was studying the means of removing to England the recumbent obelisk which Mohammed Ali had now donated to the British. To Drovetti he wrote that he was delighted the Englishman wished to waste his country's money on removing such an inferior obelisk. Instead he recommended that if France were to put up an obelisk in Paris, it should be a Theban one. To his brother in Paris he described in detail just how the obelisks could be felled and dragged to the river, and told him that the natives could be hired for a few sous and the sharifs easily bribed, especially one—"who had the soul of a Frenchman." Champollion pleaded with his brother to convince the French government to increase the budget for the extra cost of transporting one or even both Theban obelisks. "It would not be amiss to put before the eyes of the nation such a monument, so as to disgust it with the knickknacks [*colifichets*] and gewgaws [*fanfreluches*] which we call public monuments, veritable boudoir trinkets, perfectly suited to our great men, and worthy of architects who are but meticulous imitators of all the poverty of the Bas Empire."

In Cairo, Champollion was amiably received by Mohammed Ali at a palace luncheon, where they met the pasha's adopted son, Ibrahim, a pockmarked man of forty, who suddenly fell to the floor stricken by an attack of apoplexy. Mohammed Ali, thinking his son had died, allowed his eyes to fill with tears. But Dr. Pariset rushed to Ibrahim's side, and the pasha was amazed to see his son revive. Thereafter he treated both Frenchmen with extraordinary regard, and would talk to them for hours, saying: "One of you has restored the life of my son, the other has restored the glory of my country."

Before bidding them farewell, the pasha asked Champollion to write for him a short history of ancient Egypt from all of the new inscriptions he had copied, and this

Champollion did, pleading in return that the pasha forbid further destruction of Egypt's ancient monuments and prohibit the export of its valuable antiquities, requests which the pasha eventually incorporated into a decree. Not that Champollion let the decree affect his own immediate export of all that he and his group had collected.

Back in Alexandria in September, Champollion became friendly with a young naval lieutenant, Raimond Jean Baptiste de Verninac Saint-Maur, commander of the corvette *Astrolabe,* which was to take the party and all its loot back to France in November. Finding in Verninac a fellow Bonapartist, Champollion plotted with him the means of bringing back to France one of the Theban obelisks, which they hoped to have raised in memory of Napoleon's conquest of Egypt.

On December 6, 1829, after a year and almost four months in Egypt, Champollion sailed from Alexandria on the *Astrolabe,* with an enormous collection of notes and sketches, plus two thousand pages of hieroglyphic inscriptions, entirely transcribed by hand. He also had notes on all the monuments still standing along the Nile from the Pyramids to the second cataract, reproduced with great fidelity. Fifteen hundred drawings, many colored *in situ,* had corrected virtually everything published in the *Description de l'Égypte,* whose sketches, though esthetic, turned out to have been lamentably inexact, some of the inscriptions, in Champollion's opinion, having evidently been invented by a doubting or lazy draftsman who could not believe that the hieroglyphs would ever be deciphered.

Champollion arrived in Toulon just before Christmas, to find the port in great turmoil, preparing for an expedition against the Barbary pirates of Algiers, to which his new friend Lieutenant Verninac was promptly assigned.

In Paris, Champollion found his brother at a new address, by the Bibliothèque Royale (now Nationale), to which he had been appointed curator. As a present, the young Champollion had brought him a small piece of crocodile meat, too far gone to be eaten. Figeac had duly passed on all of Champollion's recommendations about bringing back the Luxor obelisks, and the minister of the navy had been quick to support the notion, going so far as to suggest the commissioning of a special vessel to do the job; but, being the same Baron d'Haussez who had gotten Champollion into trouble as a Bonapartist in 1815, the minister intended to see that Champollion was cut out of the picture and take for himself all the glory of the project, a feat he managed to accomplish so successfully that in the two volumes of d'Haussez's memoirs, Champollion is not even named.

With Drovetti (who also hated Champollion), d'Haussez organized a committee which obtained from Charles X the order to bring back to France not only the two Theban obelisks standing before the Temple of Luxor but also Cleopatra's Needle and its recumbent partner in Alexandria. To negotiate with Mohammed Ali the cession to France of the Luxor obelisks, d'Haussez decided to send a special envoy to Alexandria. As a suitable ambassador, because of his taste in art and letters, and because he had traveled widely in the Near East, d'Haussez selected the king's commissioner to the Théâtre Français, Baron Isidore Taylor, who had been aide-de-camp to General d'Orsay during the Spanish campaign against Wellington. To advise on the engineering problems of removing the obelisks, Taylor was to take with him a French naval engineer, Lefebure de Serisy, who had recently served as Mohammed Ali's adviser in reconstructing the Egyptian fleet, destroyed two years earlier in the Battle of Navarino when British, French, and Russian squadrons had defeated the Turks and established the independence of Greece.

In May 1830, Taylor and Serisy sailed from Toulon with an initial purse of $20,000 for expenses, plus various presents to entice the Egyptian viceroy. Among these, for propaganda purposes, was a richly bound folio edition of the twenty-volume *Description de l'Égypte*. There were also some socially prized items such as Sèvres porcelains, cut glass, and table crystal, as well as items considered suitable to an oriental potentate, such as arms, helmets, and breastplates. On the recommendation of Consul Drovetti, some artificial pieces of anatomy were included for the school of medicine in Cairo.

Arriving in Alexandria, Taylor found that Mohammed Ali was still in his winter palace in Cairo. He was received instead by Ibrahim, who gave the baron a stunning piece of bad news. The French had been so tardy in removing Cleopatra's Needle that it had been given away, after much soliciting, to the British consul, Mr. Barker. Upset, and in receipt of urgent requests for his return to Paris from the intendant of the king's household, who complained that his absence was prejudicing the success of the Théâtre Français, Taylor nevertheless decided to try to salvage the situation by awaiting the arrival of Mohammed Ali.

After lingering another month in Cairo, the pasha at last

Karnak, slightly north of Luxor, consisted of a group of temples occupying about 150 acres, its walls covered with intaglios of the god Amon and scenes of pharaonic splendor. It was the national shrine of Egypt for more than two thousand years. The great obelisk in the foreground was raised by Thothmes I. Other, smaller obelisks were raised by Hatshepsut and Ramses II.

turned up, sufficiently mollified by the French diplomat's manner and by his lovely presents to reverse his decision, reconfirming to Charles X of France the gift of Cleopatra's Needle. As a bonus he added both the Luxor obelisks. Mr. Barker was to be assuaged with what the pasha considered an equitable solution: an offer to the British of quite another prize, the great obelisk of Queen Hatshepsut still standing in the Temple of Karnak—the pasha being convinced that the British could never remove it.

Taylor wrote at once to Paris that the Alexandrian and Luxor obelisks were now the property of Charles X. But by July, events in France had taken a turn. News reached Alexandria of a three-day revolution in Paris which had forced the reactionary Charles X, King of France, to abdicate in favor of the bourgeois Louis Philippe, King of the French, helped into power by a conspiracy of Masons. Mohammed Ali changed his mind and refused to allow the embarkation of Cleopatra's Needle onto the ship *Dromadaire,* specially sent out by d'Haussez. Mr. Barker, seizing the advantage, quickly conceived a plan to remove the obelisk to England, placing several of the pasha's agents in his pay.

Taylor did his best to convince Mohammed Ali that nothing was fundamentally changed in France by the revolution, that the gift had not been to the person of the king, but to the nation, to the people of France. Mohammed Ali pondered, and finally changed his mind, reconfirming the gift to the government of Louis Philippe "in gratitude to France for numerous tokens of favor and friendship," but mostly in the hope of obtaining naval equipment for his infant Egyptian navy.

By this time Taylor had learned that there was no hope of getting heavy timbers from Caramanie in Cyprus needed to load the Alexandrine obelisk, so he decided to return to France to speed up the building of a special vessel to fetch the Luxor obelisks before there were any more changes of mind. In Paris, Taylor found that d'Haussez had fled to England, accused with several of his colleagues of being responsible for the reactionary ordinances which had brought about the revolution of July. His successor at the naval ministry, Gèneral Horace Sébastiani, had, however, been on a mission to Egypt under the consulate, and saw no reason to change the arrangements for the obelisks made by d'Haussez. Only there was no ship in the French navy capable of sailing 1,800 leagues across the Mediterranean, 200 leagues up the shallow Nile to Thebes, then back again loaded with a single 250-ton obelisk, let alone one capable of facing the contrary winds of the Atlantic's Bay of Biscay before being towed past the low and narrow bridges of the Seine all the way to Paris.

Such a ship would have to be specially designed and built, breaking all the rules of naval architecture. In order to hold an 80-foot obelisk, the ship would have to be at least 100 feet long. To sail the Atlantic it would have to be well keeled. To sail up the Seine it could be no wider than 25 feet. To cross the sandbanks at the mouth of the

Nile it would have to be as flat-keeled as possible, yet sturdy enough to be beached on the banks of the Nile and receive a load of 250 tons. For such an extraordinary craft it was decided to lay five separate keels specially reinforced with extra strutting to spread the weight of the obelisk evenly over its bottom.

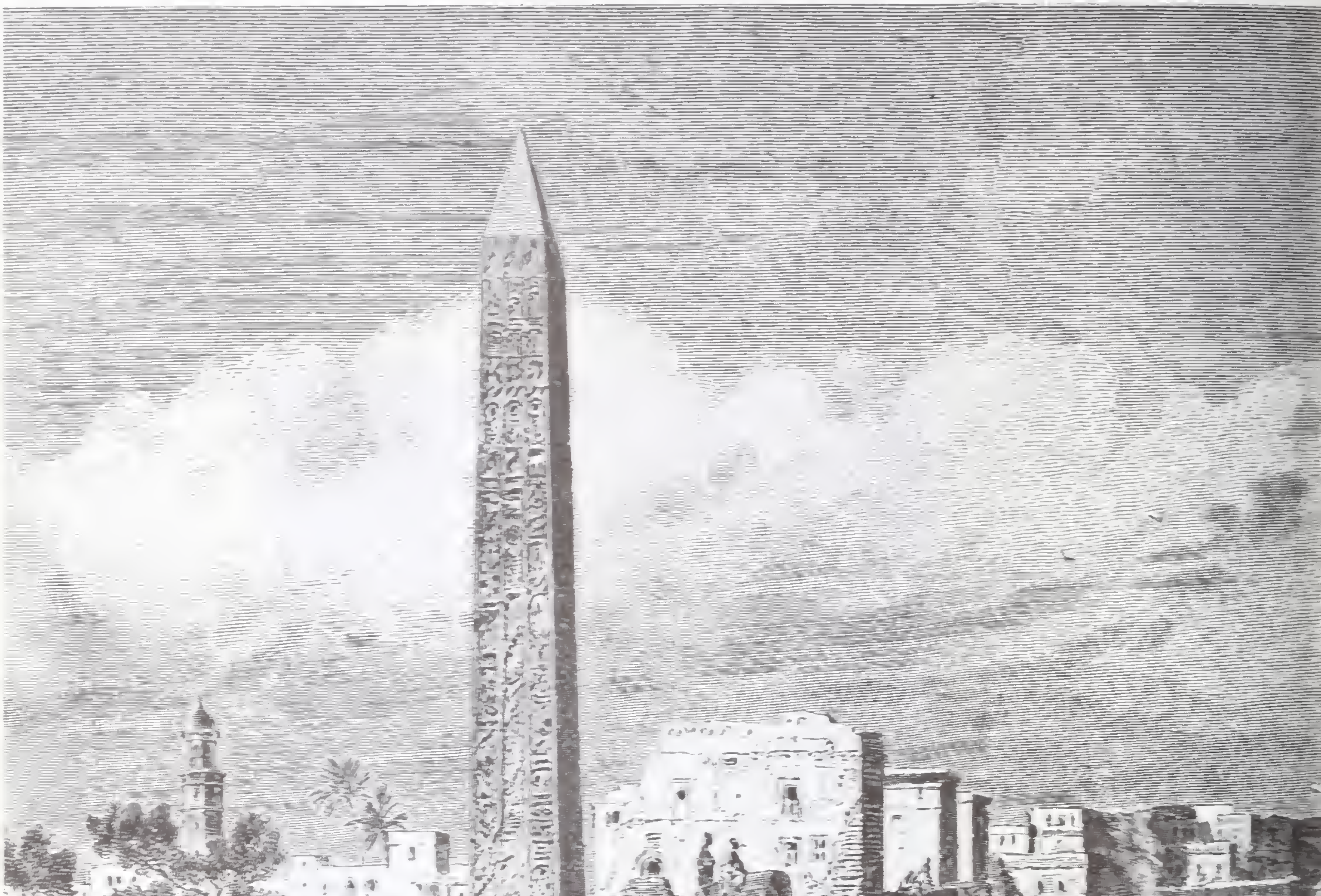
As a name for this novel ship, the one which Champollion had originally suggested, the unnovel *Luxor*, remained. And now that d'Haussez was gone he was also able to suggest as captain Lieutenant Verninac Saint-Maur, who had just distinguished himself in the French operations against Algiers by bringing back in the *Astrolabe* 10 million French francs in gold looted from the Casbah.

No sooner had Verninac deposited the gold in the French treasury than he heard of his appointment as captain of the *Luxor*. Verninac took over his new command with some doubts as to its seaworthiness, and immediately lightened its load by ordering a reduction of most of its armament. As a second-in-command, Verninac selected another young naval officer, Lieutenant M. de Joannis. Three more officers were to command a crew of 136 sailors, along with two naval surgeons, Dr. Angelin and Dr. Pons.

To handle the actual operations of felling the obelisks, the maritime prefect of Toulon recommended a diminutive naval engineer with the appropriate name of Lebas. Monsieur Jean Baptiste Apollinaire Lebas's orders were to fell the right-hand obelisk facing the palace at Luxor, as selected by Champollion, and embark it on the ship. During the felling and embarkation, Lebas was to be in sole command; otherwise command rested with Verninac. To help Lebas with his job, he was allowed to select from the Toulon base a master carpenter with assistants, smiths, caulkers, jointers, stone cutters, and several first-rate boatswains.

While Verninac loaded the ship with a year's worth of supplies, including pistols, sabers, rifles, and ammunition, Lebas loaded equipment necessary to lower the obelisk, including several 50-foot beams almost 2 feet in diameter, forty 16-inch boards of the same length, and 4 inches thick, 1,200 meters of rope as thick as a man's arm, 400 meters as thick as a man's leg, several heavy capstans, block and tackle, pulleys, and a forge. Lebas was empowered to hire as many men ashore as he needed for the job, payments for whom would be provided by the new French consul in Alexandria, M. Mimaut, who had replaced Champollion's enemy Drovetti.

On April 13, 1831, fully loaded, the *Luxor* sailed from Toulon with a favorable breeze, carrying a band of adventurers who hoped to duplicate an engineering feat which had not been accomplished since the time of the Romans—the removal to Europe of one of the great Egyptian obelisks. As the extraordinary vessel passed the boom, all the ships of the French navy lined up in Toulon harbor sounded general quarters. Toulonnais massed on the quays waved handkerchiefs; mothers, sisters, and sweethearts dabbed their eyes.



10. BOURGEOIS ADVENTURERS

With the wind either abeam or astern, the *Luxor* breezed along at a comfortable 8 knots, but it was soon clear to Captain Verninac that she was not a seaworthy craft. When the wind shifted to the east, obliging him to sail close-hauled, the keels would not hold, and the *Luxor* progressed sideways like a crab. Hit by a storm, the ship was unmanageable. As the storm died, Verninac realized that for the return trip with the obelisk aboard, he would have to have one of the navy's newfangled steamships tow him to Toulon.

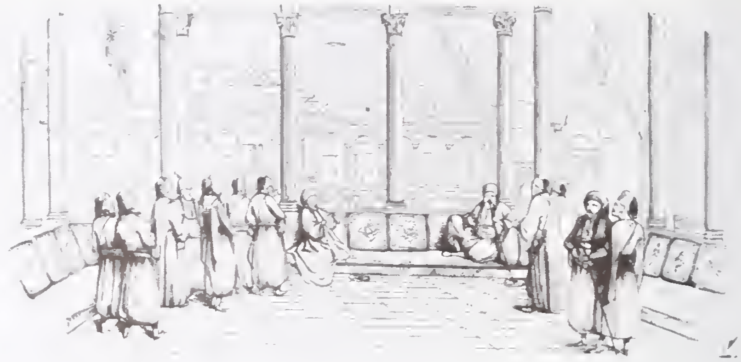
On May 3, at dawn, the sandy dunes of Africa appeared against the blue sky above Pointe d'Aboukir, reminding the crew nostalgically of both Bonaparte's victory on land and of Admiral Brueis's disastrous defeat in the bay. At 10:00 A.M., the ancient landmarks of Alexandria—for both sailor and bedouin—Pompey's Pillar and Cleopatra's Needle, appeared on the horizon, and the *Luxor* anchored in Alexandria harbor opposite the sparkling white palace of

Pompey's Pillar

the viceroy of Egypt, Mohammed Ali Pasha, and Captain Verninac went ashore to call on the khedive's son Ibrahim, whose prime preoccupation at that time was the instant recruitment of an army with which to attack his Ottoman masters, who had insulted his father.

When Mohammed Ali and his suite arrived at the palace, Verninac, Lebas, and Angelin, all in full French naval uniform with huge epaulettes and fore-and-aft hats, were received by His Highness in the large hall with arched porticoes and thick Turkish carpets. Raising himself on his cushions, pipe in hand, Mohammed Ali asked for the engineer Lebas, as if he were so small he could not see him. Laughing at his own joke, the pasha then honored Lebas by asking him to sit beside him and tell

Alexandria, founded by Alexander the Great in 332 B.C., became one of the great cities of the East, with half a million inhabitants, second only to Imperial Rome. When the Arabs conquered it in A.D. 640 they found 4,000 palaces, 4,000 baths and 400 theaters. It contained two of the greatest libraries in history, the Serapeum and the Soter each with 400,000 volumes; the former was destroyed by Christians, and latter in 641 by the Caliph Omar, who is recorded as having said: "If those books contain the same doctrine as the Koran they are of no use, since the Koran contains all the necessary truths. If they contain controversy, they should be destroyed." So the parchments were given to the public baths to be burned as fuel for six months.



him all about the problems of the obelisk. Captivated by the pasha's deep probing eyes, Lebas, as he later recounted in his report on the operation, listened carefully to "His Highness' refined, perspicacious, and profound ideas."

Mohammed Ali, as he had done for Champollion, graciously accorded the expedition a *firman* for free circulation in all his states, plus the protection of two janissaries to see that his *firman* was obeyed. He ordered that everything possible be done to facilitate the enterprise, even producing for the French, as dragoman, or guide, an ex-Frenchman who had stayed in Egypt after Napoleon and had adopted the oriental name of Youssouf Kachef, an exotic fellow who spoke excellent Arabic, and knew most of the sheikhs up the Nile.

Alexandria, at the extreme western edge of the Nile Delta, was not on an actual estuary of the Nile. The main mouth of the great river emptied into the Mediterranean just north of the town of Rosetta. Navigation on this estuary was only possible for the *Luxor* at floodtime, which would come toward the end of June, a month or more away; and even so, shifting sandbanks blocked the mouth, which became most dangerous when whipped by sudden winds. The *Luxor*'s third mate, Midshipman Juarez, sent ahead to the mouth of the Nile to sound out the depth of the sandbars, returned with a competent pilot.

At dawn on June 11, Lebas set off with a flotilla of small flat-bottomed barques called *dgermes,* loaded with the heavy equipment from the *Luxor,* heading across Aboukir Bay for the westernmost mouth of the Nile, about 12 leagues east of Alexandria. As the water at the mouth of the Nile was 6 feet deep over the sandbars, and the *Luxor* drew 8½ feet, Verninac had been obliged to lighten the ship to the utmost, and as it could no longer sail on the open sea on its own without ballast it had to be towed by a French thirty-cannon brig, the *d'Assas,* which opportunely appeared in Alexandria harbor.

Lebas, in his *dgerme,* noticed the sea was taking on a yellowish tint. From the frown on the pilot's face, he concluded they were approaching the mouth of the Nile. Small mounds of sand appeared on the surface of the water, forming sinuous passages of unequal depth, wide enough for the small boat to negotiate, but difficult for the *Luxor.* To guide the *Luxor* through the treacherous sandbars Verninac had found a single-toothed Arab pilot who had spent a lifetime negotiating what the Turks called the *boghaz,* or narrow maritime passages. At daybreak on the seventeenth, the *Luxor,* cast adrift from the *d'Assas,* headed for the *boghaz.* Small boats lined each side of the narrow frothy passage, which continued to shift under the impact of waves, current, and a stiff breeze. On the way through, Verninac caught sight of the wreck of a ship which had missed the passage and been battered against the banks. Moments later, a heavy shock signaled that all five keels had struck bottom. If the *Luxor* could not surmount the bank, she risked being caught by the sands and held for the rest of the year, putting a quietus on the whole expedition.

Heavy waves raised and lowered the ship. Sails strained in the quickening breeze. With a groaning lurch, the ship was carried across the barrier into what Verninac described as "the tranquil waters of the most beautiful of rivers." The Arabs shouted hurrahs. Cannons from the Turkish forts guarding each side of the mouth fired a welcome. Unable to respond with salvos, because they had dismantled all their guns, Verninac flew pennants and made up for his apparent rudeness by a donation of Bordeaux and Champagne to the local Turkish garrison.

There was a brilliant sun. The sky was alive with swallows and terns. Broad-beaked pelicans circled overhead as the ship slid slowly past an island which had not been there when Napoleon had charted the area thirty years before. Along the banks of the river, date palms framed a delightful panorama where the Rosetta Stone had been discovered. On the gently flowing Nile, the *Luxor* was a novelty. Natives ran from their cottonfields and rice paddies to stand at the river's edge and admire the mountainous ship. Children left their sheep and buffalos unherded to stare in wonder at what they called a floating mosque.

Three hours later the *Luxor* anchored off the actual town of Rosetta, surrounded by a cool green landscape. It was explained to the Frenchmen that many of the town's lovely houses were uninhabited since the newly dredged Mahmudi Canal, shorter and safer, had siphoned off traffic directly from the Nile to Alexandria, leaving Rosetta commercially high and dry. While the *Luxor* waited for the waters of the Nile to rise sufficiently for it to proceed upstream, Verninac and his crew were able to enjoy Rosetta and its surrounding wonderland of orange groves, banana plantations, and cool shady gardens lined by avenues of sycamores.

The town of Rosetta on the east Nile

But Lebas could not linger. He had to reach Thebes in time to dig a berth for the ship on the riverbank, as close to the obelisk as possible, so that the *Luxor* could be floated over it at floodtime and be left in a level drydock when the waters eventually withdrew.

There were four types of boats on the Nile: the *dgermes,* with large lateen sails, svelte enough to scoot up the river in any season; *agabas,* heavy flatbottomed barges, drawing very little water, used for towing supplies when the waters were at their lowest; the *masch,* known as the store-ship of the Nile, a craft of 400 to 500 tons, used to sail only during the inundation of the river; and *canges,* narrow boats, light and elegant, with the fine lines of a yacht.

Midshipman Juarez and surgeon Pons, with ten sailors and a detail of sixteen carpenters, smithies, and stone cutters, were to go ahead to Cairo, 40 leagues up the river in a mixed flotilla of native boats loaded with equipment.

Lebas, Juarez, and Pons boarded a light *cange,* which could travel speedily either by sail or by scull, and installed themselves on the stern, where a small superstructure had been divided into two rooms—a messroom and sleeping quarters.

On July 19 the whole flotilla abandoned the *Luxor* off Rosetta and set sail for Cairo. As Lebas put it, "All was new to us, the countryside, the trees, plants, costumes, and the language of the Arabs." Avidly taking stock of the varied products, many of them unknown in France, the Frenchmen let their eyes wander happily over the passing delta. The banks were bordered with flowering hedgerows, forests of date palms, and fragrant mimosa. Beyond the fertile fields, a wasteland of desert stretched to the horizon.

Here and there the Frenchmen spotted land, once fertile, which had fallen into the most depressing poverty. Nearby villages lay in ruins, replaced by hovels of sun-dried mud, roofed over with palm fronds. They noted that despite the fertility of the delta, the Arab population appeared to be miserable and half-starved, lining the riverbanks to implore assistance, displaying their naked half-starved children. Everywhere the Arab men were covered with rags, prematurely aged by ill-treatment and privation. The only social institution appeared to Lebas to be the caprice of the Turk, who could have any Arab lashed on any pretext with a *courbache,* or heavy whip of hippopotamus hide.

On the roof of every house or hut Lebas was surprised to see a pigeon coop, from which at dawn myriad of pigeons would fly out, darkening the sky, and return at noon to rest through the heat of the day. No one seemed to shoot or eat these birds; they were raised solely for their excrement, a powerful fertilizer for field and garden.

At Abou Mandour they passed a famous mosque where female pilgrims came to perpetuate their bondage by obtaining fertility from the waters of a reportedly magic fountain. Every evening Lebas and his colleagues would go ashore to study the manners and customs of the people, whom they were surprised to find essentially gay, despite the ever-present threat of the *courbache*. The curious natives stared at the Frenchmen's clothes and asked many questions.

By day Lebas would flit from bank to bank of the Nile in his light *cange,* trying to keep the Arabs, with their heavier *agabas,* constantly on the move. Like a cabby with a tourist, the river captains, or *reis,* of the *agabas,* would take the longest time, dallying wherever possible to increase their salaries, running onto sandbanks they could easily have avoided. At one point there was a near disaster when one of the grounded *agabas* sprung a leak and threatened to wet and ruin the heavy cordage needed for lowering the obelisk. Luckily the French sailors saved the day by using their leather hats, or *bousingots,* to bail the leaking craft long enough to remove the cordage.

Eleven days after leaving Rosetta, Lebas reached Cairo and complained to the Turkish governor about the malingering of river *reis*. The Turks forthwith produced the *courbache,* and it was all Lebas could do to insist that he wanted efficiency, not punishment. With a shrug the Turks assigned to him four janissaries, whose job was to keep the river captains on the mark.

Cairo from the river

They also visited the nearby plain of Memphis, where Menes, the reputed founder of the First Dynasty, is said to have changed the course of the Nile. There also his great capital city had once stood, described for the Frenchmen by Herodotus and Strabo; but the Frenchmen found only rubbled ruins among the date palms. In the evening they walked to where their *cange* was moored in sight of the earliest known pyramid, the Stepped Pyramid of Saqqarah, said to have been built for King Soser of the Third Dynasty by Imhotep, the most renowned of architects in ancient Egypt.

At Cairo, the lower-river pilots were replaced by upper-river pilots. These were of a different race, called Barbarin, the inhabitants of lower Nubia, darker-skinned, more supple in their movements, with a grace which Lebas found almost pretentious. Their faces were more like those sculptured on the monuments of ancient Egypt, their voices softer and fluted, ending in sharp notes as they spoke a dialect quite different from the Arabic of the delta.

Before starting upriver, Lebas and his companions left Cairo for a short visit to the pyramids of Giza.

The pyramids of Ghiza seen from the Nile

Everything that Lebas saw of ancient Egypt was a pleasure to him. He found his eye lighting agreeably upon the forests of columns in the temples because their number and size were harmoniously designed for the heavy roof they were intended to bear. The plans of the buildings he found simple and precise, and therefore easy to comprehend. Egyptian paintings, reliefs, and sculpture he found charming and extraordinarily descriptive, the figures admirably expressing the passions and pains which animated them. So deeply was he affected by what he saw, he found it difficult to tear himself away from the hypnotic lure of the amazing ruins.

Sailing up the Nile is favored in July by the northwest or northeast winds, which predominate throughout the period of inundation. With the wind abeam or astern the sails could easily overcome the current, except where the river looped so widely that the wind came head-on. There the Arab sailors would jump ashore and pull the *cange* with heavy lines, cadencing their footsteps with a song. As they moved further south, on either side of the Nile the plains began to be bordered with limestone mountains from whose flanks the stones of the Great Pyramids had been quarried. Here the progress of the boat was slow enough for Lebas and his colleagues to take short excursions into the Arabian hills, where the ancient monuments attracted them, temples they knew from Denon's beautiful etchings and from those of the *Description de l'Égypte.*

Lebas found the heat of Upper Egypt stifling and nearly insupportable for a European. The Frenchmen constantly quenched their thirst with water from the Nile and took advantage of every cooling breeze caught between the riverbanks, which at some points rose to high peaks where the river cut between the Libyan and Arabian chains. Sailing in the evening, refreshed by the northwest breeze, was pleasantest. As the Nile below the cataracts is bereft of rocks, there was little danger of nocturnal mishaps. Stars, barely visible in Europe, sparkled brightly in a deep blue sky, while the Arab sailors, bunched around the mainmast, chanted nostalgic songs.

The cange's great lateen sails, like butterfly wings on its antennae masts, heeled the barque through the swift current, churning up a frothy wake. On the riverbank the shadows of sycamore and palm tree slid past with a mysterious calming effect. The only sinister note was occasioned by mournful wails that would drift across the water from some darkened village.

They passed Atfyr, Beni-Sonef, Sbou Girgeh. Lebas would have liked to linger over the sights, but the threat of not reaching Thebes in time to berth the *Luxor* before the Nile receded from the apex of its inundation pressed him on. It was not till Siout, the capital of Upper Egypt, where he was required to deliver a letter to the governor, that Lebas stayed ashore a whole day.

North of Abou Fedda, Lebas learned from the pilot that they were in for trouble. Here the Arabian chain rises straight from the east bank to a height of 100 meters. Forced through a narrow passage, the Nile boiled along with enormous force, and the wind swirled and hit the *cange* from every direction. To overcome the hazard, the Arab master resorted to some magic, jabbing his knife into the mast, throwing a handful of salt into a hastily built fire, praying to the Prophet. He then tore off the head of a chicken and sprinkled its blood on the masts, anchors, and doors, attaching a few sticky feathers here and there, all the time appealing to the divinity of the river. Mixing a concoction of oil, tea, alcohol, and salt, he poured it on the turbulent waters of the Nile.

The *cange,* struggling with all its sails against a current of 4 or 5 knots, had barely covered a third of the way through the Abou Fedda passage when it was hit by a stronger squall. A bolt of lightning cracked the mainmast.

It was the forerunner of a tornado. The wind shifted around the compass, buffeting the frail barque forward and backward. Sailing on its forestay, but mostly blown along like a straw, with its keel scraping bottom, the *cange* was in constant danger of being crushed against the sheer side of the cliff. The ordeal lasted more than two hours; then the wind calmed and the skipper managed to pull the craft through to safety. Three hours later they were at Manfalout.

The wind was now favorable and propelled the *cange* so fast that in five days they were in sight of a superb forest of doums that preceded the ruins of Denderah. Lebas would have liked to visit the Temple of Hathor, from which the already famous but still undeciphered zodiac looted by Drovetti had been brought to Paris at great expense, but again he was afraid to tarry. Instead, he obtained permission from the local Turkish governor to return later and cut a hundred doums as lumber for felling the obelisk at Luxor. "For a little money," said the indifferent Turk, "the natives will bring you a whole forest."

The great Gamouleh bend in the Nile was handled by the Arabs with ropes. As they came around it the vestiges of the ancient city of Thebes appeared, lit by the last rays of the sun. To starboard stood the ruins of Gourna; beyond

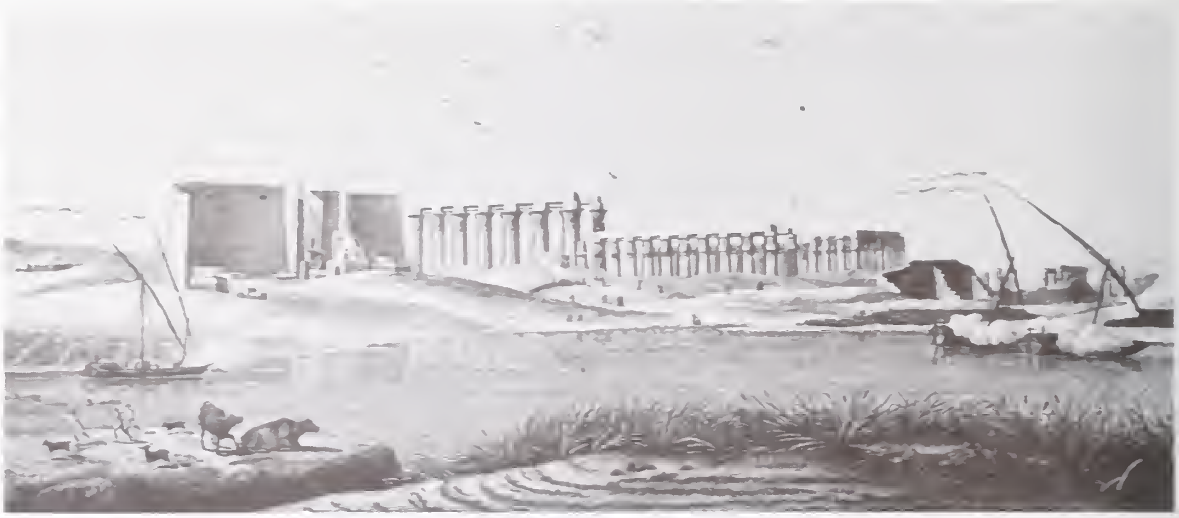
Gerald Massey explains the magic involved in mummification. As the embalmer rolled up the mummy in its bandages, he would, by the rhythm of his gestures and the formulas he chanted, fix the "shadow," or *shout*, of the deceased into the body, for fear it would wander about as a demon or unleashed passionate force. Embalmed and drugged and tranquilized by incense and music, it would not waken unless grave robbers (or Egyptologists) freed it from the shackles of its bonds. If so it would take off in search of human fluids to keep itself alive. A freed shadow, says Massey, could obsess a person to death, or take over the fetus of a pregnant woman. Destroying the mummy would no longer help. A special chant was needed to destroy the name.

Across the Nile from Luxor, beyond the Valley of the Dead, with its line of funerary temples, lies an arid, savage mountain chain riddled with deep passages and vaults—tombs for the pharaohs, where their mummies lay in richly ornamented sarcophagi in exquisitely decorated rooms filled with the treasures of Egypt. All around, more tombs for queens, princes, viziers, generals, priests, and important personages were dug into hill and valley above the floodline of the waters of the Nile.

them, against the distant Lybian chain, the temples of Medinet-About and the sinister Valley of the Tombs of the Kings. To port rose the columns of Karnak, with its immense pylons, dominated by the giant obelisk of Hatshepsut, higher than the ones at either Alexandria or Heliopolis. A mile or so up the river, still to port, stood the colonnade of the Palace of Luxor, its two pink granite obelisks, russet in the sunset, barely visible as they guarded the immense gateway.

Musing at the ruins of Thebes, Lebas was struck with wonder at the thought of a city of a hundred gates, with colossi, monoliths, and colonnaded palaces, all of which he had heard described by Champollion. But his prime preoccupation was to reach the obelisk he was to fell. He could just see it, in the twilight to the right of the great entrance to the Ramesseum at Luxor.

One by one the *agabas* drew up at Luxor on the eastern bank of the river by a sandy beach which climbed gently toward the village, a conglomeration of mud huts nestling among the ruins of the great palace of Ramses II.



Arrival at Thebes

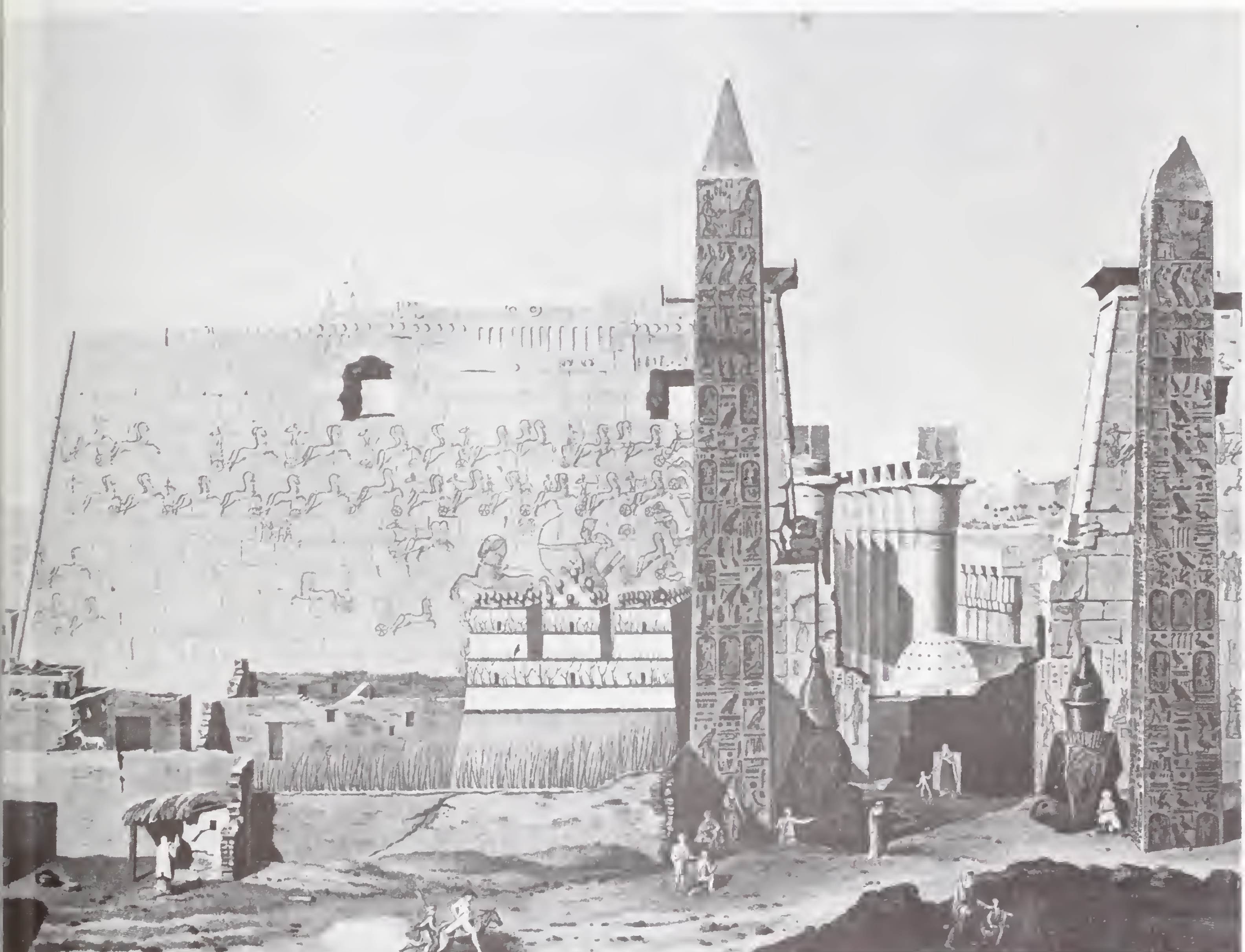
The inhabitants, attracted by the appearance of barques flying the French *tricolor,* and the possibility of *bakshish,* lined up along the bank, covered in rags, hands out, bemoaning their misery. As Lebas's *cange* dropped its anchor, he jumped ashore, followed by the French sailors, who clambered across the sand, disappearing among the mud huts to get a closer look at the one great pink granite obelisk which was the object of their journey. The natives would not believe the French had come to remove the obelisk. They considered such an idea so fanciful it had to be a ruse to disguise some ulterior motive. They believed the foreigners to be making a reconnaissance of the area before returning to take over as conquerors. "Do you not know," they explained, "that these needles were set up with a special mastic hardened by the sun which it is impossible to pull apart without cutting up the stone?" Where, they inquired, was the man big enough to perform such a prodigious feat? When they saw the engineer Lebas, they burst into friendly peals of laughter, laced with cries of "Allah! Allah!"

Lebas and his sailors crowded round the base of the obelisk, which stood in a mass of rubbled stone, its shaft deeply buried in the sand, touching it tenderly and making estimates of its height and weight. The master stone cutter they had brought from Toulon, an Italian named Mazacqui, gently tapped the eastern face, listening carefully to the resounding surface, then cried out in a mixture of Italian and French: *"Moussu, la pietra, elle est felée, mais je ne crois pas qu'elle soit routta; lou son est sano, on pourra l'enlever pourvu qu'elle tombe piano, piano"* which translates as "Sir, the stone has a lesion, but I don't think it is cracked through. It sounds quite whole. We will be able to take it, providing we lower it slowly, slowly."

Lebas was dumbfounded; there had been no mention of a fissure in any of the works he had read on Luxor. He was also worried that he might be accused of having cracked the obelisk in the process of felling it. In a sort of stupor he returned to his *cange*. The next day, more cheerful after a good rest, Lebas set to work with some hired *fellahin*. Clearing away sand and debris they traced the fissure all the way to the base, twelve feet below the surface. But Mazacqui had correctly deduced from the sound that the fissure was not deep enough to cause trouble. It appeared to be as old as the obelisk.

What did provide an obstacle were the one-story huts the natives had built so close to the obelisk they would be destroyed by its felling.

Object of the quest



Native huts nestling in the great palace of Sesostris, or Ramses II

Lebas concluded that clearing a way to fell the obelisk would mean destroying thirty of the native huts, which would have to be valued for expropriation. For this purpose, and to cope with the oriental custom of *bakshish,* Verninac had been provided with 40,000 francs, and Lebas with 20,000. But Lebas found to his surprise that for once the sight of gold had no effect upon the Arab owners, who could not be induced to give up their homes.

The dragoman Kachef then explained to Lebas that the Arabs were merely waiting for nightfall so as to be able to remove from their houses the goods they had harvested and secreted from the Turkish overlords. The next day, negotiations were resumed before an expropriation committee consisting of Lebas, the local Turkish governor, or nazir, and the local judge, or cadi, plus the headman of the village, who wore a green turban to indicate a doubtful descent from the prophet Mohammed. Ibrahim, the local interpreter, a tall, lean figure with a huge protuberance of a nose, heatedly waved his arms and kicked his legs, alternating threats with persuasion, and making a thousand grimaces. The Arab families pressed hard around the committee table, the men's faces pouring with sweat, the women, veiled, displaying their emotional distress through darting black eyes, uttering sharp guttural cries.

This brouhaha reached a paroxysm and died suddenly—at which point the interpreter told the stupefied Lebas: "We are in agreement. His Excellency the nazir

Luxor natives in the ruins of Ramses' palace, whose columns are half submerged in a millennial accumulation of dirt.

invites the committee to dinner." The indemnity amounted to 4,000 francs. Each hovel owner came personally to kiss the hand of Lebas and thank him for his munificence.

At the nazir's table, Lebas, dressed in his grand naval uniform, did not feel too comfortable, squatting before a common dish, feeding with his fingers, dipping his bread into the communal sauce, and tearing the meat with his teeth. Each dish was on the table only a few moments before it was whipped away. In all, Lebas counted thirty-five dishes, including two whole muttons, which the brin-bachi, or town major, carved up, handing Lebas as the choicest morsel, the liver, dripping like a sponge.

The meats were followed by sweets, creams, fruits, and rice cakes, all washed down with water from the Nile. To Lebas's distress, there was no wine or liquor, only Turkish coffee. After the ritual rinsing of hands, he was offered the first smoke from a hookah with an amber mouthpiece, which was passed from mouth to mouth. When Lebas expressed his surprise to Kachef over the sudden happy ending of the expropriation ceremony, he was informed with a smile that the whole performance had been a *mise-en-scène* by Ibrahim to merit a proportionate reward. All he had needed to say was: "The government wants your house. The *courbache* is at hand!" Still smiling, Kachef told Lebas of Ibrahim's first words upon the Frenchman's arrival at Thebes: "Well, friend, how much do you think this gentleman is worth?"

11. MUDDLING ON THE NILE

From what the Arabs said, and from signs left along the riverbank, Lebas could distinguish the limits of the previous year's flooding of the Nile, which had reached just 400 meters from the base of the obelisk he wished to remove. His problem was to dig a berth deep enough not only to house the *Luxor* when it arrived, but to float it again with its extra load of 250 tons at the peak of the river's coming flood.

Lebas's announcement that he would pay a daily wage, instead of merely administering the lash, brought hundreds of ready hands. But the French overseers soon found the Arabs capable of digging a simple hole, not a trench, which required the use of rules and lines; so they had to instruct them at every moment just where to dig and where to level.

Four hundred *fellahin,* dressed in cotton trousers, and equipped with spades, raised a great cloud of burning dust that hid them from the village. While the men dug, the women and children hauled dirt in wicker baskets, boys and girls in two long lines, all equally naked. They would help each other load a basket on the head, then set off all together chanting to the cadence of what Lebas called an extremely obscene song. "Such customs," he remarked in his puritanical manner, "which in Europe are repugnant to our mores, should not astonish in a country where it is the custom to call each part of the body and its function by its proper name."

At certain times of the day the heat was so intense that the young carriers, whose soles were not yet hardened, would upturn their baskets and put them on their feet while the Arab overseers, wielding palm fronds, shouted *"Yalla volet, Yalla benti!"*—Come on boys, come on girls! Drenched in sweat and covered in dust, the workers were constantly quenching their thirst from special urns of Nile water placed at regular intervals. At the drumbeat signal that ended the day's work, men, women, and children would rush to soak in the Nile, oblivious of the menace of crocodiles, then come and squat in circles of forty or fifty on the beach where Lebas would make the round to pay them their daily wage of 15 centimes. In five days the natives dug Lebas a channel 50 meters long, 12 meters

Five leagues from Thebes, at Maximianopolis, with the wind head on, and no means of hauling the anchor, the *Luxor* was obliged to stop, but the local nazir, or vice-governor, a thin-faced beardless man with a large aquiline nose, ordered his janissaries to impress the inhabitants of four local villages. From a cloud of dust appeared 400 naked men, dark-skinned, goateed, and with leather feet, reluctantly ready to do the pulling. Beaten by the janissaries, they started at a slow cadence. Inch by inch the *Luxor* moved forward to the sound of a monotonous chant in praise of the "Sultan of Fire," or Napoleon Bonaparte, who, according to the song, had "led his Western men safely to the shores of the Nile to destroy the Mameluke oppressors who dissolved before him like the mists of the Nile before the morning sun!" Under the lash, it took the gangs ten hours to move the *Luxor* 3 leagues around the Gamouleh bend. Starved, worn out from fatigue, some thirty fellahs fell by the way. But by dawn the *Luxor* could once more hoist its sails. For their efforts the surviving fellahs each received 35 centimes, a liberality which filled them with such joy they crowded round to kiss the hands of their Gallic benefactors.

wide, and 1.5 meters deep, perfectly suited as a berth for the *Luxor*.

The Nile was rising fast, its waters changing from deep green to russet, undermining the crumbling banks. By July 7 it had risen sufficiently for the *Luxor* to leave Rosetta and set sail upstream. Three weeks later, after a trip that included sailing before favorable winds, being towed by four hundred naked men, and many exotic sights for Verninac and the crew, the *Luxor* was able to anchor offshore in sight of the obelisk, loudly acclaimed by the populace, who were most amazed to see such a monumental ship being maneuvered by no more than the thin shrill sound of a whistle, without word or other signal being given.

On August 16 the *Luxor* slipped into the end of its berth, carried forward little by little by the waters of the Nile until it could be lashed into its resting place, pointing directly at the obelisk. A month later, on September 16, the retiring waters left the *Luxor* firmly grounded in its sandy berth. Two more banks of sand were built up along the ship's flanks to be watered daily so as to keep the hull from cracking in the heat. Further to protect the hull, several rows of reed matting were raised on palm beams all around the sides. The ship's masts were lowered, and

Matted against the 120° sun

The Memnonium of Thebes

all its gear was housed in a room of the great palace of Sesostris—better known as Ramses II.

Lebas had installed his engineers in the great hall of the south palace of Emenophis Memnon. Verninac now set up quarters for his crew in the two main galleries of the south portico—"where the pharaohs had once dispensed justice and the priests preached mystic lessons"—stringing hammocks between the ancient hieroglyph-encrusted columns. Sailors' lockers at the foot of each hammock gave the appearance of a regular naval barracks. In the adjoining rooms the Frenchmen created a storehouse for supplies, a bakery with an oven, a carpenter and joiner's shop, an arsenal with a powder room, a forge for the smithies, and a stable for the horse which milled the grain for their daily bread. To accommodate doctors Angelin and Pons, a hospital was built with thirty beds in a long airy hall lighted by twelve windows.

The officers were quartered on the roof of the palace, where they were given the three-room residence of the brinbachi, who was evacuated on orders from the nazir. On this rooftop, between the south wall and the northern extremity of the vestibule, Lebas arranged for a small room, 15 feet square, to be built for each officer out of Nile brick. All gave onto a broad terrace overlooking the neighboring countryside with its rolling plain, dotted with

View from the French compound

French officers' quarters

To make a solid roof atop its ancient pillars, Lebas had several palm trees ripped into joists with which he replaced the missing architraves. Filling the empty space with palm fronds, he had them covered with a mixture of Nile mud and chopped straw, which was quickly baked by the sun into a useable floor. Though a good rain might have washed it away, there was little likelihood of a downpour in the serene blue skies of Egypt.

mimosa and dates, which ran up to the foothills of the Arabian chain.

On this platform were also built a reception room, a mess hall and a common room, or divan, all neatly whitewashed and furnished with the officers' effects from the *Luxor*.

The quarters, which could easily be reached from a ramp of sand banked against the palace walls by the desert wind, were comfortable enough, says Verninac, except for the heat, which normally stood about 100° in the shade, and except for the scorpions which kept crawling out of cracks in the wall, and the vipers that rested in the ceiling, and the great gecko lizards which ran wild along the walls.

The actual village of *Luxor* had been built within the millenial crumbling walls of the two great palaces, on a ridge 700 meters long by 350 wide, 3 meters above the level of the plain, on foundations dating back at least thirty-four centuries and most likely more. The gateway between the two great obelisks led into the heart of the village where a garrison of five Turks ruled a population of eight hundred Arabs. Everywhere the mudbrick huts of the modern inhabitants were nestled in among the ancient columns, walls, pylons, and obelisks, like an incrustation of bird's nests. Where the propylaeum had stood, a mosque with a low minaret rose up for the muezzin to summon the faithful to prayers. Streets in which the windblown sand accumulated in uneven piles wound tortuously between the Arab houses, one-story affairs of sun-baked adobe brick, mainly clustered around the north end of the place of Sesostris, each surmounted by a pigeon coop with cut branches for the pigeons to roost on protected from the midday sun. Camels knelt in the dust, donkeys slept on their feet; everywhere were flies. Dogs, almost wild, the descendants of an ancient Egyptian species with long fur, pointed noses, broken ears, and narrow hips, barked almost incessantly.

The road from Luxor to Karnak, once lined with 1,500 sphinxes

One main road—possibly the ancient avenue which had once linked the quarters of Thebes to the eastern bank of the Nile—led through the town to a colonnade composed of fourteen gigantic columns, each 45 feet high with a lotus capitol. From there the avenue had led between two rows of fifteen hundred sphinxes, half-woman half-lion, almost 2 miles to the palace of Karnak. A few tamarisk trees with filiform leaves relieved the monotony of the sand.

Each sailor was assigned a plot to till, and in a few days the area around the palaces took on the aspect of a French hamlet, sailors preparing gardens and building private huts in which to spend leisure hours.

French gardens at Luxor

The flooding of the Nile had brought the countryside to life, turning dust to soil. Everywhere hedgerows sprouted with sweet-scented flowers. From France, the men had brought a variety of seeds and grains, and the land was of such vitality that stringbeans bore leaf within a few days and were edible within the month. Tomatoes, basil, sweet-peas, grew almost before their eyes. For meat the Frenchmen were provided by ambulant butchers who would slaughter their cows on the spot, spread the entrails on the ground to attract the flies, then cut off pieces to sell to the passerby. From the Nile, Coptic fishermen brought fish. Of the forty-odd species in the river only three were considered edible—the finni, the voult, and the ketcher. Turtles also flourished in the Nile, about a meter long, but were not considered by the French good enough for the table.

Auctioning fish in the market

The sailors would have liked to swim in the Nile, but on the very first day, an Arab who had gone down to fill a jar begun to scream, and before their eyes was dragged under by a 20-foot crocodile, leaving a large bloodstain on the surface. Eventually the Frenchmen discovered that the crocodile was not so dangerous, and would normally run when approached. But they kept their distance, learning to locate the reptile by a strong musty smell recognizable at 15 feet. The French were more startled by a large variety of amphibious lizard called *tupinambis,* which grew to a length of 4 feet; but they were pleased to find them good to eat.

What these hot-blooded Mediterranean Frenchmen did for women during their stay at Luxor is not spelled out in the memoirs of the chroniclers. But Lebas says they were

Bedouin market

much attracted by the women of Egypt with their lips painted dark blue, walking proudly and elegantly, their light garments barely veiling stunning forms, pure and fresh, which "conjured into delicious reality that which art and imagination alone could conceive as perfect."

And in his veiled Victorian manner, Lebas makes no bones about the availability of the Egyptian women, despite their premium on virginity, pointing out that on marriage, although the mother ritually ripped her daughter's maidenhead in the presence of a few relatives who then carried the bloodied linen through the streets to hang in the window of the house of the bride-to-be, such a custom "left leeway for a certain chicanery on the part of the mother of the bride." While an Egyptian girl could be condemned to death for losing her virginity to a European, her head being cut off and her body thrown into the Nile if she were caught *in flagrante,* the culprit, says Lebas, could still save the girl if he had himself circumcised on the spot and espoused the faith. "That being as it may," adds Lebas, "any other form of complaisance is perfectly tolerated and entrains no particular danger."

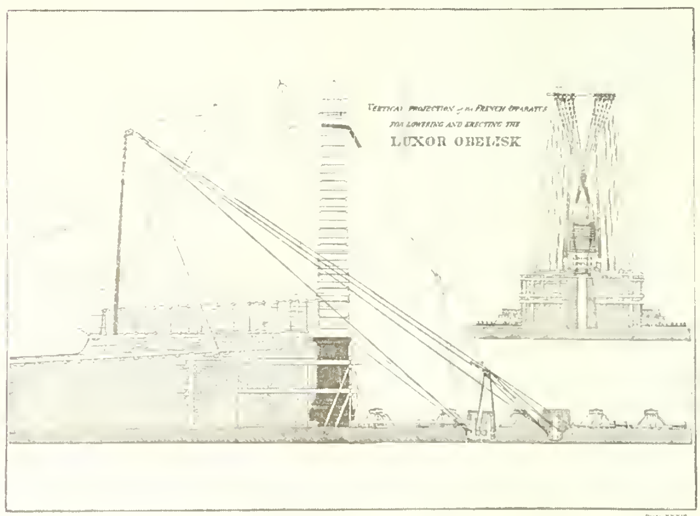
By the end of September, while the natives finished digging a 400-meter causeway along which to drag the obelisk to the bow of the sand-berthed *Luxor,* Lebas was ready to fell the western monolith. When its base had been cleared of sand and rubble, the men found a pedestal of granite which had become friable from the effect of mineral salts below the surface. The base was formed of three blocks of granite atop a single slab, the south side of which was carved into four cynocephalous or dog-headed baboons, each bearing on its breast a legend to the glory of Sesostris.

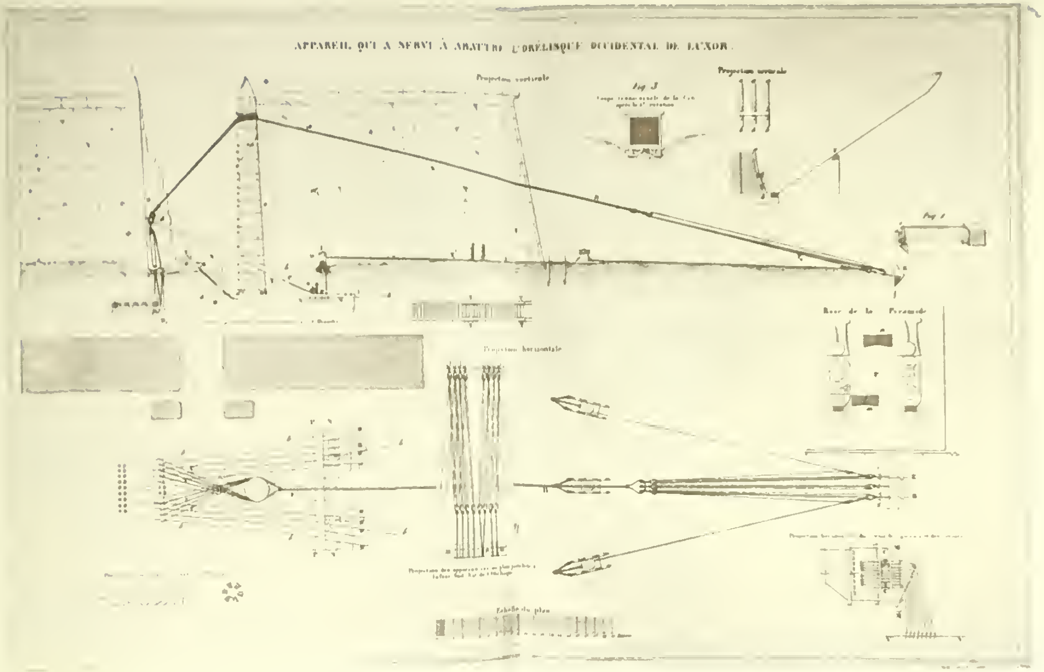
Dancing girls

Causeway along which the obelisk was dragged to the *Luxor* for embarkation

As the base was about even with the *Luxor*'s berth, it would have meant removing an extra 45,000 cubic meters of dirt to make a horizontal causeway. It would also have meant knocking down more intervening houses, and running the risk of unearthing some ancient ruins that would have been difficult if not impossible to move. Lebas decided it would be better to attempt to twist the obelisk on its base and bring it down to rest on the higher embankment of sand and rubble which had accumulated round it. He could then dig a more shallowly inclined slipway down to the river, along which it would be easier, with the help of gravity, to drag the monolith.

Lebas' method for delicately lowering the obelisk, so as not to break it





Equipment for lowering Ramses' needle

The main problem in lowering the obelisk was to do so—in the words of the mason Mazacqui— *"piano, piano."* Lebas believed the reason so many obelisks had been smashed, especially in Rome, was because they had been felled with ropes tied only around the top, and with no counterpull to slow the descent.

On August 1 three long ladders were raised one above the other along the south face of the obelisk. At a signal from Verninac, the tricolor was unfurled from the pyramidion, and the Frenchmen saluted with shouts of "Now it belongs to France! Soon to be in Paris!" Lebas, more circumspect, was reminded of La Fontaine's "one should never sell the bearskin till one has it on the floor."

The whole job of lowering the obelisk had to be done with no more sophisticated equipment than the winches, block and tackle, and the hoisting gear brought from France. The carpenters built a wooden scaffolding and then a wooden casing to protect the obelisk, economizing as best they could on the hard-to-come-by lumber. No matter what method was used to fell the monolith, its sharp edges had to be protected by boards that could not be less than 16 centimeters thick, nailed together with crosspieces and doubly bound with iron bands and screw bolts. To protect the edge of the base, on which the obelisk was to pivot and rotate, a special oak beam was hollowed to fit.

To rip auxiliary beams of date palm, and to cut through the rocklike beams of oak which the French had brought from Toulon, Lebas organized special teams of Arabs who soon became proficient at cutting either straight or curved lines as requested by the master carpenter. Such ripping in such a climate was too arduous for Europeans. In a short time the Arab children had learned the names of all the French tools, and could fetch them in an instant, saving the Frenchmen much time, which was badly needed, as a race was on to accomplish the work before the oncome of the *khamsin*, a wind from the south which lasted fifty days, making life unbearable with tempests and tornados of sand.

Then came the bad news. Some boatmen coming up the river told of cholera ravaging Alexandria and Cairo. Soon the river was filled with the *canges* of Europeans fleeing upstream, closely pursued by the plague. The French consul informed Lebas he had lost a son. Fifteen of Verninac's men caught the plague, but no one abandoned his post. Work on the obelisk proceeded as usual, and Angelin and Pons took such good care of the French victims that none succumbed.

Not so the Arab workmen. Of the village's eight hundred inhabitants, more than one hundred died, at the rate of about ten a day. The workers would suddenly keel over in the middle of their work, or would be stricken just as they were being paid their salaries. This caused an almost constant wailing from the habitations of the Arabs, where women bared their breasts, covered themselves with ashes, rolled their dark eyes, and addressed pitiful entreaties to the defunct.

Ibrahim Pacha, son of Mohammed Ali, terrified by cholera, came up the river in his red-sailed *cange,* standing alone in the bow, speaking to no man, fixing his own food, and daily washing his only change of linen in the water of the Nile. He had panicked and abandoned his army outside Cairo. At the First Cataract, he placed guards on either bank and forbade anyone to pass. This caused a backflow of refugees, many of whom docked their boats at Luxor and camped out on the beaches, spreading the plague.

A few days later, Ibrahim, shamed by an insulting message from his father, slunk back down the river to Cairo to lead his army into battle against his Ottoman masters. When the refugees saw him go, they too followed suit.

On October 1 the sun rose with a lovely tint of autumn. The obelisk was entirely sheathed in lumber, the trestles holding the block and tackle were raised and abutted. The scaffolding was removed and the tricolor once more unfurled from the top of the flower-wreathed trestle. A heavy cable was attached to the pyramidion, leading to several blocks and tackle, and half a dozen winches. Men pushing on the winches were to tilt the obelisk forward far enough to shift its center of gravity so that it would wheel and then fall by itself. To steady this movement and control the fall of the monolith, Lebas arranged for a trestle of huge poles 40 feet long to act as a fulcrum over which cordage could pull the obelisk in the direction opposite its fall. This cordage was anchored round the solid base of the second obelisk. To keep the bank from crumbling and falling as the obelisk came to rest on it, a brick wall had been built up, capped with a cylindrical pole of oak.

One hundred and ninety Arabs manned the winches. Eight men controlled the braking rope, great anxiety showing on their faces as the moment of trial arrived. The French commanders were armed with naval whistles. The villagers—Turks, Arabs, Egyptians and Copts, men, women and children, all those not engaged on the ropes, including the very old men with green turbans—were in attendance at the historic scene. So was the hawk-nosed nazir of Thebes. Sir James Gardiner Wilkinson, described by the French as an antiquary, draftsman, and geographer, turned up with three English travelers and a Greek named Triandafilon, who lived in a nearby cave. Sunlight illumined the silent faces of the colossi of Memnon, which, before they were vandalized, had resounded harmoniously to the touch of sunrays.

Verninac gave the order. The winches turned. The tackle stretched through the blocks. Tension increased as the windlasses oscillated on their axes. Unfortunately, instead of rolling, the oak cylinder at the base ripped like cloth. The wooden casing of the obelisk began to creak and crack. Heavy vibration caused the hoisting shears to tremble. The obelisk's head leaned slightly toward the river, traversing an arc of 8°, then came to a stop. All was still.

The officer in charge of the winches issued a warning that under the heavy strain the anchor points of the blocks were slipping forward in the sand. The relieving tackle was excessively taut. He suggested moving faster so as to take the obelisk past its vertical center of gravity, and shift the strain from the winches to the

braking cables and the trestle. Slowly the center of gravity swung past the vertical, and the obelisk began to fall of its own weight. It was now a question of whether the braking mechanism would hold as planned. It depended on the thrust being equally distributed. For this, Lebas had made a movable cylinder with eight necks for the ropes. Though apparently useless, it proved itself essential in this crucial descent until the obelisk lay safely on the sand in one piece.

Lebas then had the carpenters make use of the demolished scaffolding to build a 21-meter cradle in three movable parts on which the obelisk could be slid toward the river. As the rear section was freed it would be shifted to the front. But the quality of the lumber was such that the cradles could not be made as solid as required, and there were not enough pieces left over to repair a section if it were damaged. The master carpenter reported that every particle of wood had been used. If anything should break, he would be unable to repair it.

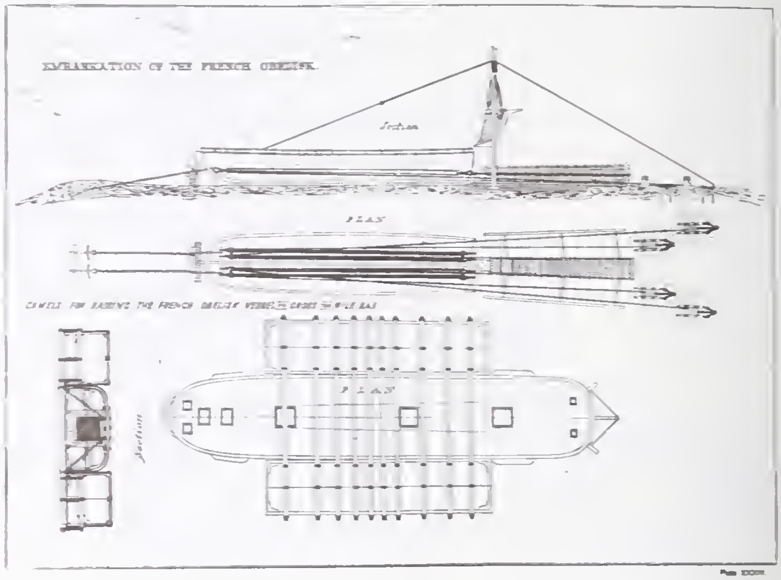
On November 16 Lebas got 160 Arabs to man the winches. The pulleys whined under the tension. Frenchmen incited the Arabs with hurrahs, but the obelisk would not budge. Two of the heavy tackles parted, causing irreparable loss. Lebas was puzzled. The effort exerted was twice what was necessary to move the obelisk, but because the cradle was completely buried in the sand, he could not spot the trouble.

It took two days to clear the cradle and see that a snapped oak pole directly beneath the obelisk had been driven 45 centimeters into the brick wall, causing an insurmountable obstacle. Lebas noted that under the heat and pressure of the strain, the soil at some points had been virtually turned to rock, too hot to handle. As for the pole, it had sheared into annular sheets like a telescope.

Ten jacks beneath the obelisk finally raised it into proper sliding position; and this time, when full pressure was exerted, the obelisk moved forward a few centimeters. Thereafter it was a matter of time and sweat—almost a month of painful hauling, averaging fifteen hours a day, while the Arabs pushed on the winches singing the ancient chant of the galley slave: *"Where is my homeland? When will we see it? When will we return to the home of our fathers?"*

All along the way the obelisk had to be controlled with sturdy props on either side to keep it from rolling off its cradle. By December 18 the pyramidion had reached the berth of the *Luxor.* To fit the monolith into the ship, the whole bow had to be cut through with a great saw, 3 meters behind the bowsprit, in a great vertical slice. As one Frenchman put it: "The ship was deflowered to receive the great phallus." The severed segment of bow was then hoisted aloft by several hoists. To slide the obelisk into the ship without crushing the hull, a ramp of packed dirt on a foundation of heavy stones was built right up to the raw cut. To drag the obelisk within the hull precisely to where its center of gravity would coincide with that of the ship, two cables had to be passed through holes in the stern and anchored in the sand some

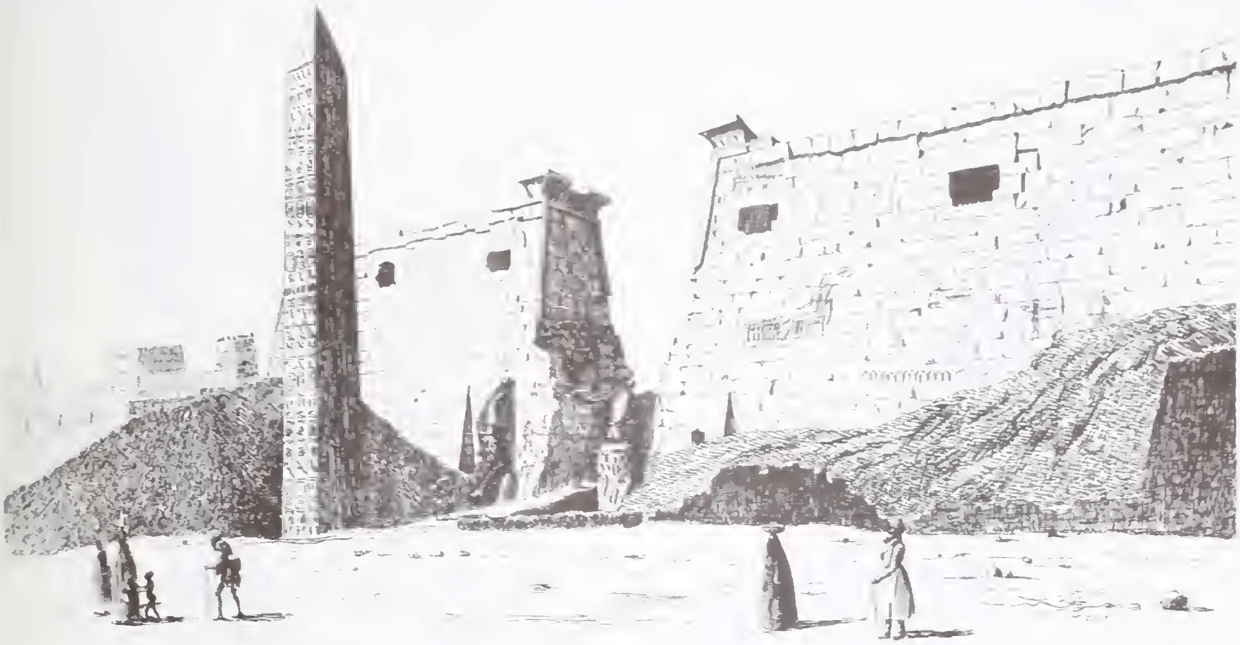
Lebas' pulley system for launching the *Luxor*



distance away, symmetrically placed on either side of the main longitudinal axis. A brick wall raised these cables to prevent any ripping of the ship's stern—also to protect the hull in case the tackle were to snap under the pull of forty-eight men.

On the morning of December 19, Lebas ordered the winches in motion. In less than two hours the obelisk was safely aboard. It had taken four and a half months of excruciating work, sleepless nights, worry, and anxiety. All together, they had moved 90,000 cubic meters of sand, cut through a sizable hillock of debris, demolished thirty houses, cared for and fed 140 Frenchmen in a country with few resources, in the desert, in the midst of a cholera plague, all the while working in clouds of burning, choking dust, with the temperature mostly above the 100° mark. It was hard, says Lebas, to describe the joy of the assembled sailors and workmen.

The next day, when the bow of the ship was refastened, the mark of the saw was virtually imperceptible. The governor, thinking it would take the French at least two weeks to place the obelisk aboard the *Luxor,* had not turned up on the nineteenth. Now neither Turk nor Arab could understand what had happened. They kept looking at the ship and the place where the obelisk had lain, and could not believe their eyes till they had touched the obelisk inside the ship. Even so, they attributed the translation to the work of *afreets,* or *jinns.* On his arrival, the governor, amazed at the performance, announced that Mohammed Ali would pay for all the expenses of lowering and embarking the obelisk, forthwith reimbursing Lebas with 25,000 francs.



The solitary obelisk which still stands guard at the gates of Luxor

But the work had taken just a few days too long. The Nile, pulling back into its channel, was leaving the *Luxor* with its heavy load high on the drying sand. There was no longer any hope of leaving before the next inundation, sometime during July 1832. It was a heavy blow. It meant the Frenchmen would not see their families for another whole year; and it meant another twelve months of living in makeshift quarters in the palaces of Luxor.

Resigning themselves to the situation, the men set about securing the obelisk within the hold of the ship; struts and crosspieces had to be fashioned, which would take the carpenters some time, working with nothing but the detritus of lumber still available. As their work aboard the *Luxor* needed no supervision, Lebas decided to take a trip up the Nile to visit the temples and ruins of ancient Egypt, at least as far as the first cataract, where Napoleon's army had come to a halt after scattering the remnant of the Mameluke forces, and where all the great obelisks had originally been quarried. He was determined to see for himself the greatest of them all, which lay half-quarried near Aswan, and discover why this particular spot had been the source of so many obelisks.

12. GALLIC COCKCROW

On January 9, 1832, Lebas embarked with his servant—"a good looking young man of seventeen with a lovely figure"—aboard a *cange* crewed by five Arabs. Casting off, they intoned a favorite chant: *"Habouzale, habouzelphi."* A favorable breeze, filling their lateen sails, glided them past an island rich in vegetation situated opposite the sanctuary of the temple.

The next day at 2:00 P.M. they reached the Temple of Esne, 15 leagues upstream from Thebes, by a small town on the banks of the Nile built into the ruins of the ancient city of Latopolis. Remnants of the old port and docks were still visible, and Lebas admired the great colonnade, which the natives used as storage space for firewood. The local mamour, or prefect, gave Lebas a letter to the nazir of Syene, assuring him that "with this, they will take you up the cataract faster than the water rushes down." What had made the mamour so complacent was a sudden infatuation with Lebas's young servant, an infatuation which engendered from Lebas the caustic remark that in the Ottoman Empire any young man could rise the faster by lying down.

The next day Lebas visited Edfu, whose gigantic temple dominated like a citadel the small town built on the slope of the hill. While anchored by a sandbank at two in the morning there was a cry of *"Arame! arame!,"* or thief, thief! His servant, afraid, says Lebas, of falling into the hands of bedouins and "suffering what might be justly considered a degrading ordeal, or repetition of the favors extended to him by the Turkish mamour," beat against the

After the evening meal, while the cabin boy fed the fire, there was always a routine of song and dance initiated by a saucy tale from some sailor, followed by a graver tale from the *reis,* usually about money and the sultan. To the sound of two hollow reeds and the vibrations from a skin glued to an earthern funnel held beneath the arm and beaten with both hands, the sailors would abandon themselves to raucous and lascivious dancing. Lacking females, the sailors' entertainment tended toward the homosexual. A sailor, his sole garment a long shirt, would make progressively more indecent movements to an applauding audience.

door until Lebas appeared with a gun. On both knees the pilot also implored Lebas to fire his gun to scare away the thieves who were known to come from underwater, their naked bodies heavily greased, to swim away with whatever they could seize, including other pretty bodies. Lebas fired in all directions, and returned to his slumbers, only to discover in the morning that the pilot had taken advantage of the fracas to seduce his servant. To dissuade the pilot from further advances, Lebas threatened to have him given two hundred strokes of the *courbache* as soon as they reached Aswan.

At Djebel Selseleh they passed large quarries dug into a hillside. Between there and Aswan they came across the temple of Loum Ombou with its grand façade consecrated to the crocodile, its vast edifice partly demolished by the river, which had undermined the foundations. As they approached Aswan, the bed of the river, which had been muddy, became studded with dangerous black protuberances of granite, highly polished by the flow of water, which, according to the Arabs, had been hurled down from the mountains by the gods who wished to close the channel.

Moored in Aswan harbor they found a *cange* flying the Turkish flag, aboard which were Mohammed Ali's doctor, Monsieur Botta, the French consul general, Monsieur Mimaut, and a desert Arab of some renown, called Baraka, meaning Providence. After a daily fare of eggs, rice, fish, and dates prepared in a hundred ways by his servant, Lebas was relieved to be invited to dinner on the Turkish *cange*, where he was feasted with choice viands and game.

Aswan (so-called by the Arabs) was the ancient Egyptian town of Sun-t ("allowing the entrance"), called Syene by the Greeks. Just below the first cataract, it formed the border between Egypt and Nubia and was an important geodetic and astronomical site. Opposite Aswan lies the island of Elephantine, the largest rock formed by the first cataract. Close to the Tropic of Cancer, it is the only location in Egypt from which an accurate observation can be made at the solstice to establish the circumference of the earth. Lebas found that Elephantine had been stripped of the lovely temple depicted in the *Description de l'Égypte*.

Lebas found the Lybian hills around Aswan to be the source of a fine-textured, rose-colored granite, normally free from seams and flaws, known as syenite, consisting of quartz, feldspar, and hornblende, from which all the great obelisks of Egypt appeared to have been quarried.

A ten-minute ride into the hilly hinterland brought Lebas to the area from which all the great obelisks were said to have been quarried. There, on a flat surface, he found the outline of an enormous obelisk half carved out of solid red granite, apparently abandoned after three faces had been shaped because of an unexpected fissure. It was difficult for Lebas, because of the effect of foreshortening, and because parts of the obelisk were buried by windblown sand, to estimate the length of the monolith, but he figured it to be one third again as long as the largest obelisk at Karnak, and to weigh three times as much, or a thousand tons. This, he concluded, would have required at least 12,000 men to slide along a greased runway as he had done with the much smaller obelisk at Luxor.

Six-inch holes drilled into the granite at eighteen-inch intervals around the recumbent stone indicated to Lebas that plugs of soft palmwood could have been introduced into them. Soaked with water, these would have frozen in the cold nights of that latitude, causing the plugs to expand and split the granite. To flatten the top, he surmised that fires could have been lit which would have made the granite crumble. The sides of the obelisk appeared to have been worked to a finish by pounding with six-inch dolerite balls which abounded naturally in the surrounding hills. The underside of big stone was pierced by a number of tunnels which led Lebas to surmise they had served for the insinuation of timbers to act as a sledge with which to move it once the entire underface had been cut away.

The largest known obelisk, half quarried from a vein of Syene granite

All of which caused Lebas to marvel at the brilliance and endurance of the ancient Egyptian engineers. Considering the trouble it had cost him to move his obelisk he could not imagine how they had managed to quarry, move, ship and raise one four times its weight without even the winches and tackle available to him.

As a final exploration on the Upper Nile he decided to study the great temple of Abusimbel, to see how the Egyptians could have carved it out of a solid mountain as described by Belzoni and recently visited by Champollion.

Classical authors gave the region an eerie reputation by reporting that the inhabitants for miles around were all as deaf as the cataract stones because of the terrible roar of the waterfall.

Back on the river, teams of camels were employed to drag the *cange* up the cataract, past the date-burdened island of Elephantine, where the ancient Egyptians had an

astronomical observatory, and a nilometer to measure the flooding of the river. Dark Nubians, excellent swimmers, skipped from rock to rock, attaching lines as brakes to prevent the *cange* from being swept away by the swift flow of current and crushed against the rocks. Overhead, swarms of black crows circled to inspect the maneuver while sand swallows darted to and fro.

Twelve leagues above the second cataract, in a wasteland of sterile mountains devoid of all vegetation, Lebas sought out the two cyclopean temples of Abusimbel, carved deep into the vertical side of the mountain, one with its entrance flanked by 60-foot standing colossi, the other, bigger still, with eight identical colossi of Ramses, seated on either side of the entrance.

From Abusimbel Lebas decided to turn back to Luxor, traveling more leisurely, taking sidetrips after duck, snipe, hare, partridge, and doves. The river itself abounded with an extraordinary variety of birds: eagles, falcons, storks, plovers, ibis, and the percnotaire, a huge beast with lovely plumage.

Lebas was most fascinated by the idiosyncrasies of three peculiar birds. One, which he called the scissor bird, because of the scissor shape of its beak, would cut its fish into morsels before swallowing them, then regurgitate the bones in a round white ball. Another odd bird, the *Sharadrius niloticus,* a sky-blue bird with black bands, called a *cak* by the Arabs, would spend its day cleaning the teeth and gullet of the sleeping crocodiles, whose open mouths were a lure for swarming insects. Lebas was also intrigued by the sacksack, a black-and-white bird, with a gray back, which acted as the sentinel of the Nile, screaming at the sight of anything unusual, and alerting birds and animals for miles around of the possibility of danger.

Back at Luxor, Lebas found that his fellow Frenchmen had spent their time tending their gardens. The acacia trees planted barely a year earlier were now 15 feet tall and as thick as a man's arm. A fig tree the size of a thumb, planted at the door of a garden, was 12 centimeters thick and covered with fruit. Some, like Joannis and Verninac, had gone on hunting trips into the interior, or on voyages of exploration up the Nile. All together, during Lebas's absence, ten Frenchmen had died from one cause or another, mostly dysentery. One sailor, failing to follow Angelin's strict rationing orders, had got into the larder and consumed 2 pounds of raw rice. Within forty-eight hours his stomach had exploded.

The year's stay had turned the rest of the Frenchman into shadowy figures. Fifty were laid up in the hospital, mostly with dysentery; and even Angelin had sickened. To relieve twenty of the sickest, Verninac ordered them sent ahead by boat to Alexandria. Though their cases weren't serious, the doctor recommended a different regime and the more European climate of the delta. All were anxious to get back to France for fear they could not survive much longer in the climate. As the Nile approached flood time, there were just enough healthy men to recommission the *Luxor* and see to clearing the sand around it. When this was done the planks were found to be tight enough to hold water, whereas the deck, which had been exposed to the sun, had cracks they could see through.

To receive the waters of the Nile around the keels, a large hole was dug. Each year the Nile announced its flooding by tiny oscillations, which took place at the latitude of Thebes sometime in late May, and a gradual change in color caused by rains in the Abyssinian highlands. At first the water would lose its transparency, taking on a greenish tint. Gradually the green would grow deeper until it could be seen in a scooped-up handful. According to the Arabs, the deeper the green, the bigger the inundation. Eventually the water turned brick-red.

That year the Nile was slow in flooding; its telltale oscillations only became evident during the first few days in June. Everyone became agitated, rushing to the river's edge to look and examine. Small twigs were placed in the ground from which to note the smallest change in level. News bulletins of the rise were posted on the door to the mosque. Faces lit up with excitement. Arab women celebrated by singing religious chants up and down the river's edge.

As late as July 30 the water continued to rise rapidly and evenly, without causing any damage. Many of the Frenchmen spent their nights by the river to watch the markers being swept away. They would even feel for them in the dark. By August 5 the water of the Nile had turned deep red, and the *Luxor* was an island. It needed only thirty more centimeters to float. Everyone believed it would float the next day, or, at the very least, the day after. On August 6 the river began to subside, and continued to fall back until August 12. The French were stunned. It meant the prospect of spending another whole year in the Theban heat. Anxiously they consulted Arabs for opinions. The imam, or priest, said the Nile was just catching its breath, and would rise again. He suggested a donation of two muttons to the mosque, to propitiate Allah.

Among the harbingers of the flooding of the Nile were beetles that rolled up their seed into a small ball of dung which they buried by the riverbank for safety against the coming flood. Nile beetles figured in the constellation of the Crab, the point along the Zodiac at which the inundation began, known as the month of Mesore.

According to Lebas, the Arabs consumed very little, especially by comparison with their Turkish overlords. He figured the yearly cost of feeding and clothing an Arab would not exceed 15 francs, his daily fare being based on three small loaves of millet bread, or *doura*, augmented, depending on the waters of the Nile, by some cucumbers, watermelons, chicory, dates, onions, or their favorite, lentils. All of the good land of Egypt, and all its produce, belonged outright to the Pasha. Only the land closest to the channel of their river, the last to be uncovered in April and May, was considered common, because of the short time it remained unflooded. Here the fellahin were allowed to sow at will their quick-growing products by the simple process of making a hole with a stick and covering the seed with the foot. Often they would have to wade into the rising water to gather late sproutings. When the waters of

On August 13 the water rose again. Verninac fixed a line to the stern of the *Luxor*, had an anchor carried out into the middle of the Nile, and attempted to winch the ship free. For three days the French pulled, but the *Luxor* would not budge. On the eighteenth, with a supreme effort, they managed to move the *Luxor* a few feet. The water rose again, a hair, and by evening the ship was once more afloat on the Nile. The greatest problem now was to get it safely down the river.

Worried about sailing the flooding waters with the heavily loaded *Luxor* facing treacherous currents and unforeseeable hazards, Verninac had ordered from Toulon two *peniches*, or pinnances—small two-masted vessels rigged like schooners, which could be propelled by oars. Though announced by a courier, they had failed to arrive, and Verninac was afraid to wait any longer lest he fail to arrive at the mouth of the delta while the water was still high enough to float him across the sandbars.

During the night, the inhabitants of Luxor and Karnak crowded the riverbank to be ready to bid the *Luxor* farewell when it hauled its anchor in the morning. At 11:00 A.M. the breeze freshened and the *Luxor* set its sails. Two

the Nile subsided in November, the first crop planted was always broad beans. On the next land uncovered in December, wheat, barley, peas, and lentils were planted. In February the fresh beans were harvested, in March the poppy seeds, in April the lentils, in May the peas. During the season of the pointed peas the natives would economize on their *doura* by walking through the fields avidly eating the peas directly from the pod. In April, when the trees were in flower, the natives would fertilize the females by hanging well-developed male fronds from the female branches. Wheat and barley were harvested in May and June. In July and August, on land not yet covered by the rising waters, corn was planted, to be harvested in October and November. But legally all of this was the property of the pashas. With the natural resources of the Nile, Lebas was convinced that in a short time modern Egyptians could be brought to a much higher standard of living in which the arts and sciences could once more flourish. Were the land distributed to the native farmers, he believed, it would bring Mohammed Ali a hundredfold in revenues. As things stood, the pasha only managed to collect a tiny portion of what the natives could be induced to cultivate, the rest being hidden or stolen by the middlemen.

janissaries came running up with a present from the nazir for Dr. Angelin: a pet hyena. It was a pathetic cortege. As the *Luxor* had been preparing to sail, and the janissaries had been unable to catch the creature, and the nazir had not been specific as to how this should be done or whether the gift was to be dead or alive, the janissaries had stoned the hyena to death and now ceremoniously brought along the carcass, already in a state of putrefaction, as a farewell gift for Angelin, who had loved the nazir's living pet.

Slowly the *Luxor* moved downstream. The crowds ran along the bank, waving; some swam out to cling to the ship's side; others followed in small boats. The French were amazed by this demonstration of affection, especially as they had seen the same Arabs totally impassive under the *courbache* of the Turks.

With the wind head-on, as it prevailed during the period of inundation, Verninac figured he could zigzag downstream from bank to bank by presenting alternate flanks to the wind. But he soon found the rudder would not respond sufficiently to keep the ship in control. The *peniches* arrived, but were 3 meters too short for the job. When Verninac tried them, they caused the *Luxor* to run up hard against the bank, luckily without damage. To solve his problem, Verninac decided to emulate the system of the ancient Egyptians as described by Herodotus. According to the Greek historian, the Nile boats of his day sailed downstream by means of a sieve of heather reinforced with rushes lashed to the bow; this caused the rapid current to propel the boat forward. A heavy rock dragged along the bottom served as a brake to help maneuver from side to side.

Turkish nazir wielding the courbache

Verninac threw a heavy anchor over the stern to use as a brake. Thereafter he was able to make his way downstream irrespective of wind or current. Unfortunately, on the thirty-first, the anchor stuck and there was no way to raise it. The ship was about to go under when the pulley snapped, its fragments being hurled to a great distance, luckily without killing anyone aboard. The next day the tiller struck ground. With the ship immobilized, the Nile waters, on the opposite side from the current, heaped a sandbank straight up against its flank; by midnight the *Luxor* was almost submerged. Luckily a sudden gust, filling the sails, dragged the ship off the embankment.

The famous Gamouleh elbow gave them plenty of trouble. At one point, they found themselves with full sails whirled completely about, moving at full speed backward down the current. Date palms whizzed past at such a speed that if the *Luxor* had hit the bank, it would have been crushed to kindling. Luckily the river began to bend in the opposite direction, and the *Luxor* was able to wheel in time.

With another anchor, Verninac managed to control the boat safely to Cairo. There they took a break from their ordeal long enough to enjoy a festival known as the dalmees, a local saturnalia, where, as voyeurs, they could enjoy the dance of the bee, in which an Arab woman pretending to have a bee in her galabia removed all her clothes in a series of wild dances. But Verninac could not dally. It had taken him as long to come down the Nile as it had to go up. He was worried about reaching the mouth in time to cross the sandbars. Any time in the past two weeks he could have crossed with ease; but September, with its great flights of pelicans, had come and gone.

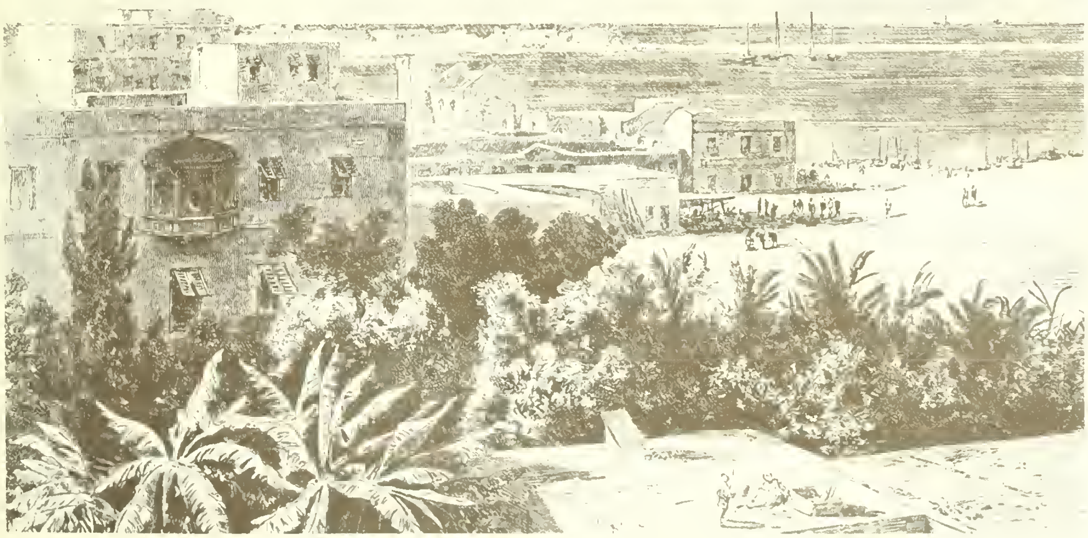
On October 1 the *Luxor* arrived at Rosetta to find the water at the sandbars 20 centimeters too low to pass. Lebas thought of raising the ship by means of two large flanking pontoons, but it was too heavily laden to withstand the strain. On the off chance that a sudden change in the wind might cause a break in the sandbars, they anchored by the mouth of the river.

It was not an uncomfortable wait; the more European climate with its autumn air revivified the crew. But weeks dragged into December and its dangerous storms. It became unwise to linger. Back at Rosetta, Verninac demasted and decommissioned the *Luxor,* storing its gear on dry land, and began to look for winter quarters for officers and men. Rosetta had its compensations. There were still plenty of bananas, oranges, and grapes. The men could pass their days at the Turkish baths, smoking pipes, or drinking coffee. The crew, says Joannis, "soon managed to create such pleasantly domestic situations they were enabled to forget the postponement of their return to France," till an unexpected event changed their plans. An Anatolian ship loaded with oranges, struck by a gust of wind, crashed into the sandbanks and sank, causing a breach of 2.5 meters in the bank, where there had been nothing but sand. The pilot who had witnessed the crash rushed back to Rosetta to inform Verninac that the breach was wide enough and deep enough for the *Luxor* to pass through.

In thirty-six hours the ship was recommissioned and reached the sandbar on January 1, 1833. By noon the weather was perfect, the wind favorably astern. Beyond the sandbank, riding at anchor, was the steamship *Sphinx*, sent from Toulon to tow the *Luxor* back to France. Inch by inch the *Luxor* moved through the breach, followed by the *peniches* holding anchors in case of trouble. A freshening breeze and sudden rough seas caused the *Luxor*'s keel to ground on the sandy bottom. As darkness fell, the ship was once more immobilized. Everyone aboard was in a state. The pilot clutched at his beard, crying "Allah! Allah!" Hardtack and wine were distributed. An anchor was rowed forward and attached to a winch. By 10:00 P.M. the slight Mediterranean tide reached its peak; with a lurch, and a great hurrah, the *Luxor* slipped over the final barrier into the salty sea.

Raising its *huinier*, the *Luxor* went to anchor by the *Sphinx* which, the next day, towed it safely to Alexandria harbor. There the *Luxor* was flooded with visitors. Ball

Alexandria harbor



after ball was given in honor of the Frenchmen, while Verninac waited for suitable weather to sail. Winter in the eastern Mediterranean can be rough and foul. Several times the departure of the French was delayed by storms and heavy winds. Apart from the lovely Pointe des Figures, and Mohammed Ali's palace, they found the French Quarter, with its wide avenues and squares, the only pleasant part of the city. There the local merchants and consuls opened their houses to the men. Lebas was again received by Mohammed Ali, who expressed great satisfaction at the successful removal of the obelisk, and was only macabre in his curiosity to know how much weight the obelisk would lose under water, if the ship should sink. When Lebas thanked Mohammed Ali for his generous help in securing to France the Luxor obelisk, the khedive replied: "I have done nothing for France that France has not done for me. If I give her the relic of an old civilization, it is in exchange for the new civilization of which she has spread the seeds in the Orient. Let the obelisk be a tie between our two countries."

Finally the *Luxor* set off from Alexandria, on April 1, towed by the *Sphinx* at a speed of 4 knots. On the night of April 2 a breeze from the west turned into a violent storm. By noon of the third the *Luxor* was dwarfed by enormous waves. The *Sphinx* was making no headway, and to avoid wasting coal, it let itself drift toward Rhodes. As a result, the *Luxor* began to roll so heavily the seas were washing over the gunwales, threatening to loosen the obelisk and sink the ship before the horrified observers aboard the *Sphinx*. To salvage the situation, Verninac spread all his sails. This inhibited the heavy rolling, but risked demasting the ship. Finally the winds subsided. By the sixth, both vessels were able to anchor in the harbor

The *Sphinx* with *Luxor* in tow

of Rhodes, which the French found depressingly Turkish, with no sign of the ancient Knights of Saint John, or the famed Colossus.

About 6 leagues away, at Marmara, on the Caramanian coast, they found a pleasant cove called La Bonbonnière. There they spent some time having their clothes washed and hunting in the mountains, where there was much game and a landscape with windmills run by pretty falls of water. Next they went to Milos in search of coal. Finding none, they went on to Navarino and Zante, still with no luck. At Corfu the British high commissioner, Lord Nugent, obliged them with supplies from the British naval base. Both the British and the Corfiotes were most cordial in their welcome, sumptuously feasting the French. Crowds came aboard the *Luxor* to admire the obelisk and compliment the officers and crew.

Leaving Corfu, the *Sphinx* and the *Luxor* bucked another storm all the way to Cape Spartivento. On May 4 the wispy outline of Etna appeared to the west, and they slipped unharmed between Scylla and Charybdis. The Liparis were shrouded in fog, but Stromboli lit up the night sky with eruptions every ten minutes. In honor of Homer's Strombolian god of the winds, Verninac uncorked the last of the Champagne. It helped them double Cap Corse and drop anchor in Toulon harbor on the tenth of May, 1833, just two years and twenty-seven days after they had left.

For fear of the Egyptian plague, the Toulonnais refused to let the crew ashore, obliging them to submit to the excruciating ordeal of a month's quarantine within sight of their homes and loved ones. Only Lebas was allowed to go ahead to Paris to prepare a berth for the *Luxor* on the city's embankment.

On June 22 the *Luxor* sailed for Gibraltar on the first leg of its journey around Iberia. Across the bay, in Algeciras, they stopped to obtain permission from the authorities to put in at any Spanish port in case of trouble or bad weather. As it was the anniversary of the birth of Fernando VII's queen, Maria Cristina, the festivities were brought aboard. Crowds of dignitaries came to examine the obelisk; in the stateroom converted for the occasion into a ballroom, everyone danced the fandango and the bolero.

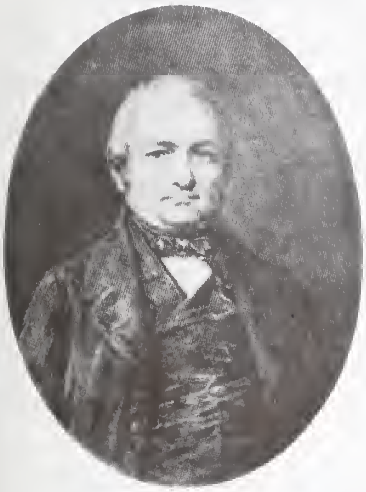
Approaching Cape Saint Vincent, the southernmost tip of Portugal, in a strong west wind, the convoy was obliged to lay off Lagos, on the Portuguese coast, where the crew of the *Luxor* witnessed the extraordinary spectacle of two warring battle fleets tied side by side. The corvettes, brigs, frigates, and schooners of Don Pedro, contender for the Portuguese throne, had just captured the superior forces of his rival, Don Miguel, despite the latter's ships of the line. On August 11 the *Luxor* caught sight of the coast of England and headed east for the military port of Cherbourg, just in time: the hurricane season had begun to ravage the channel ports, whose coasts were littered with wrecks and corpses.

At Cherbourg, Verninac received orders from the maritime prefect to await the arrival of King Louis Philippe, who was traveling with his family in western France. The king, accompanied by his wife and all the young princes, came aboard to decorate Angelin and Joannis with the Legion of Honor, and to inform Verninac of his promotion to *capitaine de corvette*. After listening to a description of the felling of the obelisk and being introduced to the ship's officers, Their Majesties were taken aboard the *Sphinx* for a naval review with lots of gun-firing and cries of *"Vive le roi!"*

The *Luxor* now had to be towed up the Seine to Paris. On September 12 the *Sphinx* took her as far as Cap de la Heve, at the estuary of the Seine, where there were more dangerous sandbanks to negotiate as far inland as Quilleboeuf, the actual mouth of the Seine. At La Heve the *Sphinx* was replaced by the river tug *Heva* for the trip to Rouen, where the *Luxor* would have to wait, tied to the Quai d'Arcourt, for the first autumn rains to raise the waters of the Seine sufficiently for the ship to be towed the rest of the way to Paris. But the rains were late; not till the middle of December did the river rise enough to move the *Luxor*.

Lebas rejoined the ship and ordered her lightened of all unnecessary equipment, including her masts, so as to pass under the twenty-two bridges between Rouen and Paris. Midday on December 14 the *Luxor,* which now resembled a flat *peniche,* negotiated the Pont de l'Arche and began its slow ascent up the Seine, drawn by eight pairs of horses. At points where the current was particularly strong, as many as thirty-two horses had to be engaged.

When the ships docked near the Bridge of Meulan, the water of the Seine was so high the *Luxor* could no longer pass under the arch nearest the towpath, and the local authorities, worried about damaging their precious bridge, made a lot of trouble before they would allow the more complicated maneuver of towing the ship through the central arch. When the *Luxor* reached the Bridge of Saint-Cloud, on the outskirts of Paris, at midnight of December 22, the bridgemaster refused to let it through, despite a written order handed him by Verninac. The water was rising so fast the ship risked being blocked below the bridge for several months. After an hour's harangue the bridgemaster finally relented, and the *Luxor,* just in time to avoid being caught, was winched through in the early hours of the morning.



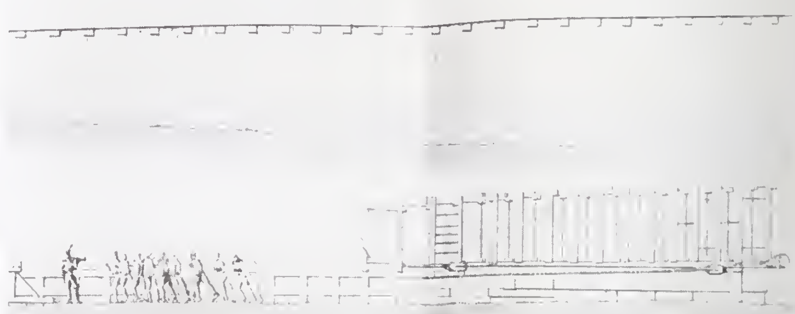
Louis Adolphe Thiers (1797–1827), historian and statesman from Marseilles, author of a history of the French Revolution, was one of the Freemasons involved in the enthronement of Louis Philippe in 1830. He became prime minister in 1836, and president of the republic in 1871.

In a thin misty rain a Parisian crowd had gathered along the Quai d'Orsay and on the Pont de la Concorde to see King Louis Philippe ride past on his way to open the 1834 joint session of the chamber of peers and of deputies at the Palais Bourbon. As the *Luxor* hove through the mist drawn by its teams of horses, word quickly spread that the obelisk from Luxor had arrived in Paris; but the crowd was disappointed to look down on the dirty, mastless ship with its tired crew in workaday waxed slickers. It had now passed from the jurisdiction of the minister of marine to that of the minister of commerce and public works, in the person of another diminutive Frenchman, described by Lebas as one who accorded to the arts and sciences "an enlightened protection," but who was to become better known as "the greatest little man of French history," the first president of the Third Republic: Louis Adolphe Thiers, a professed Freemason.

To beach the *Luxor,* with its five keels, and to avoid the risk of breaking either its stem or its cargo, Lebas had prepared another solid berth on ground near the Pont de la Concorde, just high enough to be left dry as soon as the waters of the Seine retreated from their peak.

The authorities could not make up their minds whether the obelisk should be placed at the Rondpoint des Champs-Élysées, in the courtyard of the Louvre, as a sentinel before the Madeleine, or in the Place de la Concorde as a symbol of a reunited France. Under various authorities of the Restoration, the center of the great square had been successively occupied by various monuments, the last of which was an equestrian statue apotheosizing Louis XVI on the spot where he had lost his head.

On December 24, King Louis Philippe announced he would visit the *Luxor,* which was rapidly spruced up for the occasion. Among the dignitaries assigned to greet the king was Geoffroy Saint-Hilaire, member of Napoleon's Institut d'Égypte and president of the Academy of Sciences. Arriving in his ceremonial palm-fronded uniform, complete with bogus épée, the old gent slipped on the narrow gangplank and plunged into the icy waters of the Seine, whence he was retrieved by two sailors and taken to Angelin's quarters, where his lobster-red body was toweled back to normal. The king, arriving by launch from the river-side, climbed aboard without mishap, and having inspected the obelisk in the ship's hold, gave Verninac 2,000 francs to be distributed to the crew.



Coupe de l'appareil de débarquement suivant l'axe du Bâtiment.

To drag the obelisk up the embankment, Lebas impressed a company of artillerymen. To house the obelisk, pending the decision whether or not to place it in the Place de la Concorde, Lebas hired a pavilion. Once more the bow of the ship was sawed off. As at Luxor, a wooden cradle was built to slide the obelisk on a wooden track. Two hundred and forty artillerymen pushing on winches managed to drag the obelisk safely out of the ship, and, the next day, up the ramp. Thereafter, the obelisk lay for eighteen months in the pavilion, while a suitable pedestal was being devised. It took till August 1835 to find the right granite, in a town with the odd name of Later-il-Dut, on the coast of Brittany, for a pedestal which weighed 236½ tons—more than the obelisk itself. The *Sphinx* was sent to retrieve the finished pedestal and did not arrive back in Paris until April 1836. Three hundred artillerymen manned winches as the obelisk was dragged to the very spot where Louis XVI and Marie Antoinette had been decapitated barely forty years earlier, there to be raised with a trestle similar to the one which had felled it in Luxor. Inch-by-inch the monolith advanced across the square, eased by the old Egyptian method of pouring boiling grease onto the runners. But three more months were to pass by before the raising equipment was in position, and most observers began to wonder if the obelisk could actually be erected.

On October 24, 1836, all was ready. Ten winches, each of which could lift 15,000 kilograms, were to lift the obelisk's 125,000 kilograms past the crucial point of equilibrium. By eleven-thirty 350 artillerymen stood in an elliptical enclosure, ready to man the winches at an order to be sounded by a trumpet. It was a dangerous operation. Were a single order to be misinterpreted, the obelisk could come crashing down to kill or maim hundreds of workers and onlookers. The idea of clearing the Place de la Concorde of all spectators had been considered, but was discarded as unpopular. By noon more than 150,000 Parisians had gathered as close as they could get to the action.

At the sound of the trumpet the winches began to turn, the hoisting gear tightened, tension built up, and the trestle straightened almost imperceptibly. The master carpenter called out, "The obelisk has moved!" At noon the clarion sounded. Winches began to turn to the cadenced march of the artillerymen. The point of the pyramidion left its berth and began to describe a slow arc upward. But, as the foot of the obelisk described a similar arc in the opposite direction, its sharp edge dug into its wooden base, causing the juices to squirt from the lumber under pressure.

No harm came of it, and by the time the king and queen and members of the royal family appeared on the specially decorated balcony of the naval ministry, the obelisk had reached an angle of 38°, almost the point of utmost strain before the center of gravity could shift. There was the sudden cracking sound of splitting timber, and Lebas

The Paris authorities, hoping to use the occasion to show the populace the great advances of modern engineering over that of the ancients, had decided to use the raising of the obelisk to publicize a newly developed steam engine, virtually unknown to the public—"a mysterious and formidable creation which could terrify with its noise like thunder." By demonstrating to the public that a single man at the controls could lift the whole of Sesostris' monolith, the authorities hoped to impress upon the populace how well those at the helm of the ship of state were in command of science, or, as they put it: "man's most glorious conquest over nature."

Fortunately a banal defect in the equipment voided the experiment, which was to have proved that "nature, working for man, would be the sole serf of the future."

shouted for an immediate stoppage. The tension on the braces was such that they resounded to the touch like the strings of a violin. Bolts began to buckle. Obelisk, trestle, and base all risked being hurled by the strain in the direction of the Madeleine. The workers, though in imminent danger of being crushed, did not budge. To overcome the danger point, Lebas ordered accelerated pulling.

Minute by strained minute the obelisk rose, until at last it was upright, suspended a few inches above its base. All seemed in order when Lebas realized that in the excitement he had omitted to give the order to have the retaining chains loosed from the pyramidion. Two sailors quickly climbed the obelisk to cast them off before any damage could ensue.

Now the problem was to let the obelisk down onto its base gently enough not to crack it. To accomplish this delicate maneuver, winches were ordered to make three turns, two turns, one turn, then half a turn. Thus, five years from the day it had been felled where it had stood for four millennia, the obelisk once more rested upright on a solid base. There was wild applause as carpenters climbed the scaffolding to raise the tricolor above the pyramidion.

Louis Philippe uncovered his head to salute the same colors which had been raised thirty-five years earlier by

The obelisk in the Place de la Concorde, with Napoleon's Arch of Triumph at the end of the Champs Élysées

Napoleon's savants over the ruins of Thebes. Lebas crossed the square to join the king, who had summoned him for congratulations and to invite him to dinner that night at the Tuileries. As a reward for raising the obelisk, Lebas was named engineer first-class, curator of the marine museum, and member of the counsel of admiralty.

From the Château of the Tuileries that night, Lebas could see the pyramidion of the obelisk, which his carpenters had specially illuminated. After dinner the king gave Lebas 3,000 francs to distribute to the workers who had raised the obelisk. Everyone appeared to be astounded that Lebas had managed to place the obelisk within 2 centimeters of where it had been meant to go, overlooking the fact that, originally, ancient engineers had erected it squarely on a base exactly as they had intended.

Local chroniclers, remarking that the obelisk would probably survive the splendor of Paris at least as long as it had survived the splendor of Thebes, praised its beauty, grandeur, solemnity, durability, simplicity, proportion, polish, harmony, and even its phallic qualities. But no one mentioned or seemed to have any idea as to what might have been the original purpose of the obelisks of Luxor.

The one person who might have cracked the riddle for them, Jean François Champollion, recently elected a member of the Académie des Inscriptions and named by Louis Philippe to an archaeological chair specially created for him at the Collège de France, had just finished his *Grammaire Égyptienne*—which he considered "my visiting card to posterity"—when he was struck by apoplexy and confined to bed. In January 1832, just as Lebas had been embarking to travel up the Nile to Aswan, Champollion had become too sick to lecture and was obliged to retire to Figeac. There the doctors diagnosed his strange disease as something brought back from Egypt which manifested itself in the form of bronchitis, gout, galloping tuberculosis, and partial paralysis. A career, which was about to flower brilliantly, was struck in the bud. On March 4 of that year Champollion was dead.

With this first real giant of Egyptology out of the way, a small but energetic clique of envious and malicious enemies began to poison his memory by continued efforts to minimize and ridicule his findings, questioning, as they had with Kircher, his honesty and integrity. "It is sad," remarks Erik Iversen, "that every scientific achievement must submit to the disgraceful ordeal and mock trial of envy, ignorance and stupidity, painful and often fatal to the victim, even if truth prevails."

For the next several decades after his death, Champollion's claim to having deciphered the hieroglyphs was hotly disputed. The English refused to accept the evi-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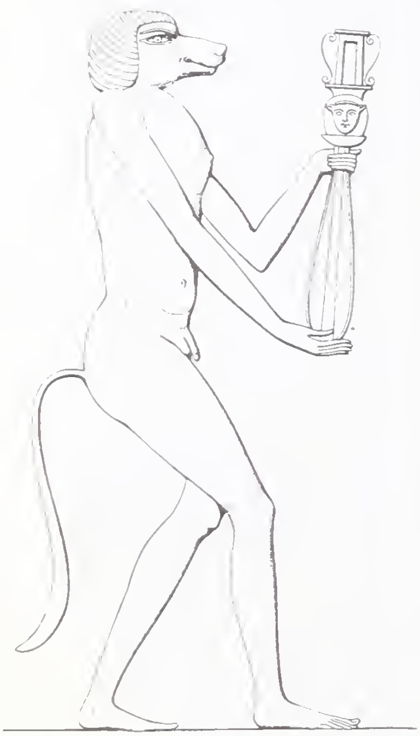


dence; the Germans rejected his method. It was left to Ippolito Rosellini to publish in ten volumes, over a period of eight years, the results of their expedition to Egypt. Not till 1866 was Champollion properly vindicated, when what amounted to another Rosetta Stone was found by the German Egyptologist Karl Richard Lepsius in the delta ruins of Tanis, inscribed in hieroglyphics, demotic script and Greek. The stone bore a decree in honor of Ptolemy III and Berenice II, his queen, inscribed in 239 B.C. in the ancient Egyptian seaport of Canopus on the western mouth of the Nile. With this newly discovered text, Lepsius was able to corroborate Champollion's dictionary of hieroglyphs and prove the accuracy of his grammar.

Sixty-four years after Champollion's death, Sir Peter le Page Renoulf at last addressed the Royal Society in London to pay homage to the brilliance of Jean François Champollion le Jeune as the true founder of modern Egyptology. Egyptologists were able to forge ahead with translations of glyphs to reveal laws, rituals, literature, customs, and manners of the ancient Egyptians. From these efforts a picture emerged of a people who had carried art and science to a height which modern man had only begun to match. At last Pico, Dee, Bruno, Cagliostro might come into their own.

To drive home to the world the importance of this revival of Egyptian wisdom, a group of British Freemasons decided to erect a symbol to it in London by bringing back from Alexandria the obelisk donated by Mohammed Ali which the French had negligently left in place.

13. VICTORIAN VANITY

Napoleon's troops had already fastened a cable around Cleopatra's upright needle in Alexandria and were on the point of felling it to bring back to France in commemoration of their 1798 victories in Egypt when they were rudely interrupted by General Sir Ralph Abercromby's Twenty-eighth Gloucestershires, who forced the French to abandon the attempt. Victory gave the British the idea of bringing back to England the obelisk to celebrate the defeat of Napoleon. But instead of the upright needle, which seemed tricky to lower without breaking, Major General the earl of Cavan, in command of the small force of Britishers left to garrison Alexandria, decided it would be easier to ship to London the prostrate monolith beside it. Cavan sought permission from the local Turkish authorities to remove the fallen needle, and schemed with his military engineer, Major Alexander Bryce, on how to embark the trophy.

To finance this operation, the British troops were "graciously" invited by their officers to "voluntarily" subscribe a certain number of days' pay to "meet the expenses of an undertaking in which their feelings were deeply interested." Officers and men—so goes the official report—"vied with each other in offering their contribution to the furtherance of an object so gratifying to their national and professional pride." Seven thousand pounds were collected to build a jetty from which to load the obelisk into the stern of a captured French frigate, *El Corso,* where it would lie on a bed of timbers.

Work was begun, and "pay issued to the working parties from the funds they themselves had contributed"; but after the soldiers and sailors, aided by a gang of Arabs, had expended a week of heavy labor they only managed to move the obelisk 6 inches. Then a gale washed away the jetty, and in London the British commanders of the army and navy ordered the project canceled, the official reason given to avoid displeasing the Ottoman sultan to whom the obelisk technically belonged, but unofficially for reasons of state. *El Corso* was disposed of; what was left of the money was returned to the troops.

Not to be totally frustrated, Cavan had a tablet inscribed to the memory of Britain's exploits against the French in Egypt. Afraid the Turks would destroy it as soon as the British left, he had it buried beneath the base of the prostrate obelisk, where no one could possibly see it. In the words of the official account: "They found the pedestal to Cleopatra's Needle and having heeled it to starboard they made a cavity to receive the tablet and replaced the heavy stone."

Once the last of the British had left Alexandria in 1803, the monolith was allowed to disappear again beneath the sand, there to be forgotten until Mohammed Ali, as the new khedive of Egypt, realized he might use the trophy as bait to obtain from the British enough corvettes to develop a navy and so defend himself against his former master at the Ottoman Porte. Renewing his offer to donate the prostrate obelisk to Britain, Mohammed Ali even volunteered to pay for it to be loaded onto a ship. But the admiralty, who did not wish to see the upstart viceroy develop even a weak Egyptian fleet along their route to India, allowed the offer to dangle.

Not so the generals who had served in Egypt in 1801, and who were still hankering and agitating for their prize. But as the years stretched into decades without their being able to change the admiralty's mind, they finally presented a memorandum to Queen Victoria's consort, Prince Albert, to see what he could do. Dutifully, the prince addressed a letter, signed "Albert," to the queen's minister, Lord John Russel, in which he supported the notion of having "this universally renowned work of art brought to London." But even his royal efforts were of no avail against the admirals.

Cartoon lampooning the khedive for walking off with Cleopatra's Needle

Only when it was rumored that Mohammed Ali was flirting with the French in the hope of improving his navy, and had offered them *both* obelisks in Alexandria, was a new ruckus raised in Parliament. But when the French unaccountably refrained from taking the obelisk, it too died down. What was needed by the military survivors of the Egyptian campaign to get their obelisk was more propaganda, and it came in the form of two reports, neither too subtle. A London magazine carried the story of a Briton having been seen sitting astride the prostrate obelisk, knocking off chunks of the inscribed stone with a hammer as mementos for himself and his fellow tourists. When the writer of the article had expostulated with his fellow Briton, reminding him that the relic belonged to the British nation, the vandal was quoted as replying: "I know. And as a member of the British nation I mean to have my share." That the story was apocryphal is evidenced from the fact that the obelisk was still buried deep in the Alexandrine sands of the delta. Some smart propagandist was pulling at Albion's heartstring.

The second story, with a French villain, induced even greater Bullish choler. It was reported that the Greek owner of the land on which Britain's obelisk lay had hired a French engineer to dynamite the monolith into pieces small enough to be used for building material.

That did it. General Sir James Edward Alexander, a ranking Freemason and great-nephew of Sir Alexander Bryce, who, as Major Bryce, had originally helped Lord Cavan try to remove the obelisk in 1801, went into action. It was March 1875. "I determined," wrote Alexander, "to endeavour to save the national disgrace of the loss and destruction of the trophy, and resolved to do my utmost to have it transported to London to grace the metropolis with a monument similar to those at Rome, Paris and Constantinople."

Alexander found the khedive, Ismail, who had been educated in Paris, a pleasant-looking man, in good condition, wearing the usual red fez, dark surcoat, and white vest, but no sign of rank, a mode he had adopted since the opening of the Suez Canal six years earlier, when he had begun to claim rank as a European sovereign. But his administration was so expensive and his aides so corrupt he was soon obliged to sell to Britain his shares in the canal, which signaled the beginning of his downfall.

Alexander's first move was to go to Egypt and confirm permission from Mohammed Ali's grandson, the reigning khedive, or viceroy, Ismail Pasha, to remove the obelisk. From the British government Alexander received partial assistance in that Lord Derby, then foreign secretary, gave him a semidiplomatic status by instructing the British agent in Egypt, General Stanton, to introduce him to Ismail Pasha. In Cairo, General Alexander put up at Shepherd's Hotel, full pension, for 16 shillings a day. Among the guests were Lord Grey, whom Alexander described as keeping up the British sporting reputation abroad. He had just spent eighteen thousand cartridges on pelicans, ducks, quail, and one on a crocodile.

Alexander's audience with the khedive took place on March 25, in the Palace of Abdin, guarded inside and out by a reconstituted body of Mamelukes, in crimson and gold. For the occasion, Alexander wore a general officer's undress uniform with a sword and a sash. In French, the khedive said to Alexander: "This obelisk was presented to the British nation by my ancestor Mohammed Ali Pasha, for services rendered to Egypt. It belongs to Britain. I give it up freely. How is it to be removed?"

Alexander explained, as best he could, and accepted the gift with good grace, knowing that the khedive was being generous because he wished to sell to Great Britain his shares in the Suez Canal to help defray part of the 100-million-pound debt he had run up with a swarm of foreign concession-hunters, who had helped him to loot the country. Taking his leave, Alexander returned to Alexandria, where he asked his dragoman, Mustapha Ali, to show him the obelisk.

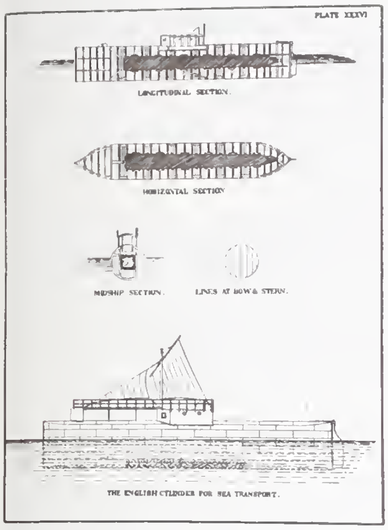
"There," said the dragoman.

"Where?" said Alexander. "I see nothing."

Mustapha gave orders to an Arab standing nearby, and when a large amount of sand had been cleared away, a portion of the obelisk came into view. It lay near the seawall, which was wasted by the water of the Mediterranean. For some distance out, the sea was very shallow and choked with the remains of ancient buildings, broken columns, and other debris from centuries past. So encumbered was it that an ordinary vessel capable of carrying a 200-ton load could not possibly come close to shore, especially a shore that was frequently exposed to gales.

Several people came forward with suggestions to Alexander as to how he could move the obelisk.

First, the obelisk had to be completely uncovered, so as to examine its condition and accurately estimate its weight. A working party of Arabs was engaged, and Dixon was able to establish that the obelisk was 68½ feet long, with a base 7½ feet wide. From this data he estimated the obelisk had a volume of 2,517 cubic feet and a weight of 186⅓ tons.



Dixon's plan for transporting the obelisk to England

Alexander settled instead on the advice of a civil engineer from the North England Iron Company to whom he had been introduced by an officer of the Porte, Chamberlain Bey. The engineer, Waynman Dixon, also a high-ranking Mason, explained to Alexander that he and his brother John has been interested in the obelisk for some years and had worked out a careful scheme for getting it back to England.

Having had a good look at the obelisk, Dixon was convinced that the only method of getting it into the sea, and back to England, was to encase it in an iron cylinder which could be rolled down the slopes till it floated. If the cylinder were built in properly watertight segments and given a keel, it could be towed by a regular steamship—all the way to England. Such segments, said Dixon, could easily be built in a British naval yard, and shipped out to Egypt. Only, who was to pay for the job?

In a letter to a friend and fellow Mason in England, Dr. William James Erasmus Wilson, Alexander had already referred to "Cleopatra's Needle." Wilson, a doctor in his middle sixties, who had piled up a fortune as Britain's leading dermatologist, augmented by shrewd investments in gas- and oil-company shares, offered to meet and discuss the matter with Waynman Dixon. An indefatigable traveler in the Near East, particularly interested in Egyptian antiquities, Wilson was renowned as a generous benefactor of charities, having bequeathed no less than £200,000 to the Royal College of Surgeons.

When Wilson found out that Dixon was also a high-ranking Mason "all formality and ceremony were at once banished." Dixon told Wilson he could encase the monolith in boiler plates, steady the cylinder with bilge plates, ballast it, fix on a rudder, a cabin, and a spar deck, then tow the whole thing to England for about £7,000. Would Dixon, Wilson asked, undertake safely to set up the obelisk in London on the banks of the Thames for £10,000—"no cure, no pay"?

"Willingly," replied Dixon; and Wilson's only further stipulation was that Dixon converse with another Freemason, civil engineer H. P. Stephenson. They met in a solicitor's office in Bedford Row and agreed upon a contract.

But by this time, back in Alexandria, Alexander had found himself stymied. The obelisk had been entirely surrounded by a tall palisade, put up by the owner of the land on which the obelisk lay, a Greek named Giovanni Demetrios, who had been complaining to the khedive for a score of years to get the obelisk removed from his property as it was a hazard to its development. Now the

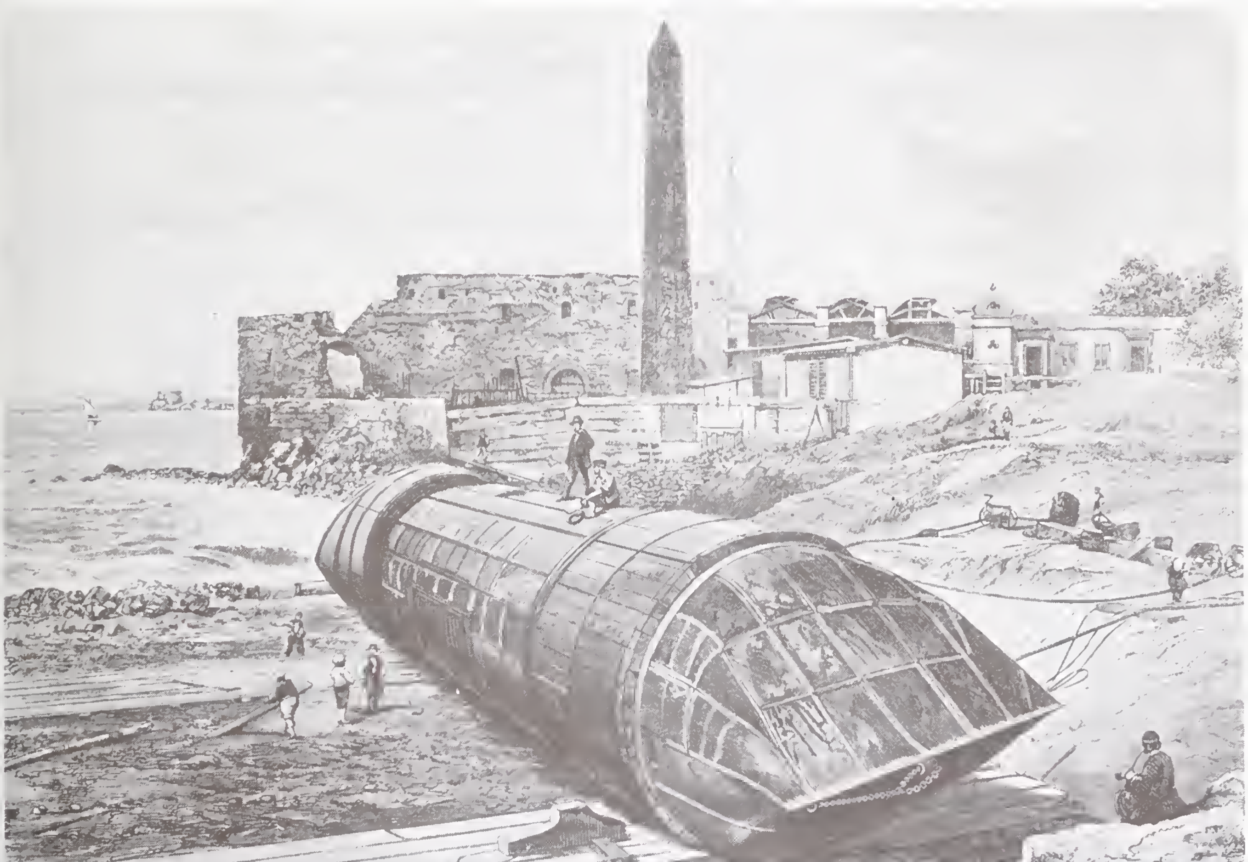
Greek complained that by giving away the obelisk without consulting him, the khedive had wounded his feelings, adding that the khedive had no right to allow strangers to trespass on his private property. Demetrios refused to allow anything to be done unless he received a heavy indemnity for the removal of the obelisk.

To resolve the situation, Alexander called on Demetrios with a lady friend—a Mrs. Gisborne—in the hope, he said, that female influence might affect the old Greek. Alexander found him living in a handsome residence in a beautiful garden, a man of culture, with his personal physician in attendance, Dr. Neroutsas Bey, "a very intelligent antiquary." After much coffee-taking and palavering, Demetrios gave in, explaining that as a Greek, who was thankful to Great Britain for what she had done to help liberate his country, and as a connoisseur and collector of antiques in his own right, he had no desire but to help. There was only one condition: that he be considered the donor of the monument. Alexander readily agreed, and a deed of gift was drawn up which showed that both Demetrios and the khedive had made a present to Britain of the obelisk.

It was now only a question of receiving the iron cylinder segments from England and of assembling them about the obelisk. To superintend the job, Waynman Dixon had commissioned an old salt, Captain Maximilian Carter, who had served twenty-two years with the Peninsular and Orient Line. He was to inspect the segments of the vessel being constructed at the Thomas Iron Works Company under the instructions of a naval architect.

Meanwhile, Dixon recruited another gang of Arabs to remove all the sand from about the obelisk. With hydraulic jacks capable of lifting 100 tons, he had them raise the shaft onto a solid bed of long pine beams and railway sleepers, uncovering in the process several skulls and

human arms and legs, which he promised to the British Museum. When Captain Carter arrived in Alexandria, he was pleased to find the obelisk lying parallel to the sea, but concluded he would have a hard time rolling the completed cylinder into the water because of the hundreds of building stones lying about the shore front and extending far into the sea; many of them were relics of old Roman pavement, others, more ancient, were covered with Egyptian hieroglyphics. Divers were hired to remove enough of these enormous blocks of stone—some of which weighed more than 20 tons—so as to make a path for the obelisk through the shallow water to where it could be floated in a depth of about 10 feet. But some of the blocks were so large they had to be blasted with dynamite, as did some buildings further out to sea whose huge walls appeared to be the foundations of an enormous Roman bath.



Cleopatra's Needle encased in its iron cylinder, 9.8.1877

When the cylinder was finally wrapped around the obelisk in ten watertight compartments, it looked like an enormous boiler, 93 feet long and 15 feet in diameter. Dixon figured that if the center of gravity of the obelisk inside the cylinder was kept 10 inches below the main axis of the cylinder, it would—once it was a vessel—

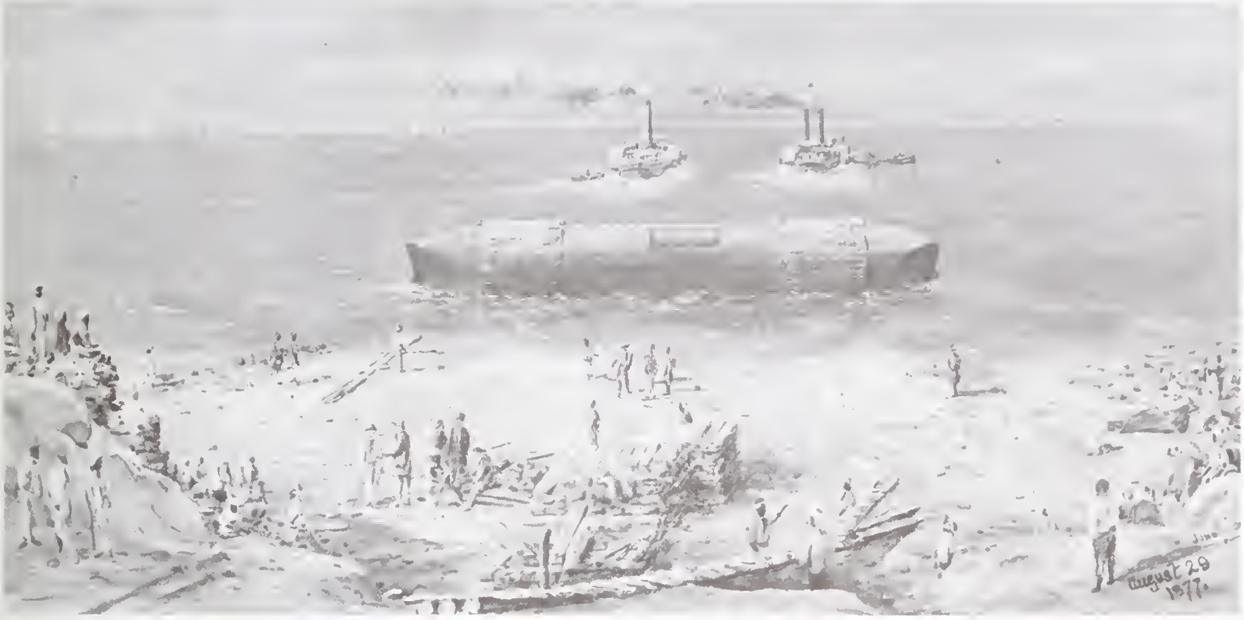
remain in a state of equilibrium in the sea, no matter which way it was rolled by wind or wave. To protect the outer surface of the cylinder while it was being rolled into the sea, timber rings 9 inches thick and 18 inches deep were strapped around it, near the ends, making huge wheels on which the vessel could roll. To start it rolling, hawsers were passed nine times round the vessel and taken to winches on board heavy lighters moored some distance out. Other hawsers were fastened on land to check any undesired movement.

On the day set for the launching, August 28, 1877, a terrible fog shrouded the scene, but it soon cleared, and several thousand spectators turned up from the mixed population of Alexandria to view the operations in what developed into a heat wave of 90° in the shade. A select group of visitors, protected by parasols, included Princess Said, sister of the khedive, and the British consul general, Mr. Vivian.

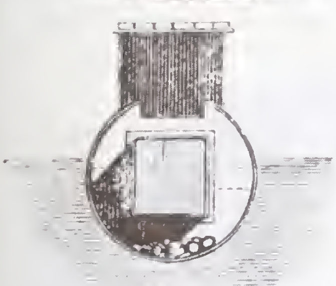
At the appointed signal, the winches began to pull, hawsers strained, and the cylinder slowly turned, its movement hardly perceptible. By noon it had made one full revolution, covering a distance of 50 feet. Then the anchors began to drag out to sea, and the ropes had to be shifted to tugboats which steamed away at full power, just managing to keep the cylinder rolling. By 5:30 P.M., the cylinder had reached the water's edge and by seven it was in 3 feet of water; there it was left for the night.

Soon after daylight on the twenty-ninth, tugs began to

Floating the cylinder



The cylinder being towed to the Alexandria docks



With the use of heavy jacks, the obelisk was placed 4 inches below this axis and forced into place with heavy timber struts. The other 6 inches were gained by loading 12 tons of iron rails into the vessel's bottom as ballast. Further to steady the craft, its fore and aft compartments were completely filled with concrete.

tow again, and by noon the cylinder should have floated. But it didn't. It was half full of water, and there was no way to get inside because the manholes had rotated to its underbelly. Arab divers were summoned, but could not figure out what had happened. When a hole was cut in the surface, above water, and a double suction pump set to work, it had no effect on the level of the water within the cylinder. A deepsea diver in proper suit found that a large stone, hidden in the sand, had penetrated the bottom of the cylinder. Water had mysteriously flooded all the compartments. It was then discovered that in the excitement of the event, everyone had forgotten to close the bulkhead manholes.

To remove the half-ton stone took several days. The cylinder had to be rolled so that its 18-inch hole could be riveted from above water. Two more days and the cylinder floated. Safely towed 9 miles to a great floating dock belonging to the Egyptian government, it was to be fitted with 40-foot bilge keels riveted to the bottom, plus a cabin, a bridge, and a rudder. As soon as the latter was hung from the stern, the vessel was ready for the open sea.

For a crew to man the cylinder under his command, Carter had hired five Maltese sailors and a Maltese carpenter, who agreed to make the run to England for £20. A boatswain insisted on fifty. To tow the cylinder, Dixon had obtained the *Olga,* a steamship belonging to William Johnson and Company of Liverpool, for £900, half to be paid in advance and the remainder on safe arrival, with the obelisk, in Falmouth.

On September 19 a party was held aboard the cylinder, attended by "a hundred and fifty ladies and gentlemen" who watched as the daughter of the British admiral MacKillop Pasha christened the cylinder *Cleopatra* with a bottle of Champagne broken against the stern. On September 21, 1877, despite remonstrances from the Maltese crew that it was bad luck to set off on a Friday, Captain Carter, who had worked himself into a state of exhaustion to get the *Cleopatra* shipshape, agreed to sail. Dixon, traveling on the *Olga,* was anxious to get the obelisk to London and avoid having to wait for fair weather in the spring. Slowly the *Olga* steamed out of Alexandria harbor, with the *Cleopatra* in tow.

The odd-shaped vessel showed herself to be staunch and buoyant, but not easy to steer. She yawed wildly, and in an undulating sea pitched severely, causing great and uneven tension on the 700-foot wire towline. Even at a moderate speed the *Cleopatra* would sink her bow, obliging the *Olga* to go dead slow.

Captain Carter spent all of the first night on deck. The next night the heat was so oppressive his men could not sleep below. Stretching themselves on the narrow deck, wherever they could find room, they tried to snatch fitful half-hours of sleep. Then the breeze freshened, and the *Cleopatra* began to plunge, making sixteen to seventeen dives a minute, completely submerging her bow, which required the crew to hold on with both hands as the sea swept over the entire vessel.

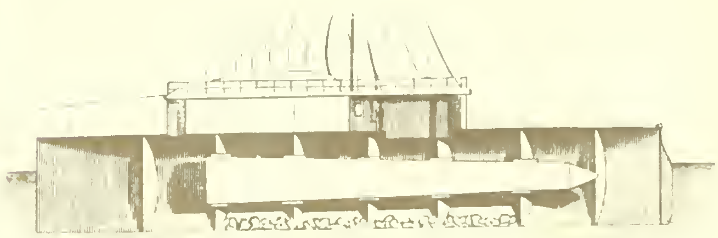
The boatswain got sick from an inflamed liver, and the crew asked to put into Malta. Lest they all bolt, the captain refused. Instead, he gave them each a glass of grog and opened a bottle of Champagne for himself and

The *Cleopatra* towed by the *Olga*

The captain in his cabin

Taking care of the boatswain

the invalid boatswain. One man short, Captain Carter had to stand watches, assist in the cooking, and even trim the lamps at night. He no longer took off his clothes except to wash them and put them on again. Every six hours he took pains to examine the compartments below deck to see that all was secure. To reach the obelisk, he had to wriggle down a small hole in the floor of the saloon, crawl through the manholes in the various divisions, and examine each diaphragm. When the candle he held in his mouth as he crawled beneath the obelisk began to burn his nose, he had to drop it, obliging him to grope his way back for a full half-hour before he could reach the open air. It was not, said Carter, using a Britisher's understatement, "drawingroom work." At first he had difficulty squeezing through the narrow manholes. Later he joked that the regular but simple diet enabled him to slip through "like a halfstarved rat."



Longitudinal section of the cylinder with ballast and bulkheads

Near the island of Galita, the ship ran into much thunder and lightning. A ball of fire danced on the masthead, and there were wild screams from the *Cleopatra*'s crew of "the devil! the devil!" Carter explained it was nothing but Saint Elmo's light, not unusual in the Mediterranean in stormy air full of electricity.

On October 2, the *Olga* signaled she had to put into Algiers for coal. There the ship's crew got so drunk they assaulted their chief officer, tearing out one side of his whiskers. At Gibraltar, when Dixon went ashore and engaged two more sailors, he was warned by naval men that October was a singularly bad month to head across the Bay of Biscay, especially with such a tricky cargo. There was also a report from America warning that a hurricane was expected to cross the Atlantic in mid-October. But Dixon was determined not to have to leave the *Cleopatra* in Gibraltar for the winter. So they sailed on as planned.

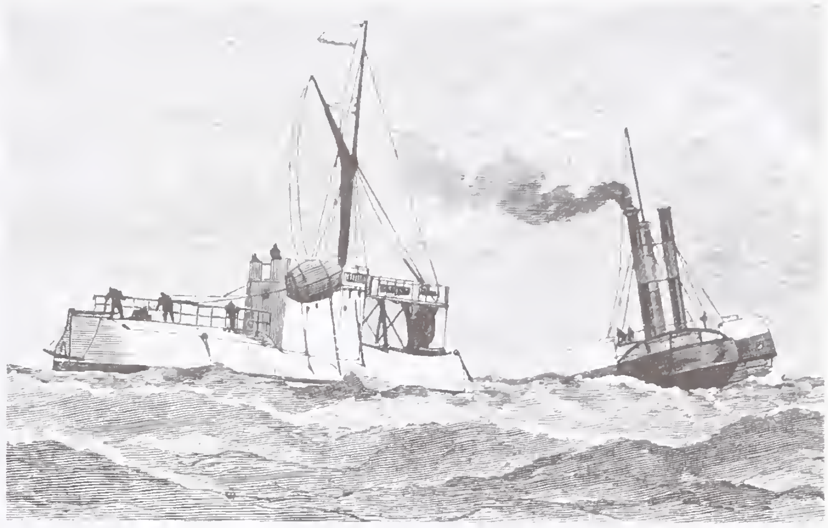
On October 10, at 2:30 A.M., the two vessels spotted the light off Cape Saint Vincent. At six thirty they rounded the cape itself. From the west-northwest a long Atlantic swell

Rough going in the Bay of Biscay

set in, over which, according to Carter, "the *Cleopatra* rode like a duck." As they passed the mouth of the river Tagus, steamers came out to have a look at the strange craft. On Saturday, October 13, at 5:00 P.M., Carter reported seeing Cape Finisterre, the westernmost point of northern Spain. There was a light southerly wind; but he also noticed unmistakable signs of an approaching storm.

On the fourteenth, Captain Booth of the *Olga* noted in his logbook that at latitude 44°55′ north and longitude 7°52′ west, off the northernmost tip of Spain, the wind freshened, increasing with squalls and fast-rising seas. But with the *Olga*'s engines going dead slow, the *Cleopatra* was doing all right. Nevertheless, to steady the *Cleopatra* against the rising waves, a sea anchor was prepared in the form of a conical canvas bag 6 feet long by 15 feet in circumference, its mouth kept open with crosspieces. When thrown overboard at the end of 40 or 50 fathoms of rope, it would help keep the vessel's head to the wind.

By noon a furious squall came up from the south-southwest, accompanied by hail and rain. The wind increased till it was blowing a heavy gale. So long as the vessel was before the wind, Carter felt he had no cause for anxiety, although the whole of the after part of the vessel was frequently immersed, the sea occasionally rolling over the cabin. All afternoon the barometer contin-



ued to fall, while the wind began to veer to the west. As the sea became more quarterly, it broke heavily against the deckhouse, and Carter had serious fears of the whole superstructure being swept away.

By 5:00 P.M. he made up his mind to heave to, and lie with his head into the wind to ride out the storm on his sea anchor. Captain Booth on the *Olga* acknowledged his signal and replied, "Greater risk to tow line if heave-to!" Nevertheless, he set a mainstay sail and just before sundown proceeded with what Carter called "consummate skill and judgement" to bring his ship well round to the wind. Only just too late. The *Cleopatra*'s broadside was struck by a tremendous sea which overwhelmed her, hurling her over on her starboard beam, where she remained with a heavy list. The timberwork securing the iron rails employed as ballast had given way. Shifting about, the rails caused the vessel to lay over at an angle of more than 45°.

Carter, who had already been wrecked three times before, and had been on an Indian ocean liner when it caught fire, did not panic. Instead, he opened the manhole door in the saloon floor and went down with his crew into the hold to try to right the ballast. The gale was now at its height. Though the seas were breaking completely over the *Cleopatra,* she was only making water at the upper bolt-holes. With the hull half full of water and 12 tons of railway iron sloshing around, the job wasn't easy. After an hour's work, the crew finally got the ballast shifted sufficiently to right the vessel. Then a huge wave struck the starboard side and the ballast shifted again, causing the ship to list to port at an even worse angle than before.

Slowing her engines almost to a stop, the *Olga* came as close as practicable, distinguishing signals of distress

from the *Cleopatra.* At this point the gale began to slacken. Toward 9:30 P.M., Captain Booth decided to risk lowering a boat, and called for volunteers. The second mate, William Askin, a young man of twenty-six, immediately volunteered, along with five seamen, all from Liverpool.

Captain Booth stopped the engines and got a lifeboat safely clear of the ship and into the water. In the dark, Booth could just distinguish the lifeboat as it approached Carter's vessel. A line thrown from the *Cleopatra* was caught by Askin and one of his mates, but they were unable to hold onto it. As the rope slipped through their hands, the boat drifted past the *Cleopatra*'s leeward side into the dark night.

On the *Olga,* Captain Booth waited for the reappearance of his lifeboat, which he assumed to be on the far side of Carter's vessel. When it hadn't arrived by eleven, Booth maneuvered as close as he could to the *Cleopatra,* and hailed her, to ask about the boat. He could make nothing of the answers, except that the men were in serious distress. The *Cleopatra* was listing very heavily to port, and he noticed that they had cut away her mast.

Booth's only recourse was to launch a "messenger buoy" to sweep the *Cleopatra* with a line in the hope that its crew might grapple it and haul it aboard. The wind was moderating slightly; but a heavy sea was still running, causing the *Olga* to pitch and roll so heavily she was shipping much water, and the attempt failed.

As there were no volunteers to man another lifeboat, Booth concluded he had no other choice but to keep as

Captain Carter's sketch of the problems encountered in the heavy sea

close as he could to the *Cleopatra* and wait for daylight. All night Carter and his crew continued in their efforts to right the ballast. As often as they did so, the merciless sea threw it back. When day dawned, the gale had moderated considerably; though the sea was still running high. As the *Olga* approached, it found the *Cleopatra* settled heavily on her port beam, its crew still alive and in full force. Of the lifeboat, not a sign.

Booth slipped another cask overboard as a buoy, but again it failed to reach the *Cleopatra*. Edging closer, he managed, after several ineffectual attempts, to throw a line aboard the crippled vessel by means of which a 5-inch hawser was hauled in to keep her in position. Standing to leeward, Booth lowered a boat which managed to reach the *Cleopatra* and take Captain Carter and his Maltese crew safely aboard.

Booth then cut loose from the vessel, leaving her on her beam end, expecting her to sink at any moment. At full speed he proceeded in search of the missing lifeboat. With lookouts aloft he steered westward and soon passed a boat hook and then a messenger buoy, but saw no sign of the lifeboat. By ten thirty, there being nothing in sight from aloft, Booth bore up and ran down to leeward, passing the *Cleopatra*'s severed mast, but saw nothing of her hull, or of the lifeboat.

At noon, hopes of finding either the boat or the *Cleopatra* began to fade. Booth concluded that the lifeboat had been swamped and the crew lost. The *Cleopatra*, with her precious needle, must have gone to the bottom. Heading for Falmouth, he prepared a signal to the effect that six men had perished in a lifeboat, and the *Cleopatra* and her cargo had been lost in a heavy gale in the Bay of Biscay.

In London, where the press and the public had been following the moves of the *Cleopatra* from dispatch to

London reports the abandonment of Cleopatra's Needle in the Bay of Biscay dispatch, arguing as to where the trophy should be placed, the news was stunning. Everyone was suddenly glum and silent. Only Dixon refused to believe the *Cleopatra* was lost. He insisted that the vessel had been left with eight watertight compartments and only a small amount of water in her hold, leaking from the bolt-holes on her top. The huge stone, according to Carter, had been perfectly secure when the ship was abandoned. All the seams were tight, and all of the manholes fastened. The worst that could happen, said Dixon, was that the 12 tons of rail ballast could roll from side to side, listing the vessel alternately from port to starboard, but with the fore and aft compartments filled with cement, Dixon maintained, the vessel could not capsize.

Furthermore, he pointed out that the 200 fathoms of steel cable hanging from her bows would act as a sea anchor, keeping her head to the wind, and that if she were to run into shallow water, the cable would act as a regular anchor. Convinced the *Cleopatra* was still afloat, Dixon appealed to the first lord of the admiralty to dispatch a steamer in search of her, pointing out that she was a serious hazard in the track of passing vessels, especially as she had no lights.

On October 15, the *Fitzmaurice,* a small iron screw steamer of 297 tons, bound from Middlesbourcugh to Valencia, Spain, with a cargo of pig iron, encountered heavy winds in the Bay of Biscay and was forced to lie to until the seas calmed sufficiently for her to resume her course. Off the northern coast of Spain, some 90 miles north of the port of Ferrol, and 15 miles northeast of Corunna, the *Fitzmaurice* sighted a strange object in the sea. As the *Fitzmaurice*'s captain Evans reported the event, at about 5:00 P.M. he spotted what appeared to be the bottom of a ship on the lee beam. Putting the helm hard up, he bore down upon the object and just at dusk realized it was the *Cleopatra,* about which all Britain was agog.

As there was too much sea to board her, he waited, with great difficulty, on account of the rough weather, till dawn of the following day, when he was able to fasten two 9-inch hawsers to the vessel. Two hours later the strain of the heavy sea caused both lines to part. The captain launched another boat and screwed more hawsers to her, setting off at a very slow pace through the heavy sea.

The next morning such a heavy gale blew from the southeast that the ropes parted again, and the captain was only able to refasten them with the greatest difficulty. Limping along, the *Fitzmaurice* finally managed to tow the *Cleopatra* into the pretty little port town of Ferrol, one of the best harbors in Europe. As soon as he was able to inspect the way in which the obelisk had been packed, Evans saw that it was still in perfect shape, but concluded that whoever had arranged the ballast had been a soldier, not a sailor. When the news reached London of the safe discovery of both *Cleopatra* and obelisk, there was general rejoicing, except for the fate of the six missing sailors. From Balmoral, Dixon received a message that Queen Victoria had suggested inscribing the names of the six drowned men on the pedestal to the needle.

At Falmouth, another message, undelivered, awaited the drowned second mate, William Askin, to inform him that his wife had given birth to their first child. A fund was immediately set up for the widows and dependents of the drowned sailors. Dixon put up the first £250, and the owners of the *Olga,* who had thought highly of Askin, and had placed him first in turn for promotion in their service, undertook to organize the fund.

Meanwhile, John Dixon, Waynman's brother, set off with Captain Carter for Glasgow to sort out the salvage costs with the owner of the *Fitzmaurice,* a Mr. Burrell. They did their best to induce the Scot to be moderate in his charges, on patriotic grounds, explaining that it had been a great honor for him, in the eyes of the nation, to have been owner of the vessel which had picked up the *Cleopatra* and towed it to Ferrol. They suggested he be content with that honor, providing the crew was paid a moderate sum for their trouble. Burrell claimed £5,000 in cash. When Dixon offered him £600, the "hard-headed Scotchman" could not be moved.

In Liverpool, Carter went to retrieve from Captain Evans his sextant and other instruments, as well as his log book. His portmanteau had been broken open and thrown overboard with all his private papers, and about £20. His clothes were gone. So were several antique coins and rings. The *Fitzmaurice*'s mate was wearing his shirtstuds. Yet Captain Evans declined to relax the lien on the *Cleopatra,* or on the obelisk, until the claim for salvage was met in full.

Taking the case to an admiralty court, Dixon was able to obtain a reduction in the salvage price from £5,000 to £2,000. As soon as the sum was paid, Captain Carter was able to proceed to Ferrol on a Spanish steamship with a fresh crew from Liverpool to refit the *Cleopatra* with 2 tons of nuts, bolts, chains, and varied ironwork.

At Ferrol, which was well provided with dry docks and warehouses, Carter was able to fit out the *Cleopatra* with a new mast, sails, steering yoke, and tiller. Water and

The *Cleopatra* leaves Ferrol in tow of the steam-tug *Anglia*

provisions were taken aboard on January 1, 1878. To tow the vessel to England, a 270-ton, 140-horsepower iron tug, the *Anglia,* arrived from Liverpool with a well-known artist aboard from the *Illustrated London News,* who was commissioned to make sketches of the *Cleopatra* and her obelisk for an avid British public, more anxious than ever for the arrival of the trophy. Dixon was worried that the *Anglia* would have to weather another 350 miles across the Bay of Biscay; but he had received a good meteorological forecast from the *New York Herald,* and he estimated that there would be a long moon starting January 19.

The *Cleopatra* resumed her journey on the fifteenth, moving at 5 knots on a tow line of 120 fathoms. Again the ships ran into a gale, which sent huge waves breaking over both vessels, tossing them badly.

"Shall we bear up and turn back?" signaled the captain of the *Anglia*.

"Not if I were in your place," answered Carter. "Better proceed at half speed."

One more boisterous night with heavy rain, and on January 21 *Anglia* and *Cleopatra* pulled into Gravesend in the mouth of the Thames to a chorus of cheers from a crowd on land, and a telegram from Queen Victoria congratulating Dixon on the safe arrival of the needle. *Anglia* and *Cleopatra* responded by dipping their ensigns.

At London's East India docks, the dockmaster, sensing the patriotic air in the wind, generously allowed the *Cleopatra* to dock free of all the usual charges.

But now that the obelisk was safely in the British capital, the great dispute was renewed as to where it should be placed. The earl of Harrowby maintained that

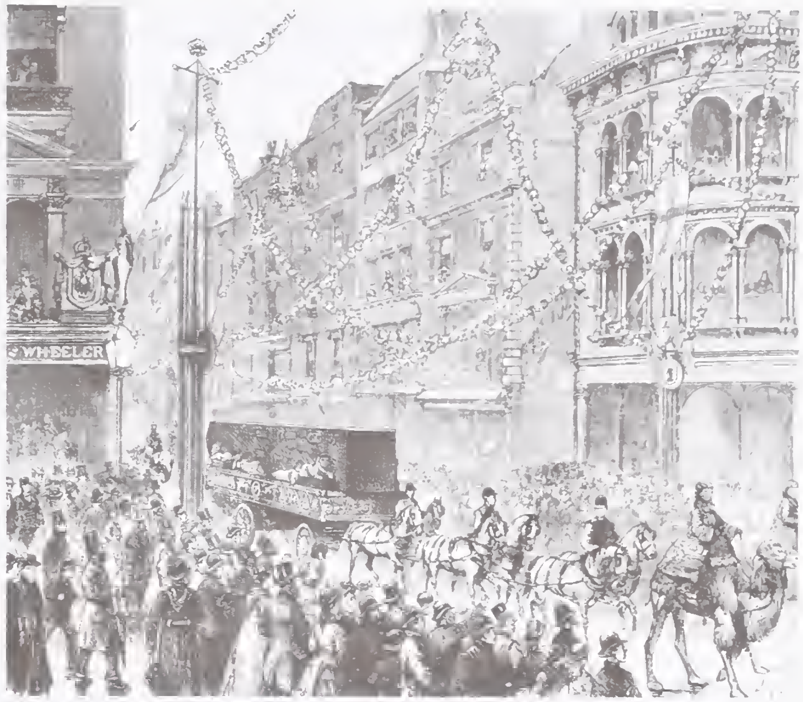
The *Cleopatra* at Gravesend, in the mouth of the Thames, as drawn by the artist aboard the *Anglia*

the choice of the site should be determined by what he called "moral fitness." His idea of a morally fit place was Parliament Square, where the trophy could recall its associations with the victories of Nelson and Abercromby in "surroundings which remind us of the most venerated memories of national history."

"In any other position," said the earl, "it would be a mere tall stone, a mere monolith, only remarkable for its dimensions, and for imperfectly seen configurations upon its surface, but having no significance, telling no story, awakening no associations. . . ."

Imaginative illustration of the obelisk already raised in Parliament Square.

Even more imaginative scene of the obelisk being paraded through the streets of London



The needle by moonlight

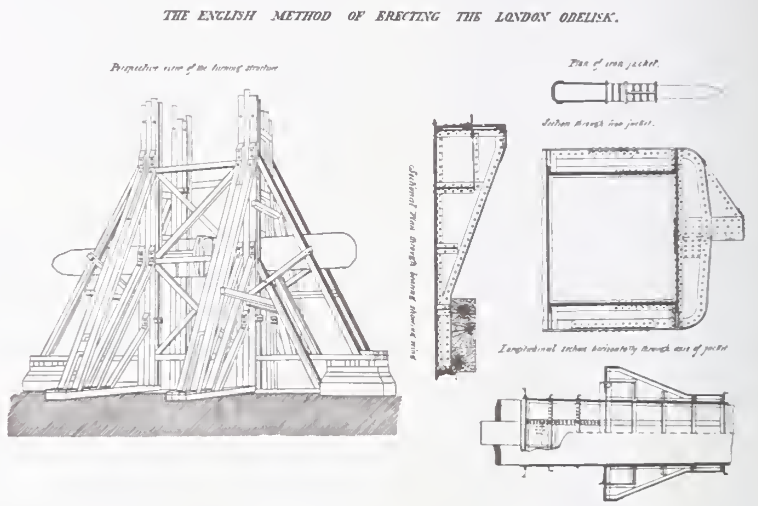
In *The Times,* "A Peer in Reply" thought otherwise, saying that Harrowby had failed to see the moral fitness of placing this relic of tyrannical pharaohs in a spot "hallowed by centuries old associations with the development of our parliamentary institutions and Christian religion." The anonymous peer summed up his argument: "it would be the violation, not the fulfillment of all moral fitness."

Still others wished to place the trophy in front of the British Museum, where it could be closer to other Egyptian antiquities, but the spot was ruled too dark and too small and it was feared that underground utilities would be endangered. At last it was decided to raise the monument on the Adelphi steps of the Victoria embankment, where the obelisk could be admired from a distance (especially by the crowds coming over Waterloo Bridge), where it could have a small park around it, and where, because of its proximity to the river, it would not crush in transit, with its 186 tons, any of the gas or sewer lines of London. Yet even the embankment was objected to by a fellow of the Royal Institute of British Architects, John Holden, who raised the question of possible dangers to the needle from the pressure of the wind, suggesting it might be blown over. John Dixon, with a heavy sigh, pointed out that, from his calculations, whereas less than 30 pounds of pressure per square foot could send a man flying, level Charing Cross station, or sweep a passenger train from the rails, 130 pounds of wind pressure would not upset the obelisk.

"No obelisk," said Dixon, "has ever been overturned by the wind."

As an ornamental base of the obelisk, it was arranged that an architect and an engineer with the Gilbert and Sullivan names of Vulliamy and Bazalgette provide four bronze sphinxes. These colossi, 19 feet long, 9 high, and 6 wide, were to be copies of an authentic Egyptian sphinx set up in the garden of the duke of Northumberland's castle whose sphinx was thought to be of the same period as the obelisk because of a Thothmes III cartouche on its base. Vulliamy and Bazalgette also filled with solid concrete two arches in the embankment that had been used as reservoirs for water with which to flush the steps, thus providing the obelisk with a solid base 4 yards thick and with an area of 1,500 square yards, the lot resting on a tenacious stratum of London clay.

To raise the obelisk onto these sphinxes, four immense uprights had to be fashioned out of six heavy balks of timber, 60 feet high and a foot square. They were to be braced together by tie beams, and supported in their vertical positions by struts thrown out on all sides.



Dixon's method of raising the obelisk on the embankment

The obelisk was fitted with an iron sheathing, 20 feet long, forged in four pieces, so as to be raised 40 feet on a pair of iron girders which fitted into the grooves of a great wooden framework, there to be allowed to swing on its axis from a horizontal to a vertical position.

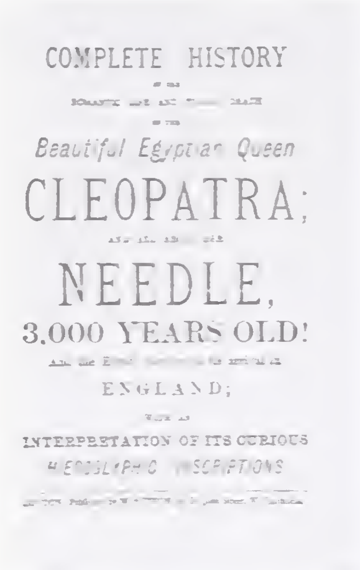
While the "battle of the sites" was still in progress, the *Cleopatra* lay in the East India docks, with a few plates removed so that the public could catch a glimpse of the great butterfly dormant in its cocoon. General Alexander, who had worked so hard to bring the needle to England, naturally rushed to see it, taking with him a popular military figure, Colonel Lennox Prendergast, whose fame derived from having been with the Scots Greys, in the celebrated charge of the heavy dragoons at Balaclava.

While waiting for the completion of the pedestal, it was decided to moor the *Cleopatra* off the steps of Saint

The *Cleopatra* at Westminster in the shadow of Big Ben

Thomas Hospital, opposite the Houses of Parliament. Shortly before noon on Saturday, January 26, 1878, the *Cleopatra* left the East India docks wearing a holiday dress of bunting, to be towed by one tug, and steadied by two others, up the Thames on a sluggish tide. Salutes were fired from the wharves as the cortege passed, and cheers rang out from the bridges. Watermen made a profit from towing passengers round the *Cleopatra* at threepence a head; and, as no one had a clue as to why the obelisk had originally been raised in Egypt, let alone the meaning of the hieroglyphs, hawkers did a brisk trade in penny histories, published by W. Sutton, 91 Saint John Street, W. Smithfield, which purported to be "A complete history of the romantic life and tragic death of the Beautiful Egyptian Queen Cleopatra, and all about her needle, 3,000 years old, and the events that led to its arrival in England, complete with an interpretation of its curious hieroglyphic inscriptions."

To explain the hieroglyphs, the pamphlets quoted the incomprehensible translations of Dr. Birch of the British Museum, who amused and amazed with such passages as: "Horus, the powerful bull, beloved of the Sun! the King of the south and north, Menkheper-Ra, his father Tum has



COMPLETE HISTORY

Beautiful Egyptian Queen

CLEOPATRA;

NEEDLE,

3,000 YEARS OLD!

ENGLAND;

INTERPRETATION OF ITS CURIOUS

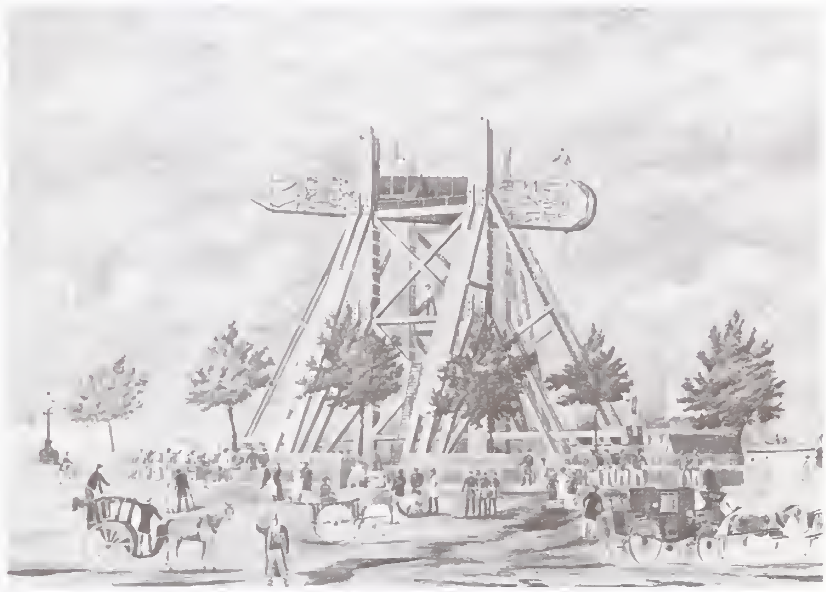
HIEROGLYPHIC INSCRIPTIONS

set his name up to him in the palace attached to Heliopolis giving him the seat of Seb, the dignity of Khepera, the son of the Sun Thothmess III, true ruler, beloved of the Benu of An, ever living." The penny histories further pointed out that whereas the inscriptions on three sides had been deciphered, those on the fourth side had not, and "therefore any representations to the contrary in other accounts are spurious."

Four months later, on May 30, the *Cleopatra* left her moorings off Saint Thomas Hospital for her last cruise—almost running into a string of coal barges. Luckily, Captain Carter, who stuck with the vessel to the last, managed to avoid a collision. At high tide, the *Cleopatra* was floated between two pairs of graduated posts, 65 feet apart, to her final resting place, where she was promptly put up for sale. When no one felt inclined to buy such a relic, even as a souvenir, she was ordered dismantled and stripped. Curious onlookers watched her slow disintegration, and the striptease revelation of her phallic cargo. Most visitors were only allowed by card or appointment, among them such notables as the prince and princess of Wales (later Edward VII and Queen Alexandra), Benjamin Disraeli, Earl of Beaconsfield, and Dr. Erasmus Wilson, who was later to pick up the check for the whole party—in return for a knighthood.

Dismantling the cylinder

When the carcass of the *Cleopatra* had been stripped clean, the obelisk was raised by hydraulic jacks and slid onto the embankment by screw traverses until its center of gravity came to rest over the proposed site. So delicately was the obelisk balanced that Dixon was able to make its apex describe an arc of several inches with nothing but the pressure of his own weight.

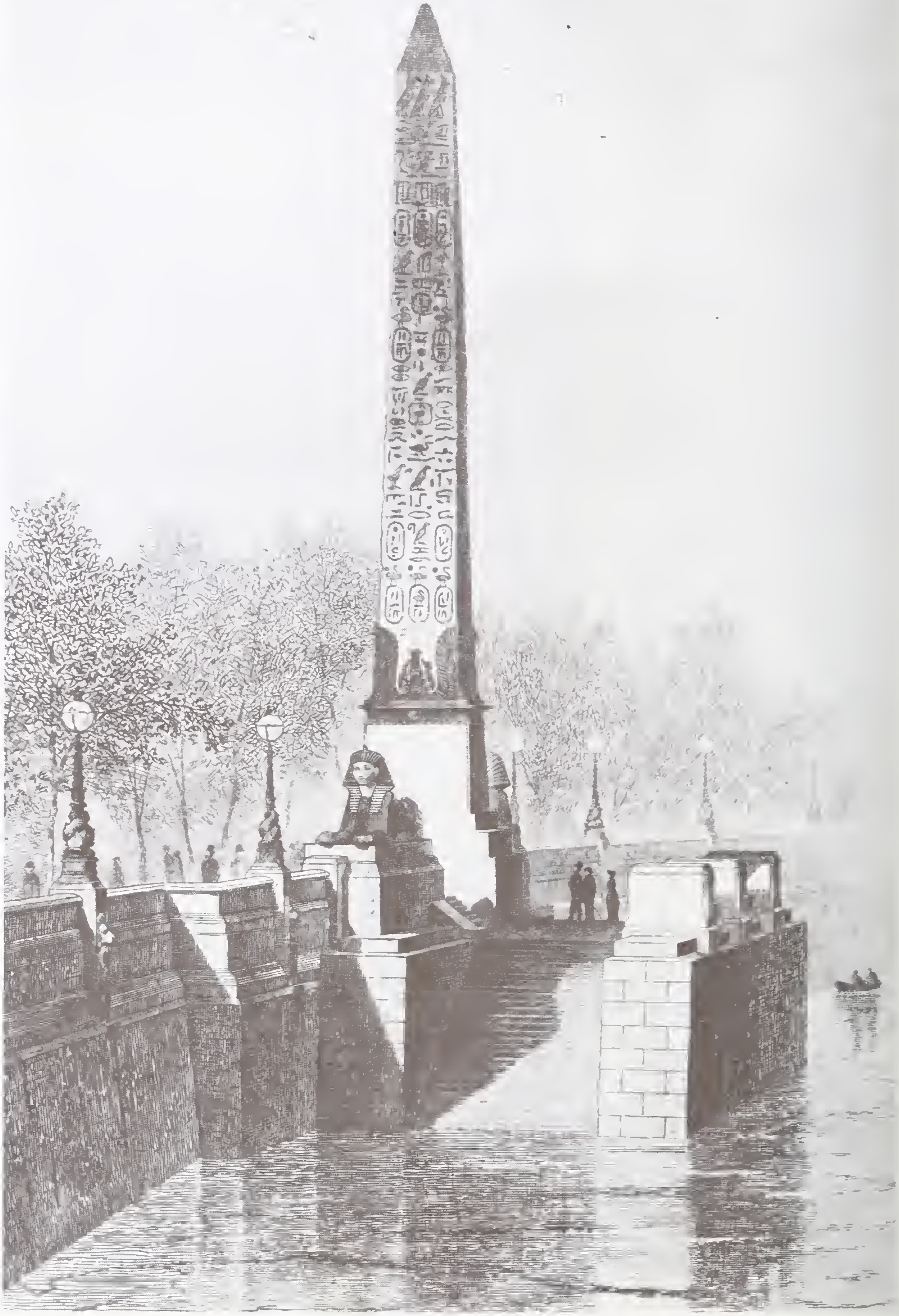


The needle about to be erected. In the pedestal were placed a collection of curious objects considered important to the Victorian world: 1878 photographs of twelve beautiful Englishwomen, a box of hairpins and other articles of feminine adornment, a box of cigars, several tobacco pipes, and an Alexandrian feeding bottle. To this were added a set of toys, a shilling razor by Mappin, a Tangye hydraulic jack, specimens of wire ropes and cables used to raise the obelisk, and a complete set of British coins plus one rupee. Along with samples a standard foot and pint went a portrait of Queen Victoria, a map of London, several current newspapers, and copies of the Bible in various languages. Finally there was inserted verse sixteen of chapter three of the Gospel of Saint John, translated into 215 languages, Francis Bacon's version of which is: "For God so loved the world, that he gave his only begotten Son, that whosoever believeth in Him should not perish, but have everlasting life."

On September 13, an hour before the obelisk was to officially swing on its pedestal, a heavy downpour scattered the gathering crowds. But the sun returned at 3:00 P.M., and from behind a line of constables barricading the embankment, thousands watched as the great rose granite obelisk of Thothmes III, controlled by ropes and chains, swung slowly to an angle of 45°, then 60°, then firmly came to rest on its new London base just as Big Ben chimed three thirty.

The crowd burst into cheers, which reechoed from the roads, the river terraces, and the bridges. A Union Jack was run up on the flagstaff overtopping the pyramidion on the north side, and a Turkish flag was raised on the south, in honor of the khedive, who was to be disposed of by the British within the year and sent into exile on the Bosporus for not having paid his debts. There were more cheers for the queen and for Waynman Dixon.

The penny pamphleteers, awed by the hoary antiquity of the monument, pointed out that it might have been seen by Abraham when he went down into Egypt, that Joseph, who married the daughter of Potiphar, a high priest of On, may have witnessed its first erection; that Moses, brought up by the priests of On, may have brushed against it daily.



Others pointed out that the obelisk had been standing in Egypt when Troy had not yet fallen, when Homer was not yet born, when Solomon's Temple was not yet built, and that it was still standing when Rome had risen, conquered the world, and passed into history.

An American naval officer and fellow Freemason of Waynman Dixon's, by name Henry Honeyman Gorringe, whose hope was to raise Cleopatra's still standing sister needle in New York, and who was to have a great deal more to say about obelisks, summed up the London by-standers' satisfaction that afternoon with his lapidary: "The time-worn shaft will remain erect for many years to come."

But the penny historians had the last word when they augured that the needle would look down "upon all the present and future stupendous creations of human genius, until the advent of the yet unborn but surely approaching time when IT and the land whereon it stands and the ancient life-teeming, wealth-laden Thames shall sink out of sight, and the British Empire be no more."

14. MANHATTAN'S MASONIC MONUMENT

William H. Vanderbilt

The obelisk of Thothmes III as it stands on Greywacke Knoll. First raised in Heliopolis in the sixteenth century B.C., as one of a pair, with Cleopatra's Needle, it stood at the east entrance to the Temple of the Sun, its orientation deducible from the glyphs on its face. Most likely knocked down by Cambyses when he destroyed the temple in the sixth century B.C., it was raised by the Romans in Alexandria, where it stood through the burning of the Caesareum in A.D. 366 and the sack of the city by the Saracens in A.D. 640. The English traveler Paul Lucas who visited Alexandria in 1714 found the lower portion of the shaft buried to a depth of 12 feet.

The first suggestion that an obelisk be removed from Egypt to the United States appears to have been made by Ismail Pasha, at the time of the opening of the Suez Canal in 1869. He made the offer to William Henry Hulbert, editor of the *New York World,* and a leading American Mason, who was in Cairo for the festivities. In September 1877, when the prostrate obelisk at Alexandria was being removed by Dixon, Hulbert was informed by an English friend, Louis Sterne, then in New York, that because of the good relations Dixon had developed in Egypt, he could definitely secure, as a gift to the United States, the standing obelisk in Alexandria. He would also undertake to remove it to New York if someone could be found to defray the cost, which Dixon estimated at £15,000.

Hulbert discussed the offer with fellow Masons Judge Ashbel Green, and Chauncey M. Depew, then proposed to William H. Vanderbilt, the railroad tycoon, reputed to be the richest man in the world, and also a Mason, that he provide the funding. When Vanderbilt agreed, Hulbert spoke with the secretary of state, William M. Evarts, who instructed the consul general in Cairo, E. E. Farman, to take up the matter formally with the khedive, using "all proper means at his disposal."

On March 4, 1878, Farman reported to Evarts that the khedive made no special objection to the transport of the obelisk to New York, but warned that it would be best not to make too much noise about its removal. There was evidently considerable local opposition to the idea, especially among the foreign residents of Egypt. Hulbert informed Dixon that the upright needle had been given to the United States and that Vanderbilt had agreed to pay the £15,000 needed to move it. But Dixon, who had just been obliged by a higher admiralty court to pay the full £5,000 salvage for the *Cleopatra,* was so out of pocket he complained that he would have to raise the ante to £20,000 to deliver the obelisk to New York. Hulbert rejected this increase, without even consulting Vanderbilt, and began to solicit tenders for the job, immediately snaring Lieutenant Commander Henry Honeyman Gorringe, USN, who read the announcement in the *New York World* of June 17, 1879, and promptly offered his services.

Henry Honeyman Gorringe

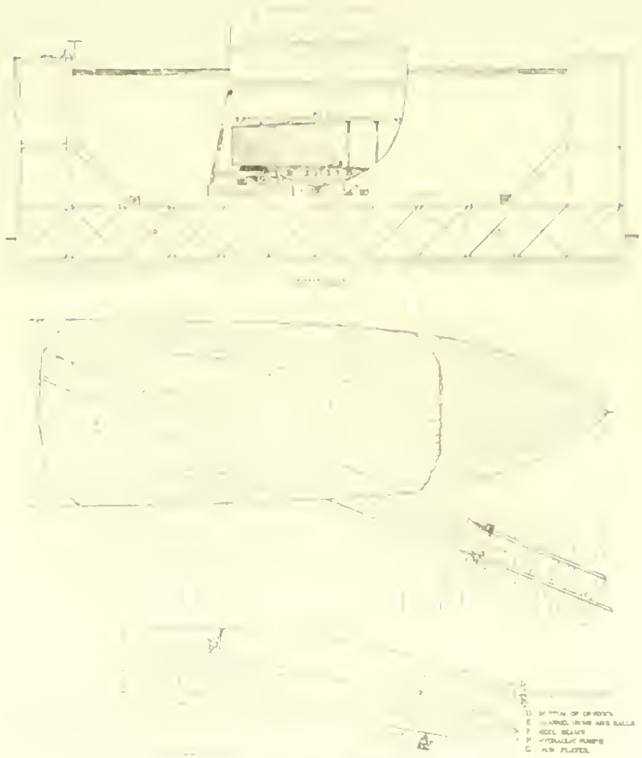
Thirty-eight years old, Gorringe had been employed in the United States Hydrographic Service, where he had recently been commissioned with a fellow naval officer, Lieutenant Seaton Schroeder, to cruise through the Mediterranean on a navy paddlewheeler, the *Gettysburg*. During a stay in Alexandria in 1878 the two officers had several times inspected the standing obelisk and conceived a vague plan of conveying the monument to America if the chance ever presented itself. Gorringe even studied the method used by Lebas to remove the Luxor obelisk, and the method used by Dixon for Cleopatra's Needle, deciding that both plans were unsuited to the transport of the standing obelisk to New York.

Hulbert and Vanderbilt were sufficiently impressed by Gorringe's plan to present to him an outline of Vanderbilt's terms. If Gorringe would undertake to bring over the obelisk and raise it on whatever site might be approved by the New York commissioner of parks, furnishing the underground foundations at his own expense, Vanderbilt would pay him $75,000 upon completion of the work; but he would assume no liability whatsoever until the obelisk was securely in place. Within two days, Gorringe accepted the proposition and its conditions.

At the request of Secretary Evarts, Gorringe and Schroeder were granted a leave of absence from the navy. Evarts also sent a dispatch to the United States vice-consul in Cairo, N. D. Comanos, asking that all proper official and personal aid be rendered to Gorringe so as to accredit him to the government of the khedive as the officer authorized to receive the obelisk on behalf of the City of New York. Gorringe's only remaining problem was to raise the money necessary to carry out the venture, an endeavor which led him straight into what he termed "almost insurmountable difficulties." At length, a fellow Freemason, and friend of long standing, Louis F. White of New York, offered him sufficient funds to start his operations.

Though neither of the vessels transporting the Paris and the London obelisks had been motored, Gorringe figured the ship that would carry the New York obelisk had to be constructed with her own motive power and be large enough to care for herself under all conditions of weather. But he abandoned the idea when he found that construction of such a vessel around the obelisk would cost the whole amount promised him by Vanderbilt. The alternative was to embark the obelisk on an ordinary ship. Here again, there was no precedent for the loading into a steamship such an enormous weight. The largest and heaviest masses yet placed intact in a steamship's hold

Gorringe's sketch indicating how to place an obelisk within the hold of a ship



had been some 100-ton guns made in England for shipment to Italy. As the obelisk could not be carried on deck without specially strengthening the vessel, at great expense, the only place for it was in the hold below the waterline. How to get the obelisk into the hold was the problem.

Gorringe's plan called for embarking the monument into the steel hull of a steamer through an aperture made in the bow, as Lebas had done at Luxor. But when he and Schroeder searched for a suitable American vessel, they could find none.

On August 24, 1879, Gorringe and Schroeder sailed for England on the *Arizona*, reaching Liverpool eleven days later. There they spent two weeks searching for a suitable English steamer to charter; again, none was available. The rates quoted for a charter were equivalent to the cost of purchase. So the naval officers decided to go ahead to Alexandria and prepare the obelisk in the hope of finding a suitable ship when and if the time came to load it.

From England they traveled through France and Italy to Trieste, still part of the Austro-Hungarian Empire, with the intention of buying timber for felling the needle. There they were told they could purchase timber just as cheaply in Alexandria, whither they sailed from Venice on the S.S. *Ceylon*.

Arriving in Alexandria on October 16, they found a great agitation had been started among the foreign residents to prevent the removal of the obelisk. A howl had gone up when the news leaked out that some Americans proposed to remove the needle. Violently abusive articles appeared in the press; meetings were held and petitions to the khedive were circulated for signature. Threats of personal violence were made, openly and by letter, against anyone who would attempt to start work on the removal of the obelisk.

Egypt was no longer the country it had been under Mohammed Ali or under his son Said Mohammed, or even under his grandson Ismail Pasha, who had been forced three months earlier to abdicate and retire to exile in a palace on the Bosporus, where he remained a state prisoner of the sultan; because of his wildly extravagant expenditures and the debts he could not repay, the Great Powers had seized the opportunity to intervene in Egypt and establish a joint Anglo-French control commission.

As Alfred Milner puts it in his *England in Egypt*, trying to take some of the blame off Ismail: a series of unfortunate conditions had been necessary for Ismail's personality to become "as pernicious to his country" as it did. "It needed," says the historian, "a nation of submissive slaves, not only bereft of any vestige of liberal institutions, but devoid of the slightest spark of the spirit of liberty. It needed a bureaucracy which it would have been hard to equal for its combination of cowardice and corruption. It needed a whole gang of swindlers—mostly European—by whom Ismail was surrounded."

Gorringe was amazed by all the clamor over an obelisk which, until his arrival, nobody had bothered about in the least, even to the extent of preventing its defacement and the accumulation of offal around it. Two men had been allowed to make a business of breaking off pieces from the sharp edges of the shaft and from the edges of the intaglioed hieroglyphs to sell to relic hunters. It would not have been impossible, said Gorringe, for anything to have been more neglected and less appreciated by the residents of Alexandria and the tourists who passed through the city en route to the Nile, than was the Alexandrian obelisk. "The disagreeable odors and clamors for backsheesh hastened the departure of strangers," said Gorringe, "and they rarely devoted more than a few seconds to its examination."

As soon as the two American naval officers had established themselves in apartments in Alexandria, near the site of the obelisk, they set off for Cairo accompanied by vice-consul Comanos to obtain an audience with the new khedive, Tewfik Pasha, Ismail's son by a simple *fellah* woman. Tewfik received Gorringe and Schroeder very cordially and inquired about their plans for transporting the obelisk, cautiously expressing the hope that it would not be taken down unless they were sure of being able to remove it. To speed up such an operation, he gave them an order to the governor of Alexandria, requesting him to formally deliver to them the obelisk on condition they be charged with all expenses incurred in its removal.

Unlike his brothers, Tewfik Pasha, had not been educated in Europe, and was so displeased with the news of his succession to the viceregency of Egypt he beat up the servant who brought him the message.

Gorringe took the first train back to Alexandria and presented the order to Governor Sulficar Pasha. Within three days a formal transfer of ownership was accomplished. To the protests and petitions from the European consuls and other resident foreigners to prevent the transfer, the khedive and his ministers replied: "Too late. Cleopatra's Needle is in the possession of the United States Officer sent to receive it."

The foreign residents now attempted to physically prevent Gorringe from removing the obelisk. When a force of laborers started clearing away the ground around the base of the obelisk on October 27, an individual arrived and ordered the work stopped. He claimed to Gorringe to be the owner of the ground on which the obelisk stood, and said that if work continued, he would apply to the Italian consul, whose janissaries would be sent to forcibly eject the Americans and their employees from the premises.

Gorringe immediately fetched the American vice-consul, and together they called on the Italian consul, who informed Gorringe that any Italian subject occupying a property which belonged to him had the right to the Italian consul's protection, if necessary by the armed force of the Ottoman sultan's janissaries. The owner, explained the Italian consul, had been given authority by Mohammed Ali to build a bathing establishment by the seashore near the obelisk, but his property had been destroyed by the sea during a gale. Claiming compensation from the Egyptian government, the Italian had commandeered the land around the obelisk and built on it a shanty as insurance against losing his case.

Gorringe discovered that the claim had indeed been pending since the international courts had been organized in Egypt for the trial of cases between foreigners and the Egyptian government, and between individuals of different nationalities. But so absurd was the claim, it had never been placed on the docket, and was only kept current at the insistence of the Italian consul. To remedy the situation, Gorringe notified the Italian consul general that he would institute a suit for £15,000 against anyone who attempted to interfere with his work of removing the obelisk, and limited the time to four o'clock that afternoon for an amicable acceptance of his proposition to rent the ground.

There were some surprised Italians, but their consul shortly thereafter informed the American consular agents that the Italian claimant had accepted Gorringe's offer to lease the land, and proposed the appointment of arbitrators to fix a suitable sum. Before nightfall the lease was effected.

On the morning of October 29, a hundred Arabs, varying from ten to seventy years of age, began work, divided into three gangs. The middle-aged dug and filled baskets; the old lifted them to the backs of the young; these carried them to the shore and emptied them into the surf. This hivelike activity continued for a week until 1,730 cubic yards had been removed. The pedestal and steps to the obelisk had been cleared, and enough space created in which to construct a caisson to transport the obelisk to the port for embarkation.

Demolishing the foundations under the obelisk, without blasting, was difficult, as the cement had set to an unexpected degree. But as soon as it was broken up, the pedestal steps were moved out from under the obelisk. To raise the pedestal clear of the steps, steel wedges were driven under it until there was room enough for the end of a bent steel bar to be inserted. Hydraulic pumps acting on the upper part of this bar raised the pedestal clear of the steps and held it suspended until channel irons and cannonballs could be placed beneath it to move it with greater ease.

When Gorringe found the bottom of the lower step below the pedestal to be nearly at mean sea level, he felt certain that the foundation could not have sunk so nearly uniformly, and that a subsidence of the ground of about 17 feet must have occurred since the obelisk had been erected nineteen hundred years earlier. The sea had gradually approached the site of the obelisk, and the constant washings of the surf had begun to affect the foundation. For some fifteen years the obelisk had been inclining gradually toward the sea, leading Gorringe to the conclusion that in a few years it would have fallen, doubtless breaking.

At some point in its history, all four edges of the base of the obelisk had been broken away, and four bronze crabs, shaped like sea crabs, had been inserted at the corners, the better to support it. Only two crabs remained; the others had long since been stolen by thieves who inserted stone blocks in their place.

While the excavations were still in progress, another attempt was made to prevent removal of the obelisk. A creditor of the Egyptian government applied through the international court to seize the obelisk and keep possession of it until his claim was paid. Gorringe realized that the entire proceeding was simply aimed at stopping his work, getting the obelisk under the jurisdiction of the court, and keeping the case pending until his attempt to remove it had been abandoned. So he raised the American flag atop the obelisk and, in his words, "prepared the means of defending it in a manner that carried conviction." When the court was advised that the American was taking no notice of the writ, and intended to use resistance against anyone who tried to take possession of the obelisk, it withheld the writ.

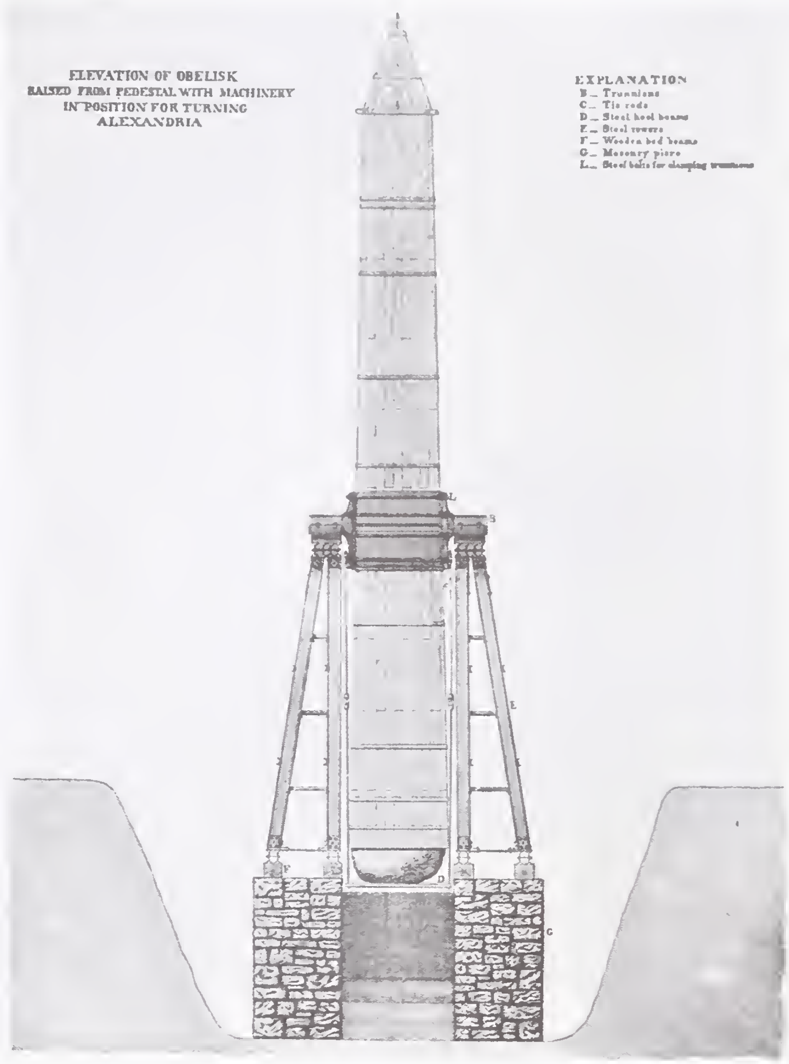
No sooner had this affair quieted, when some of the consuls general in Cairo, at the instigation of resident European archaeologists, again attempted to have the work suspended, so that the matter could be referred to their various governments, arguing that by the terms of a convention entered into by several powers, the Egyptian government had agreed to prevent the exportation of any object of antiquity. Gorringe met the threat by pointing out that no attention had been paid to this convention when the English had removed their obelisk, and that the consuls and archaeologists themselves were constantly shipping articles to Europe. To clinch his argument, he showed that the Ottoman *firman* which gave legal assistance to the Egyptian government stipulated that Egypt should not make treaties with foreign powers, and that therefore the convention was without legal basis. But fearing that pressure might be put on the khedive or his ministers, Gorringe negotiated through a prominent and powerful pasha in Constantinople, whom he had befriended, to ensure prompt confirmation of the gift of the obelisk from the Ottoman Porte, if such a *démarche* became necessary.

More determined that ever, Gorringe now set his men to work day and night, to get the obelisk off its pedestal. The material and machinery for removing the obelisk had been shipped from New York via Liverpool and arrived on November 11. But there was no truck in Alexandria suitable to transport the great trunnions, or truncated arms, like those of a cannon, on which the obelisk was to be turned from a vertical to a horizontal position. Placed on the only vast truck available, the heavy trunnions were hauled to the site by a gang of Arabs on the Christian sabbath—when there was less traffic on the narrow streets of Alexandria—for which effort an American missionary roundly abused Gorringe and his Arab workers from a borrowed pulpit, denouncing the holiday removal of the obelisk as the work of the devil. As Gorringe described the situation, the Arab Mohammedans spent their sabbath, or Friday, in a rational manner, sleeping during

Machinery and trunnions designed by Gorringe for raising and turning the obelisk

the morning, attending services at the mosque at noon, and devoting their afternoons to social intercourse and amusement. The Christians, almost to a man, said Gorringe, "would devote the thirty-six hours from Saturday evening to Monday morning drinking, gambling, fighting, and other excesses, and return to work drunk, sleepy and bruised."

Before the obelisk could be turned, timber had to be provided onto which it could be lowered. As the Egyptian prime minister, Riaz Pasha, had ordered the governor of Alexandria to offer Gorringe the same assistance in removing the obelisk as had been offered the British, Gorringe was convinced he was to have the use of the timbers which had been left by the British, still in a government warehouse. But the officer in charge, a European, was against the removal, and managed to evade the order. The only alternative was to buy some soft planking at the exorbitant price of $4,300.



The obelisk raised sufficiently to remove the bronze crabs securing it to the base

On December 2, the turning structure was placed in position. Three days later the obelisk was lifted clear of the pedestal, and the heavy bronze crabs removed. Rumors had been circulating that a demonstration by the foreign residents was to take place when the obelisk was turned horizontal in the presence of the governor of Alexandria. But Gorringe had found a friend, and fellow Mason, in Rear Admiral Aslambekoff, of the Russian Imperial Navy, who, from aboard his flagship, the *Qminim,* in the port of Alexandria, promptly landed a large force of unarmed but trained seamen to form a cordon around the obelisk.

On December 6, the day set for the turning, large crowds of Greeks, Italians, and other Europeans gathered in the vicinity, becoming noisy and unruly when they were prevented by the Russians from entering the cordoned-off enclosure. The moment the obelisk began to move there was absolute stillness; the only sound came from the

rendering of the ropes around the posts and an occasional creak of the structure as the point of the obelisk slowly described an arc. All seemed in order when a very loud crack occurred, followed by an even sharper snap. One of the tackles had parted. Gorringe gave the order to slack the other tackle, to retard the motion but not arrest it. Instead of slackening his line, the man attending the fall "lost his wits," held fast, and the second tackle snapped.

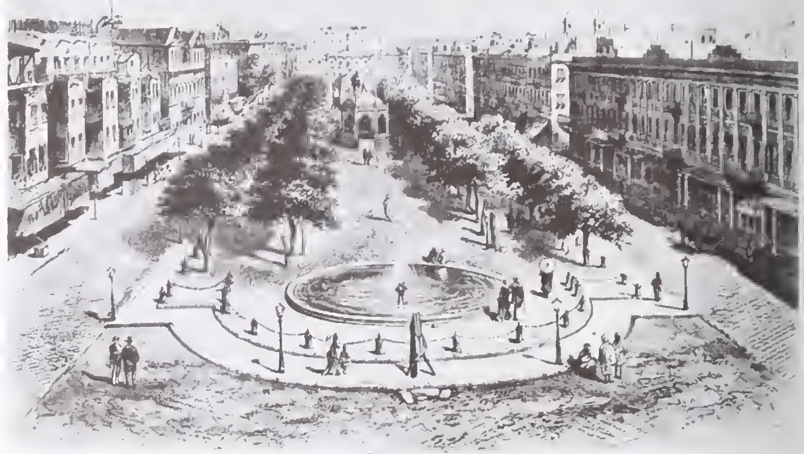
The obelisk, moving slowly at first, gathered speed. There was intense excitement. The Arabs and Greeks around the base began to flee. An ear-splitting sound reechoed, and the obelisk heavily struck the stack of timbers, splintering three courses of balks, and rebounded twice, finally coming to rest in an almost horizontal position. By some miracle the needle was intact. The Alexandrian crowd, giving vent to what Gorringe called its first manifestation of friendliness, raised a loud cheer.

Shattered timbers break the fall and preserve the needle.

The man attending the first tackle explained that having looked up to see what had caused the noise, he had involuntarily checked the passage of the rope through his hands. This brought the whole strain onto his tackle, causing it to break. The man on the second tackle, unaware of the accident until he saw his companion flee precipitously from the obelisk, excusably, said Gorringe, lost his self-control, and down went the obelisk.

As soon as the weight had been transferred to the stacks of lumber the towers and trunnions were removed, and demolition of the piers gradually began in order to lower the obelisk 43 feet to ground level, at the rate of 3 feet a day. An iron truss cradle which moved on cannon balls had been specially designed and made in the United States to transport the monolith overland to the port of embarkation. This distance was less than a mile, and the route was over comparatively unfrequented streets, except for a short stretch across what had once been the ancient causeway connecting Eunostos island with the mainland, now the most important part of the city.

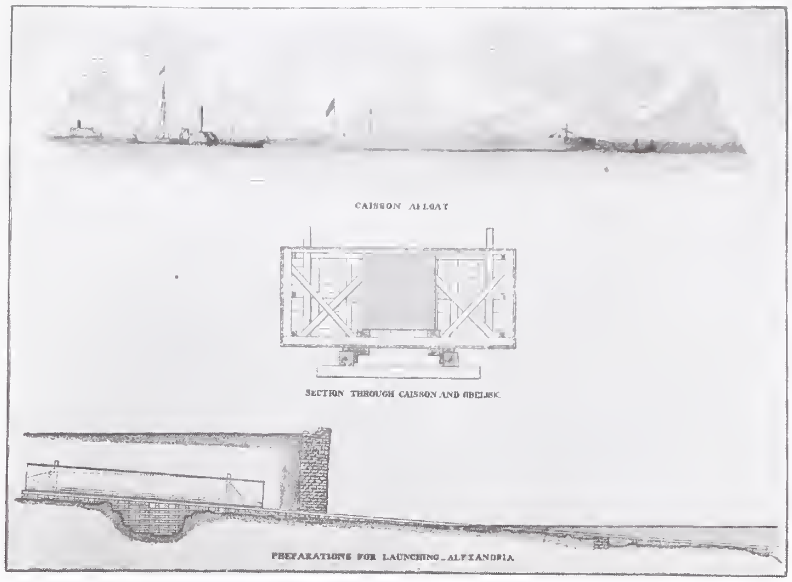
The foreign merchants were determined not to allow the obelisk to be moved through the city, using the excuse that it might crush the sewers. Gorringe's guarantees of repairing all damage were of no avail. Nor could the


The streets of Alexandria

Egyptian government intervene and overrule the foreigners. In return for keeping the streets paved and clean, the government had transferred control of the streets to the foreign merchants.

The alternative method, sea transport in a wooden caisson—covering a distance of 10 miles—was expensive and very dangerous. The transportation cradle, which had cost $5,100, became a dead loss and had to be thrown away. The cost of constructing the caisson was another $2,200. But preparations for launching a caisson over a shallow bank still encumbered with heavy blocks of marble and granite was even more expensive. Despite the passage cleared by Dixon, the submerged foundations of the famous palaces of Alexandria were still directly in the way. These obstructions could only be removed by divers, a difficult task along an open coast, with the surf breaking two-thirds of the time.

Diving operations, whenever the sea would permit, continued until March 1880, during which time the divers had to be paid whether at work or not. A single day of heavy surf often destroyed the work of diving operations of a whole week. A pier with derricks had to be constructed to lift out the blocks. The estimated weight of material removed, ranging from 3 to 7 tons apiece, was 170 tons. The difference in cost to Gorringe, owing to the refusal of the foreign merchants to allow the obelisk to move overland, was close to $21,000. A wooden caisson 83 feet long, 11 feet deep, 22 feet wide at one end, and 30 feet at the other, was built around the obelisk in order to float it to a dry dock. Inch by inch the caisson was pushed forward till it finally floated. Armed with two keels and two



Much lubricant was used on the ways to facilitate the caisson sliding into the sea, and every precaution was taken against fouling the sliding surfaces, but after the caisson had slid rapidly for 20 feet, it abruptly stopped. As with the *Cleopatra,* a towline was run out to a tug, and two anchors were planted offshore with cables leading to the caisson; but the combined force of the tug and threefold purchases on the cables did not move it an inch, even when a pressure of 100 tons was exerted. The cause was found to be a foreign body, washed in by a heavy sea, which had stripped the sliding ways.

The wind turned to a gale, and the waves threatened to break the caisson and the obelisk within it. To save the situation, water was let into the caisson. When the seas subsided, water was pumped out and the obelisk, still intact, was floated to Alexandria.

keelsons, the caisson was successfully towed to the port of Alexandria.

Meanwhile, Gorringe had been negotiating for the purchase of an English or Italian steamer, when his attention was attracted by an old tramp, the *Dessoug,* chiefly, as he put it, because of "the fullness of her form and particularly of her low line." Lying dismantled in the Alexandria arsenal, she had been built in England in 1864 and employed in the Egyptian postal service between Alexandria, Smyrna, and Constantinople, until extravagance and corruption in the service had caused her withdrawal. Careful measurements showed that there was just enough room under her lower-deck beams to take into her fore compartment the full length of the obelisk. Though her hull was perfect, her hold, said Gorringe, was filthy, for she had been neglected "to a degree that cannot be imagined." To refit her and repair her, which was to be Schroeder's job, a large expenditure was necessary, which made it essential she be purchased at a low price. To accomplish this, Gorringe decided not to make an offer at once, but to treat the matter with apparent indifference.

Leisurely he commenced negotiations via the assistant postmaster general. After several informal conferences, an offer of £5,000 sterling was made to the postmaster general, who affected, said Gorringe, to regard such an offer as a joke, suggesting that the matter of price be treated seriously; other negotiations, he added, were pending for the purchase of the *Dessoug*. This simply meant that a firm of shipbrokers, who had been trying to charter or sell Gorringe a vessel, when informed of his negotiations for the *Dessoug,* had made an offer to the

Egyptian government in the hope of being bought off by the American. A member of the firm even offered to withdraw if he was paid a commission of 10 percent on the purchase money.

To bring matters quickly to a head, Gorringe informed the postal ministry in Cairo that his own offer would be withdrawn at noon the next day, unless formally accepted before then. Quickly, the Egyptian government accepted the offer of the shipbrokers, but demanded an immediate guarantee of payment. The brokers, who had no use for the vessel except to sell it to Gorringe, offered it to him for £6,000, but were informed that he would not purchase her from them under any circumstances.

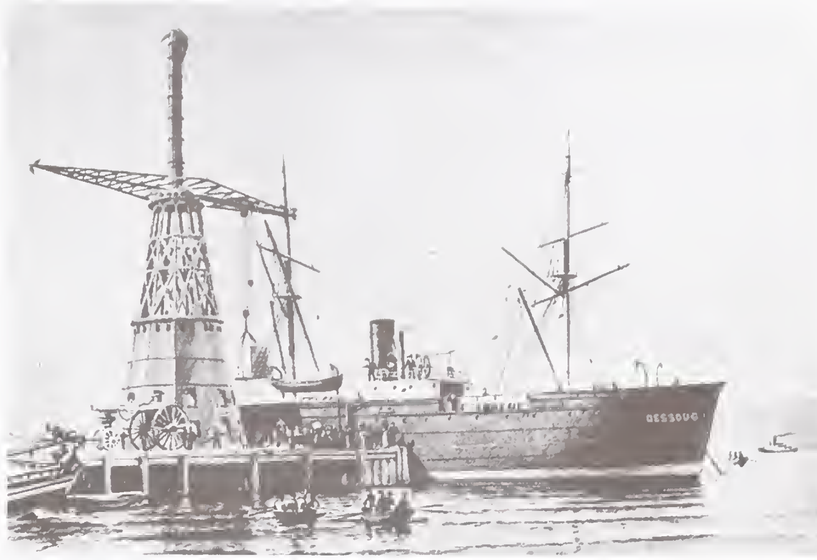
When the brokers could not give the required guarantee, and the time allowed had elapsed, Gorringe was notified by the government that he could have the vessel for £5,100. The money was paid, and the transfer effected on December 3, in the strictest secrecy. This was because another government vessel, laid up in the same arsenal, had been seized, along with the money paid for her, on a warrant issued by the court on behalf of someone who had a claim against the Egyptian government, so that transfer could not be effected from the government to the purchaser.

Legal transfer to Gorringe was quickly effected in the office of the director of postal services, whose representative then went straight aboard the *Dessoug* with Gorringe to haul down the Egyptian flag and raise the United States ensigns on mastheads and peaks in the presence of the amazed Arabs in charge of the vessel. When ordered to gather their personal belongings and leave, the Arabs made no protest, but insisted first on delivering what Gorringe called "formal and fervent prayers."

This was lucky; for Gorringe discovered that a seizure of the *Dessoug* had only failed because of his quick and secret action. A notice in Arabic, Greek, Italian, French, and English was posted on each gangway, prohibiting anyone from coming aboard, at the peril of his life, without permission. "As there was no one to whom I could call for protection," Gorringe wrote, "I was bound to protect my property myself, with all the means in my power." Several boats approached the gangways, but seeing the signs and the welcome Gorringe had prepared for them, no one attempted to board.

One condition of the purchase was that Gorringe be allowed to use the government's floating dock for embarking the obelisk as soon as it was felled. Orders from Prime Minister Riaz Pasha, acting for the nervous khedive, were specific, but when the obelisk and the *Dessoug* were

The *Dessoug* as Gorringe found her



ready to be mated, the Egyptian official who had control of the dock refused to comply, ordering several small river steamers to be hauled into the dry dock instead of the *Dessoug.* Before Gorringe could appeal to Cairo, the official had the dock pumped out and the plates torn off the bottom of the steamers; that way they could no longer be floated, no matter what the ministry ordered. When Gorringe realized that the riverboats could just as easily, and much more cheaply, have been hauled out on shore than into an expensive dry dock, he knew the official had been acting deliberately. He attributed the maneuver to the widespread belief in Alexandria that the obelisk could not be embarked in the manner he proposed, and felt that this had caused the official to speak of the embarkation as if it would entirely destroy the dock, or occupy it to the exclusion of all other business for a long period.

Nearly five weeks passed before the dock was disengaged, but Gorringe did manage to get the caisson slipped in earlier by having the level of dock water altered, which did not affect the small steamers "beyond washing out their filthy holds and destroying some of the vermin for which they are justly celebrated." Even so, the official refused to follow direct orders from Cairo and only let Gorringe enter the caisson on condition that he allow another big ship to dock before the *Dessoug.* To this Gorringe was obliged to agree because the caisson was leaking so badly there was danger of its being sunk by accident or design. As soon as it was in the dock, Gorringe had the caisson demolished, not so much to advance the work of embarkation but to ensure that the obelisk could not be removed from the dock other than aboard the *Dessoug.*

On May 10, 1880, the *Dessoug* entered dry dock. A foreman shipwright was brought from Glasgow expressly to superintend the opening and closing of the hole. Three gangs of thirty Arab boilermakers went to work day and night without intermission. Seven thousand rivets, sixteen frames, and thirty plates had to be removed from the starboard bow to make a hole large enough to admit the obelisk at an angle of 21° to the axis of the keel, the greatest angle at which it could be embarked without having to turn it twice during embarkation.

The caisson had been placed in the dock in just the right position for the shaft of the obelisk to be slid into the *Dessoug* as soon as her hole was readied. Gangs of carpenters were engaged in the difficult job of packing timber under the forward run of the hull, and under the track of the obelisk, to prevent straining the frames. The bed of the track was laid continuously from where the obelisk lay, through the aperture, and into the hold. The

Inserting the obelisk

obelisk was then rolled in on cannon balls. To ensure uniform pressure on the balls, soft wood was packed in between the iron channel and the stone.

It took ten days for these nuptial preparations, and eight hours to consummate the insertion of the obelisk. Almost as soon as the pyramidion had disappeared within the cavity, the last frame was up and riveted again. Inside the hold, a force of the best shipwrights that could be hired in Alexandria shored and stowed the obelisk against the serious danger of its shifting at sea. To obviate the risk of being broken by the inner working of the ship, the obelisk was placed on a bed of Adriatic white pine, very spongy and soft, while 10 feet at the extremities was left without support. When this was done, Gorringe felt that the vessel could be laid on her beam-ends without causing the obelisk to break adrift.

On June 1, three weeks from the day the vessel had entered dry dock, she was floated out with the obelisk within her. It was then necessary to ballast the vessel and load the pedestal and base. The largest of the base steps weighed 7 tons, the smallest nearly a ton. The pedestal itself weighed nearly 50 tons, and had to be placed in the after hatchway, on a special iron frame, to distribute the weight; but the most powerful crane on the quay could only lift 30 tons.

Gorringe decided on a wild gamble. He would try to lift the pedestal with the additional and simultaneous help of an available floating derrick that could lift 25 tons. Slowly the pedestal was raised 30 feet in the air; but just as it was being swung over the hull of the steamer, a sharp sound was heard, and the pedestal began to oscillate. Were the pedestal to fall, it would destroy the vessel, which Gorringe ordered instantly moved. The steel wire with which the pedestal was slung had stranded; only two of the seven strands remained intact. A chain cable was quickly substituted, and the pedestal safely stowed away.

At last, the *Dessoug* could sail; but the nationality of the vessel remained a delicate question to settle. Under the laws of the United States, she could not be registered as an American vessel. Sailing under the Egyptian flag would have involved serious risks. The British or another European flag, according to Gorringe, would have been even more objectionable, especially in terms of the evasion of laws relating to ownership. Finally Gorringe concluded there was no course available but open defiance of the law, which he felt the circumstance warranted. To make the voyage to New York, he determined to sail without registry of nationality, thereby taking the risk of having his

The 50-ton pedestal about to break loose over the stern of the *Dessoug*

steamer seized by any vessel at war, or by the authorities of any port at which he might be obliged to touch. Gibraltar was the only port he intended to call at for coal, and there he had a personal acquaintance with the chief military and naval authorities, whom he felt confident would not examine the ship's papers too closely. Further to lighten the risk, he made arrangements for taking on coal from lighters on the eastern side of the Gibraltar peninsula.

Providing a crew and securing a reasonable rate of insurance for the voyage had been the cause of endless trouble and negotiation from the day the vessel was purchased. By insisting that he would pay no more than a 2-percent premium, or make the voyage without insurance, Gorringe finally got the agents to lower the premium from 25 percent to 5 percent, and finally to 2 percent.

For a crew he was obliged to send to Trieste, and for officers, to England. The second and third officers turned out to be confirmed drunkards. One had to be dismissed to prevent him from killing himself, as he twice fell from the second deck to the hold, and twice overboard while drunk.

The quartermaster, according to Gorringe, would have done credit to a pirate ship. Only the engineer was useful, but hard-drinking. Before the ship was even ready to sail, forty-eight men deserted, convinced that the obelisk would sink at the first touch of weather. As the ship had no nationality, deserters could not be arrested; and without the means of enforcing discipline, the only available method, as Gorringe put it, "was the summary one." To get a full crew, Gorringe sent a power of attorney to a ship's agent in Trieste, stipulating that the next lot arrive in Alexandria only the day the vessel was ready for sea, so they could not back out. With this ruse, Gorringe managed to keep all but three men aboard; but of the lot only four could speak or understand English.

Back from Cairo, where he had rushed to make his personal farewell to the khedive and thank him for having resisted the pressure of foreigners to revoke his father's great gift to the City of New York, Gorringe took command of his unusual charge. On Sunday, June 12, moorings cast, the *Dessoug* steamed slowly out of Alexandria harbor amid a general dipping of colors and the sound of steam whistles and the cheers of the other ships' crews. But could she, Gorringe wondered, cross the Atlantic? Or even the Mediterranean as far as Gibraltar?

At Gibraltar, instead of being seized as a prize, the ship was visited by the governor, Lord Napier of Magdala, and Lady Napier, accompanied by the staff of Government House. Taking on coal and fixing two leaking boilers delayed departure three days, but at midnight on June 25 the *Dessoug* steamed out into the Atlantic. The weather was rough, but all went well till they passed the Azores. Fifteen hundred miles out of New York there was a terrible noise from the engine room and the engines came to an abrupt standstill. The after crankshaft, which had a flaw, had broken in two.

Fortunately Gorringe had had the foresight to place aboard a spare section, obtained at great difficulty as part of the articles of purchase. With all the men available working day and night, the brasses were bored and the shaft reconnected in six days, during which the *Dessoug,* progressing on its sails, covered a little less than 100 miles. To add to this ordeal, the weather turned foul and a waterspout formed to windward, moving directly toward the ship. With too little wind to maneuver, and being without cannons to fire into the spout and break it up, Gorringe realized they were in for a heavy dowsing. All the hatches and skylights were quickly covered, and the bulwark ports opened in the hope of excluding as much water as possible from below. There was a suspenseful five minutes, then the spout changed its course, passing 50 yards to starboard. Had it burst on the *Dessoug*'s deck with its 50-foot column of water, it could have seriously endangered both ship and cargo.

On July 13 the vessel ran into another heavy gale, with high seas that almost completely arrested its progress. Two huge waves did considerable damage to boards and skylights; but a close watch was kept on the obelisk and its fastenings, and no movement was detected.

Steaming ahead as hard as the boilers would allow, the *Dessoug* stood off Fire Island on July 19, where, by a prearranged signal, her position was reported to New York. At 2:00 A.M. on July 20, she anchored off Staten Island, at the quarantine station, and after having been granted pratique, or permission to communicate with shore, moved up the Hudson to moor off Twenty-third Street.

There now occurred, on a smaller scale, the same "battle of the sites" which had taken place in London. Before leaving New York, Gorringe had consulted with William Hulbert and F. E. Church as to William Vanderbilt's preference for a location. All had expressed a preference for the area of Central Park near the Metropolitan Museum, rather than the other favored sites, which were the circle at the intersection of Fifth Avenue and Fifty-ninth Street, and the southwest entrance to the park, the chief objection to these sites being the fear that the monument would be lost among the tall buildings surrounding it. On July 27 it was decided that the obelisk would be erected on the top of Graywacke Knoll, in the park by the Metropolitan Museum, one of the highest points on Manhattan, in the midst of pretty drives and walks. To avoid further needless discussion, strict secrecy was maintained about the choice.

Gorringe would have liked to land the obelisk from the East River, within easier reach of the knoll, but the strong tidal currents and the short intervals of slack water made this impossible. The best landing he could find for the obelisk was at the foot of Ninety-first Street and the North River; but first he had to land the pedestal, and as it was impossible to move it by truck over the roadway of this street, the *Dessoug* was first moored along the wharf at the foot of Fifty-first Street, where a derrick was able to land the pedestal with a speed strongly in contrast with its embarkation at Alexandria.

This was the largest and heaviest stone on record (with the exception of the obelisk itself) ever to have been

moved on wheels through the City of New York. Thirty-two horses in sixteen pairs were attached to the truck for hauling; the first forward impetus was given by hydraulic pumps applied to the tires of the rear wheels, and as soon as the truck was in motion, the horses were started and kept going at a slow trot. But the weight was too great; the wheels sank into the pavements. When this occurred, the slings which bound the pedestal were slackened until the truck was released and timbers could be slid on the pavement beneath the wheels.

The route to be followed was along Fifty-first Street to Fifth Avenue and up to the East Eighty-second Street entrance to the park. From there to the site, the pedestal was successfully moved on greased skids, just as it had been originally in Egypt. But there it came to a rest. No action had been taken by the Department of Parks to prepare the knoll for the foundation. Four laborers from the department had merely removed the young trees to clear away the surface. A few days later their work was even suspended without apparent reason. Gorringe complained that it was the invariable custom for the department to prepare foundations for the reception of monuments and statuary contributed by individuals for the adornment of the city, and that in this case the custom was being violated.

Anxious to get the foundation prepared before winter, Gorringe decided to go ahead on his own and sought from the department almost daily the requisite authority to proceed with the work at his own expense. This was withheld for several weeks, and only granted under onerous conditions that involved a large increase in the cost of the work. Political and religious bias had evidently been behind this attempt at sabotaging what was seen to be an enterprise designed to enhance Masonic prestige in the city. But the delay could not be extended indefinitely, and by the beginning of October the earth was removed from the top of the knoll, the surface of the granite leveled and the cavities filled in with cement. Over this a thin layer of concrete was laid and the foundation replaced, so that it stood exactly as it had in Alexandria, each piece in the same relative position to the others, and to the points of the compass.

There only remained the 7-ton syenite base which was reserved for the Masonic ceremonies, this being the last piece to be placed before the 50-ton pedestal was moved into position. The Most Worshipful Jesse B. Anthony, Grand Master of Masons in the state of New York, was invited to lay the "corner-stone," and, after consultation with the commissioner of parks, fixed October 9 as the date.

On that morning nearly nine thousand Freemasons paraded past an estimated thirty thousand New Yorkers lining the sidewalks between Fifteenth Street and Eighty-second Street. Each commanderie of Masons was headed by a band. At the entrance to the park, the crowd grew more dense, and in the park itself it was so great that policemen were unable to keep spectators out of the spaces reserved for the ceremonies. The column of Masons, having marched to the base of the pedestal, opened ranks three deep and faced in.

The line extended all the way to Sixtieth Street, where the Grand Master and the Grand Lodge officers left their carriages and marched through the line to the platform on the Graywacke Knoll, followed by the Masters and Wardens of the lodges. The ranks were closed, and the commanderies were massed on the west side and the lodges on the north and east sides, while the south side was crowded with spectators, some occupying as a vantage point the great pedestal at the foot of the knoll.

When order had been obtained, the Grand Master addressed the brethren: "This monument in its associations brings forcibly before us that period of which at present we know so little and of which the researches of the scholar, the calculation of the astronomer, the study of the rocks by geologist, and the skill of the engineer, are each year adding to our information and startling us with wonderful results. This trophy comes from that land the history of which was long lost in the mist and obscurities of ancient fable and tradition,—a land of wonderful creations of human power and genius, that has been, and long will continue to be, a place of interest and curiosity to the learned."

Looking up into the gray autumn sky, the Grand Master continued: "The Egyptians were the first to have observed

Jesse B. Anthony, Most Worshipful Grand Master of Masons of the State of New York, laying the cornerstone of the future monument

the course of the planets, observations which led them to regulate the year from the course of the sun." He then suggested that the great pyramids which were believed to have been constructed as tombs might also have been designed for astronomical purposes. He attributed to the ancient Egyptian priesthood, twenty-five hundred years before Christ, knowledge of the precession of the equinoxes and the ability to predict with certainty the position of stars over periods of thousands of years.

As the Masonic marshals kept order in the crowd, the Grand Master continued: "Egypt itself is a book of history,—one of God's great monumental records, on the face of which He has written with His own hand many of the strange events of the past. It was the birthplace of literature, the cradle of science and art, the garden and garner of the world. The people of those days excelled in many respects the advanced growth of the present century. Could we but know that which time will yet unveil, we should be astonished at the revelation and ashamed of our littleness."

Pausing to survey the multitude, he asked: "Should we not take a broader ground and look to the principles which antedate the time assumed for the origin of Masonry as at present constituted? There can be no question but that in the secret societies of Egypt are to be found some elements now embraced in the principles or symbolism of Masonry of the present. . . ." Then with full Masonic rites the Grand Master laid the cornerstone.

All that now remained was to disembark and raise the obelisk. Ever since Gorringe had docked in New York, he had been occupied with the problem of getting the obelisk ashore. Unfortunately the owners of the docks had also discovered this fact. On opening negotiations with their representative, it became evident to Gorringe that as the dock owners had the right to fix whatever price they pleased and make their own conditions for the use of their property, they were going to dictate their own terms without regard to the customary charges. In fact, they fixed a price far in excess of that charged for other steamers, and made Gorringe give security for any injury to their property that might result from disembarking such a load.

Gorringe offered the owners the same rates paid by other steamers, and proposed the appointment of a commission of experts to watch the operation of disembarking the obelisk and decide what amount of damages, if any, should be paid them resulting therefrom. The dock owners answered that unless he accepted their terms and conditions *at once,* they would not agree to take the *Dessoug* into the dock at any fixed rate, according to turn, but would leave the disembarkation of the obelisk till some time when there was no immediate demand for the facilities. Without replying, Gorringe left the office, determined to devise some other plan for disembarking the obelisk.

At first he thought of taking the *Dessoug* to Philadelphia or Baltimore, disembarking the obelisk in the spacious dry dock in either of those cities, and bringing it to New York on floats by canal. But negotiations with the dry-dock owners and their representatives developed the same feeling as in New York about extra charges. Besides, Gorringe realized there would have been no end to obstacles in connection with the Customs authorities and navigation laws. The *Dessoug* had neither register nor nationality, and could not legally leave the port of New York.

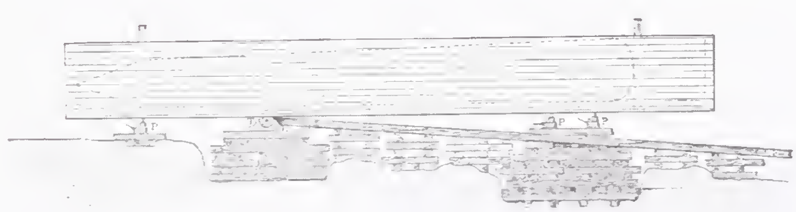
Gorringe next planned the construction of a marine railway at the foot of Ninety-sixth Street, where the obelisk could be landed directly onto Manhattan island.

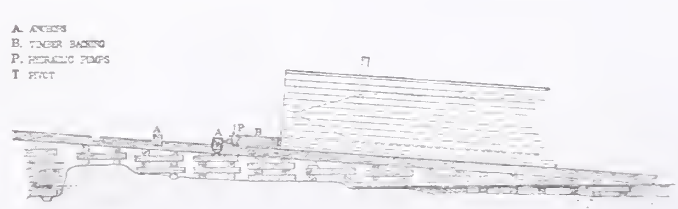
But this was found to be impracticable because of the Hudson River Railway, which skirted the shore, and because of the abrupt decrease in the water's depth close to the riverbank. The Dock Department insisted that the structure be removed entirely and the piles pulled out after the disembarkation of the obelisk, which would have cost almost as much as building it.

Having almost despaired of being able to accomplish his object without yielding to the demands of the dock company, Gorringe reached a solution which he summed up in one word: *tide.* He determined to make the rising tide lift the obelisk onto any available marine railway, and the falling tide land it. There would thus be no lack of power, and no need of a dry dock.

Before communicating his plans to anyone, Gorringe visited incognito all the marine railways on the shores of New York bay, and fixed on a new one at Staten Island as the best adapted to his purpose. The proprietor had no knowledge of his plans until the terms of an agreement had been entered into for the occupation of his ship. When everything was satisfactorily arranged, only the *Dessoug*'s bow was hauled out of water on August 21 on the east shore of Staten Island while iron shipwrights worked at opening a hole in it.

News that the obelisk was to be disembarked on the morning of September 16 brought to Staten Island a crowd of spectators who occupied every available spot from which to view the work. The weather being favorable, pontoons were pumped out at low water and adjusted to their proper position under the obelisk. The rising tide caused them to gradually raise the cross-timbers clear of





Front and side elevation of the pontoon for floating the obelisk ashore the capping on the piles until the weight of the obelisk had been transferred from the stage. At high water, 4:00 P.M., they were hauled out of the ship into the bay, bearing the obelisk on their decks.

At the foot of Ninety-sixth Street, a landing stage had been prepared for the obelisk, identical in principle to the one at Staten Island. The steamer *Manhattan,* belonging to the Dock Department of the city, was in readiness to tow the pontoons from Staten Island. The steamer *Rescue* of the Coast Wrecking Company stood in attendance to escort it. The time of high water at the foot of Ninety-sixth Street was about two hours later than at Staten Island. The distance was 12 miles. At 4:55 P.M. the *Manhattan* started ahead with the pontoons in tow. As she proceeded up the bay, tugs and steamers diverged from their course to greet the strange object with vigorous and prolonged blasts of their steam whistles. The obelisk reached the landing stage at Ninety-sixth Street at 7:15 P.M. The evening was very dark, and it was difficult to adjust the pontoons between the rows of piles. After one or two failures, owing to the swiftly running tide, the job was finally accomplished. As soon as the pontoons were in position their valves were opened to admit water, and in a few minutes the obelisk had been landed on Manhattan.

The next hurdle was the Hudson River Railway tracks skirting the riverbank, which carried passenger trains at frequent intervals, the longest time between trains being only an hour and a half at noon. To have blocked the road for more than two or three hours would have involved serious loss and much inconvenience to travelers. Orders were given by the railway officials to stop all trains at

Disembarking the obelisk from the *Dessoug*

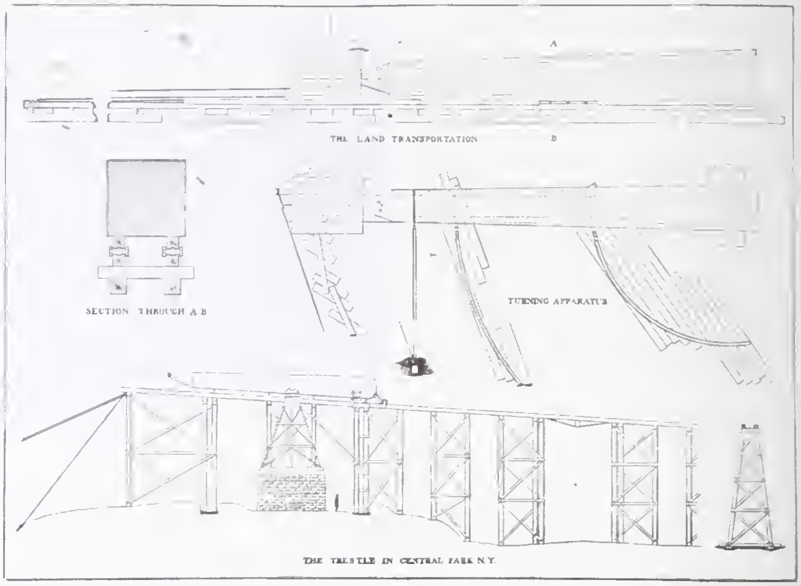
Crossing the Hudson River Railroad

11:00 A.M. Immediately after the passage of the last train, a temporary bridge was thrown across the track and in one hour and twenty minutes the obelisk was resting on the roadway of Ninety-sixth Street. One freight train had been delayed twenty-five minutes. The regular passenger trains were not delayed at all.

Gorringe first tried rolling the obelisk on cannon balls in iron channels, but the channels crushed under the weight, and he could find no economic way to reinforce them. So he reverted to the ordinary cradle, rollers, and track of a marine railway. The traction to be overcome averaged 38 tons—that is, the strain on the purchase was equal to a lift of 38 tons before inertia and friction could be overcome. To keep the cradle from slipping back in case the rope or anything connected with the pulling purchase should give way, men were stationed in the rear of the obelisk with large iron wedges, held close against the rollers. The least retrograde movement could be caught by the points of the wedges, and the weight of the large end of the obelisk would then act as a brake.

Rainy weather, difficulty in finding suitable men, and other varied factors delayed the work, and the obelisk did not reach West Boulevard until October 27. A heavy fall of snow on December 28, followed by intense cold, delayed the operation of hauling the obelisk into its trestle. It wasn't till January 5, 1881, that the center of gravity was placed directly over the axis of the pedestal and foundation, and the tedious land journey was completed. In the end it had taken 112 days to travel the 10,905 feet to the knoll in Central Park, at the rate of about 97 feet a day.

On January 15 the obelisk was lowered from the trestle by hydraulic pumps until its entire weight rested on trunnions in the turning structure. When tested, the obelisk turned easily in either direction. As the bottom of the obelisk was imperfect from injuries received in ancient



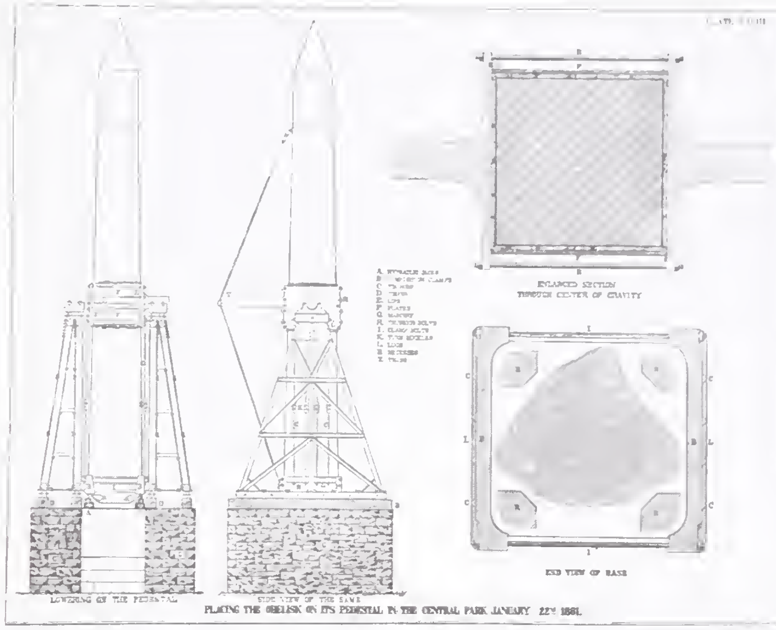
Gorringe's plan for land transportation

Trestle crossing the main drive in Central Park

times, and not more than two-thirds of its area would come in contact with the pedestal, Gorringe decided to give it maximum stability by supporting its corners with four bronze crabs exactly like the ones used by the Romans. These were cast at Gorringe's own expense from plaster models of the originals by a sculptor, Theodor Baur, who endeavored to make them as nearly as possible the same as the crabs cast by the Romans nineteen centuries earlier, and they averaged 922 pounds each. More than merely ornamental, they gave the obelisk an added bearing surface on the pedestal so that it would require a severe earthquake to budge it.

On January 22, long before the hour fixed for turning the obelisk, spectators occupied every available space in the park and its vicinity from which a good view could be obtained. In spite of the piercing cold wind and thick bed of snow that lay on the ground, Gorringe noted that ladies formed at least half of the estimated ten thousand per-

Machinery for placing the obelisk on its base on February 22, 1881



sons who came to witness the erection. A cordon of park keepers encircled the immediate vicinity of the site, and with difficulty kept the crowd from encroaching within the space reserved for workmen. A platform had been raised on the north side of this space to accommodate distinguished persons and officials, guarded by a battalion of sailors and marines from the Brooklyn Navy Yard, who arrived at the park a little before noon, headed by the Marine band.

Five thousand cards had been issued as a souvenir of the event, bearing on one side a picture of the obelisk as it had stood in Alexandria, and on the other an announcement that it would be placed on its pedestal in Central Park at noon. The mayor, the aldermen, and other officers of the city, many of the civil and judicial officers of the state, many civil, judicial, army, and navy officers of the United States, nearly all of the foreign consuls residing in New York, a large delegation of the members of the Grand Lodge, almost all the members of the Anglo-Saxon Lodge in a body, and a large number of distinguished citizens and professional men, accompanied by their wives and families, crowded onto the platform. A few minutes before noon the Honorable William M. Evarts, secretary of state, the Honorable Nathan Goff, Jr., secretary of the navy, and Mr. William Henry Hulbert, editor of the *New York World,* drove up to the foot of Graywacke Knoll, and took positions reserved for them on the platform.

As Fontana had instructed the workmen in Saint Peter's Square, the men now handling the raising tackle and those handling the withholding tackle had been told, respectively, to haul and slack away only when Gorringe held up his hand, and for as long as it was held up, and to stop as soon as he lowered it.

After a moment's conversation with Evarts, the signal was given, and 220 tons of obelisk slowly turned, while the spectators preserved a silence that was almost unnatural. When the obelisk reached an angle of 45°, Gorringe gave the signal to stop so that it could be photographed. This broke the spell, and when the obelisk resumed its motion, a loud cheer went up which was prolonged until the shaft stood erect, and the Marine band played national airs while the sailors presented arms. Only five minutes after the first signal was given, the obelisk was vertical on its pedestal. Congratulations followed, and the spectators dispersed.

Turning the obelisk

A number of lead boxes of different shapes and sizes had been prepared to fit into available spaces enclosed by the steps to the base, and into these were placed articles contributed by the various government departments in Washington and by individuals who considered them suitable relics of nineteenth-century civilization in America, such as the *Congressional Directory* for 1880. The Treasury Department sent a full set of medals of U.S. presidents, plus a full set of silver and minor coinage for the year 1880. The Department of the Interior contributed such enlightening items as the *Report of the Commission of Education* for 1877. The War Department sent along the weather record for July, as well as the general orders announcing the death of General Myer. The Navy Department outdid itself with silver medals commemorating its victories in the War of 1812, and a model of an improved anchor.

Gorringe tried to secure a complete system of the newly invented Bell telephone, but failed. When he asked a representative of the American Bible Society to contribute editions of the New Testament, or any part of it, in all the ancient and modern languages and dialects into which it had been translated and published, he was referred to a bookstore where he could buy them. He did; and they were carefully deposited in a lead case, where he hoped "they would be preserved for an indefinite period." To fill vacant spaces in the boxes, a variety of books were inserted, such as *Webster's Unabridged Dictionary,* the works of William Shakespeare, a New York City directory, a map of the city, the *Nautical Almanac, Hayden's Dictionary of Dates,* Wilkinson's *Egypt,* an *Encyclopedia of Mechanics and Engineering,* and a *Compendium of Electricity and Magnetism,* unaware that the ancient Egyptians might have already encoded such secrets in the dimensions of the obelisk.

Fifteen months had elapsed from the day the work of removal had begun in Alexandria. During that time the obelisk had traveled 5,380 miles by water, and 11,520 feet by land; it had been lowered 39 feet, and lifted 230. The expenses, much exceeding the original estimate, ultimately amounted to $102,576. But Gorringe was relieved that his work had been completed with no accident or incident to spoil its success.

The ceremony of formally presenting the obelisk to New York City was fixed for February 22, and the use of the grand hall of the Metropolitan Museum nearby was tendered by the trustees. From noon on, not a train on either of the elevated tracks, nor a car on the several street railways, went uptown that wasn't loaded with passengers. By 2:00 P.M. an estimated twenty thousand people were in Central Park between Graywacke Knoll and the museum, filling all the adjacent walks and drives.

At 2:10 the doors leading to the museum were opened and the holders of tickets were admitted by a platoon of park police specially pressed into service. Gorringe compared it to the crush of a favorite opera night ten times intensified. The mayor, W. R. Grace, was there to receive the gift to the city, seated next to Secretary Evarts, Gorringe, and the president of Columbia University, F.A.P. Barnard. Dr. Crosby, a Protestant minister, began the ceremonies with a prayer somewhat different in tone from that of the Masonic dedication:

"Almighty God, our Heavenly Father, Who hast given to us a goodly heritage in this land of liberty and peace, and hast afforded us opportunity and means for growth in wisdom and knowledge, we desire to lift up our hearts to Thee with Humble and grateful acknowledgment of Thy mercies and to ask for Thy continued favor. We thank Thee for the prosperity of our beloved city, for its health and thrift, for its wealth and enterprise, and for its institutions of charity and education. We thank Thee for the centers of refined culture Thou hast enabled our citizens to establish by which to elevate and enlighten the public mind, and now this day we do give Thee our hearty thanks that Thou hast permitted the enterprise which connects us with an extreme antiquity to be brought to a successful termination; and we pray Thee, most gracious Lord, that those who have been especially instrumental in forwarding this work may be rewarded by seeing its utility, both as an ornament and a teacher among us, adorning the city, while it contrasts our light and privileges with the darkness and tyranny of the older time. We beseech Thee, Almighty God, to accept our petition for Jesus' sake. Amen."

A hymn, which had been adapted to the music of Martin Luther's "Ein' Feste Burg," rang out with greater fidelity to the object of the ceremony:

Great God, to Whom since time began
The world has prayed and striven;
Maker of stars, and earth, and man—
To Thee our praise is given!
Here, by this ancient Sign
Of Thine own Light Divine,
We lift to Thee our eyes,
Thou Dweller of the skies—
Hear us, O God in Heaven!

15. E PLURIBUS UNUM

Masonic lodges were introduced into the American colonies at the time they were being proscribed by Clement XII in 1738. By the beginning of the Revolutionary period, there were lodges in each of the thirteen colonies, including seven Provincial Grand Lodges.

Whether or not the idea for a union of the colonies originated among colonial Freemasons, it was certainly achieved through their leadership. Boston Masons organized the Tea Party at the Green Dragon Tavern, described by Daniel Webster as "the Headquarters of the Revolution" and by the British as "a nest of sedition." Paul Revere was a Master Mason, as was every general officer in the Revolutionary army, starting with Jospeh Warren, Grand Master of the Massachusetts Grand Lodge, the first to die at Bunker Hill. Two thousand more Masons were among officers of all grades, including Catholics and a score of the Jewish faith, such as Colonel Isaac Frank, aide-de-camp to George Washington, and Major Benjamin Nones, on General Lafayette's staff.

Of the fifty-six signers of the Declaration of Independence, some fifty were Masons, as was its prime author, Thomas Jefferson. The same was true of the Constitutional Convention.

In colonial times Freemasonry had been the only institution in which leaders of the different colonies could meet on common ground—Protestant, Catholic, or Jew. Local government differed too widely, from the town-meeting system of Puritan New England to the vestry system of the Southern colonies. In the Lodges men of the most diverse religious and political views, rich and poor, could come together in a spirit of mutual harmony and confidence. Founded on the broad universal principles of the brotherhood of man, the immortality of the soul, and the existence in the universe of a Supreme Architect, the lodge became a sanctuary in which any man, from general to private, could meet on an equal plane—something the princes of the world found hard to tolerate.

As Americans began to rebel against the injustice of George III's government, the lodges became divided into "modern" and "ancient," the former patronized by royal governors and British civil military officers, mostly sympathetic to the Crown; the "ancient," composed primarily of merchants, mechanics, and laborers, was intensely demo-

Drafting the Declaration of Independence

George Washington as a Master Mason

cratic, in favor of independence. With the progress of the war, independent American lodges superseded those of English, Irish, and Scottish jurisdiction.

In Virginia, when the members of Alexandria Lodge No. 22 declared themselves independent of any foreign jurisdiction, they named George Washington as First Master of the Lodge. Washington, at the age of twenty, had been entered on November 4, 1752, as an apprentice Mason in the lodge at Market House in Fredericksburg and nine months later, in his twenty-first year, was raised to the degree of Master. In the midst of hostilities, in 1780, when the idea was suggested at the Grand Lodge of Pennsylvania of creating a Grand Master of all the Grand Lodges formed or to be formed in the United States, George Washington was unanimously elected to fill the post. But the commander in chief, too busy with the war, was obliged to decline.

At last, when peace came, it was the Grand Master of New York's Grand Lodge, Robert Livingston, who administered to Washington his oath of office as first president of the United States. When the cornerstone of the nation's new Capitol was laid on September 18, 1793, the ceremony was performed in concert with the Grand Lodge of

Masons from Lodge 22 parading in Alexandria, Virginia

Maryland and with several lodges under the jurisdiction of Washington's Lodge 22, with the new president clothing himself for the occasion in a Masonic apron and other insignia of the brotherhood.

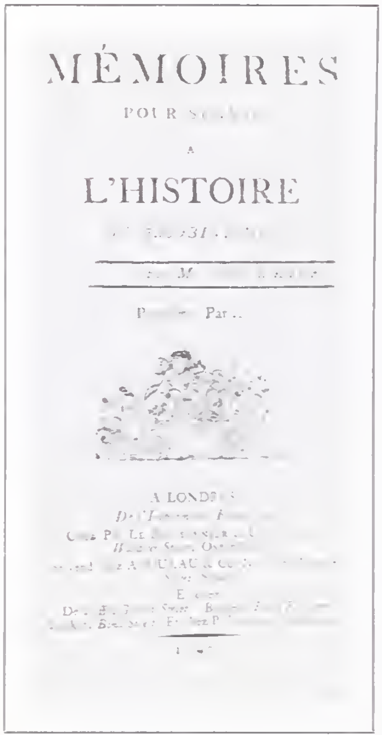
At George Washington's burial on his estate at Mount Vernon, 20 miles south of the District of Columbia, six of the pallbearers and three of the officiating clergymen were brother Masons from Alexandria Lodge 22. And "the mystic funeral rites of masonry" were performed by the new Grand Master of the Lodge, as, one by one, Washington's Masonic brethren cast upon his bier the ritual sprig of acacia, Osirian symbol of the resurrection of the spirit. On the coffin with two crossed swords was placed the Masonic apron specially made for Washington by the Marquise de Lafayette. So it is not surprising that the idea to raise to Washington's memory the greatest Masonic monument in the world, an obelisk of marble to tower majestically 600 feet above the waters of the Potomac, visible from his home in Mount Vernon, should have been conceived in the minds of America's Freemasons.

Within hours of Washington's death, his fellow Mason, Representative John Marshall of Virginia, later the country's first chief justice, rose in the House and moved that a monument be raised to the man "first in war, first in peace, and first in the hearts of his countrymen." Promptly in both Houses a bill was passed to raise $200,000. But no money was appropriated; and for a quarter of a century no step was taken to implement the resolution. Instead, the infant nation, founded on the tenets of the great liberating movement of northern Europe, which aspired to

Obelisk marking Washington's tomb in Mount Vernon, Virginia

religious liberty and the right of every man to worship God according to the dictates of his conscience, found itself swept by tides of religious intolerance almost as deadly as those of the sixteenth century, and the waves of controversy ebbed and flowed around the building of the monument.

The trouble all started in England in 1797, when a reactionary French Jesuit named Augustin Barruel fled to London from the September massacres of the French Revolution and brought out a five-volume opus, *Memoirs pour servir à l'histoire du Jacobinism,* in which he placed the blame for the bloodbath of the Terror squarely on Freemasons, singling out Saint-Germain, Cagliostro, and Weishaupt as the major Masonic villains. Tracing the slogan of "Liberty and Equality" back to the early Templars, Barruel declared that the secret of Masonry *did* consist in those two words, but that "in the higher degrees the twofold principle of liberty and equality is unequivocally explained not only by *war against kings and thrones,* but by *war against Christ and his altars.*"



MÉMOIRES

POUR

A

L'HISTOIRE

A LONDRES

To Barruel, the Jacobins had instituted the Terror as members of a vast plot to overthrow society and religion, the worst villains being Weishaupt's Illuminati, cuckooed into Freemasonry. In his early volumes, Barruel claimed that a formal and systematic conspiracy against all religion had been formed and zealously prosecuted by the encyclopedists Voltaire, d'Alembert, and Diderot, assisted by Frederick II of Prussia. In his third volume Barruel attached the "wickedest anti-Christian conspirators: devoted to atheism, universal anarchy and the destruction of property, boring from within to undermine every government, wishing for the nations of the earth to be directed from their nocturnal clubs." Imagine, wrote Barruel, "thousands of lodge rooms converted into nests of human vipers, men possessing warped intellects with one uncontrollable impulse surging through their arteries—destruction! destruction! destruction!—and you will be getting down to the true cause of the holocaust which drenched the French nation in human blood."

Barruel charged that not only the lower orders of Masonry were duped by Weishaupt, but also those of Weishaupt's own Illuminati, for whom he had provided another top-secret level of direction known as the Aeopagus, a withdrawn circle of directors of the whole order, who alone knew its secret aims. To Barruel, such revolutionary leaders as La Rochefoucauld, Lafayette, and the duc d'Orléans, had become Illuminati agents and dupes of the more extreme radicals such as Danton, provocateurs who sparked the Illuminati-directed rebellion. Barruel further charged that the entire French Masonic establishment had been converted to Weishaupt's revolutionary ideas, its lodges turned into secret committees which planned bloodshed. "Masonic units, dotted by the thousands all over the map of Europe, were thus transformed into places of anarchy, devoted to creating mob violence."

In his fourth and fifth volumes, Barruel went into the minutiae of how the holocaust had been carefully plotted in a secret meeting between Saint-Germain and Cagliostro, who had organized "six hundred thousand masons into a conspiracy with the duc d'Orléans as the chief villain, ambitious to possess the throne of France." Barruel attributed to Saint-Germain, Cagliostro, and Weishaupt the deliberate steering of the Revolution into the Terror. "The power to govern France was vested in the *Comité de Salut Public* composed of three hundred men, all leaders in the Illuminated Order." And, according to Barruel, these same Illuminati had spread to America and infiltrated American Masonry.

Jefferson, after reading one volume of Barruel's *memoirs,* called it "the ravings of a Bedlamite." Historian Vernon Stauffer, more politely dismisses the connection between Illuminati and the French Revolution as "suffering from the fatal defect of lack of historical proof." And John Morris Roberts, in his recent *The Mythology of Secret Societies,* sums up the conclusions of more rational historians: "It is difficult to grasp, let alone understand, the success—and enduring success—of this farrago of nonsense." Not only, says Roberts, does Barruel "mistranscribe and misreport," he is "careless about ideological and doctrinal distinctions. He wrote nonsense about Swedenborg and the Martinists, and he cribs, uncritically, stories which weaken his case in the eyes of anyone who has some acquaintance with the world of which he is writing." And yet, Roberts concludes, almost audibly sighing: "Few objective scholars have dictated the shape of their subject for so long as this unbalanced and indiscriminate priest."

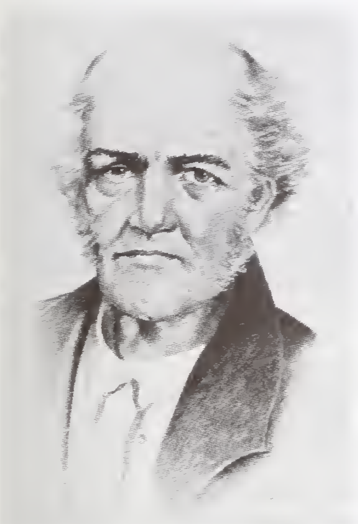
Hardly was Barruel's book off the presses in England when a Scottish Freemason, John Robinson, professor of natural philosophy at the University of Edinburgh, with the excuse that he was anxious to disculpate English Masonry from having been involved in the French Revolution, brought out a sequel echoing Barruel's "data" in *Proofs of Conspiracy Against All the Religions and Governments of Europe, Carried on in the Secret Meetings of Free Masons, Illuminati and Reading Societies*. The book was a quick best seller; with the result that as further editions were brought out in Edinburgh, Dublin, and New York, a wave of anti-Masonic and anti-Illuminist feeling spread across America, carefully enflamed by Barruel's brother Jesuits. Even Washington was accused of having been an Illuminatus, and was obliged publicly to play down his Masonic connections.

President George Washington in the Alexandria Masonic lodge

When, in 1799, a German minister, G. W. Snyder, sent Washington a copy of Robinson's book with the warning that the Illuminati were preparing to "overthrow all government and religion," asking the ex-president to prevent the plan from "corrupting the Bretheren of the English Lodges over which you preside," Washington replied that he had heard "much of the nefarious and dangerous plan and doctrines of the Illuminati, but never saw the book until you were pleased to send it to me." Subtly, Washington added that he wished to "correct an error you have run into, of my presiding over the English Lodges in this country. The fact is, I preside over none, nor have I been in one, more than once or twice, within the last thirty years—I believe notwithstanding, that none of the Lodges in this country are contaminated with the principles ascribed to the society of the Illuminati." All of which was palpably true, though perhaps somewhat sophistical, as the lodges to which Washington belonged after 1776 were not English, but American.

In another letter, written a month later, Washington further corrected Snyder's misunderstanding. "It was not my intention to doubt that the doctrines of the Illuminati, and principles of Jacobinism, had not spread in the United States. On the contrary, no one is more fully satisfied of this fact than I am. The idea that I meant to convey was that I did not believe that the Lodges of Freemasons in *this* country had, as societies, endeavoured to propagate the diabolical tenets of the first, or pernicious principles of the latter, (if they are susceptible of separation). That *individuals of them* may have done it, or that the founder, or instrument employed to found the Democratic societies in the United States, may have had these objects—and actually, in my view, had a separation of the people from their government, is too evident to be questioned.'' And although the next four presidents of the United States were all Masons, an organized surge of anti-Masonic feeling swept the country, threatening the institutions of Masonry and testing the fidelity of its members. To be seen wearing a Masonic emblem meant risking social ostracism.

In these circumstances, the prospect of erecting a Masonic monument to Washington grew dimmer. On January 15, 1824, Representative James Buchanan (later president) proposed that something be done about the 1799 resolution. His proposal was tabled. And even when John Quincy Adams, the first non-Masonic president, reminded the members of Congress of the resolution in December 1825, no action whatsoever was taken.



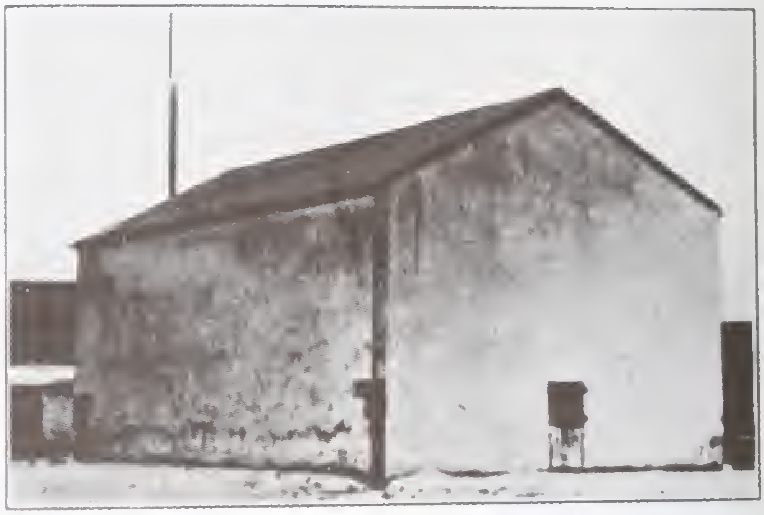
William Morgan

In the country the anti-Masonic movement had increased as there came into being the first third party in American politics, the Anti-Masonic party, which grew rapidly as a result of the hysteria generated by the disappearance in 1826 of a brick mason named William Morgan, little known other than for his penchant for the bottle, and for a dubious past as a Mason. In May 1825 Morgan had been mistakenly exalted to the degree of Royal Arch Mason in Batavia, New York, on the basis of his oath that he had received the earlier necessary degrees in Canada, where the Masonic ritual was somewhat different. But Morgan's drinking habits and his financial looseness aroused suspicion, and when it was established that he had not been initiated into the lower degrees, he was dropped from the order. In revenge, Morgan decided to publish a book containing the ritual secrets of Freemasonry, for which he obtained a contract from a printer of the *Batavia Republican Advocate,* also a former Mason who had failed to advance in his lodge in Albany, and ever since had cherished a grudge against the brotherhood.

As Morgan set to work on his book, keeping the local barrooms advised of his progress, feeling began to run high among Masons that a stop should be put to what they considered Morgan's treachery. News of the intended publication finally roused Masons in New York State to take action, though most counseled that if the book were greeted with silence it might become stillborn.

John Whitney, an ardent New York Mason, incensed by Morgan's behavior, went to Governor De Witt Clinton, Grand Master of New York Masons, but was advised to purchase Morgan's manuscript, for which $1,000 would be made available, and warned to do nothing that might conflict with the law.

On September 11, 1826, Morgan was arrested on a warrant sworn out by a tavern keeper in Canandaigua, New York, and charged with theft. Acquitted, he was re-arrested for a debt of $2.68 and jailed for his inability to pay. On September 12, Morgan was released on payment of the sum by a third party, who, with several companions, drove Morgan away in a coach. Morgan was later traced to Fort Niagara, where he had been confined in an unused military depot. Thereafter he disappeared completely. As



Depressing military depot where Morgan was held captive

a *cause célèbre* for anti-Masonic propaganda, the disappearance was a true bonanza. A great cry was raised, and his abductors were accused of being Masonic murderers, fulfilling their secret oath to dispose of traitors in the most gruesome way. According to formal allegations of the Anti-Masonic party, the ritual manner of inflicting death on traitors among Masons was "cutting the throat and tearing out the tongue, tearing out the heart, severing, quartering and disemboweling the body, and burning the ashes—tearing the breast open, and throwing the heart on a dunghill to rot—smiting the skull off, and exposing the brains to the sun—pulling down the house of the offender, and hanging him on one of the timbers—striking the head off, and placing it on a lofty spire—tearing out the eyes, chopping off the hands, quartering the body, and throwing it among the rubbish of the Temple."

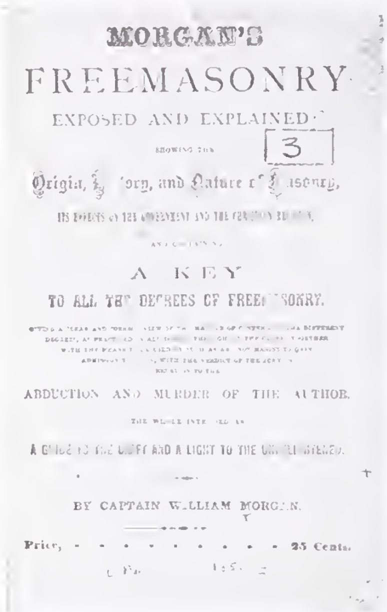
To calm a population outraged by this further "farrago of nonsense," Governor Clinton issued three successive proclamations urging all good citizens to cooperate with the authorities in helping to find Morgan and punish his abductors. A $2,000 reward was offered for information leading to his recovery and for bringing to justice his assailants. A free pardon was offered to anyone involved who would uncover the offenders.

The discovery that certain Masons had arranged for the change of horses and drivers for the 125-mile drive from Canandaigua to Fort Niagara, brought jail sentences to those involved. And every possible effort was made to prove as murderers these Masons; only lack of a body made it impossible. When a man's corpse was washed ashore on the beach of Oak Orchard Harbor, New York, about 40 miles below Fort Niagara, Morgan's widow, though she admitted the clothes were not those of her husband, expressed belief that the body might be his. But whereas Morgan had been bald, with a smooth face and the peculiarity of long white hairs in his ears and nostrils, this body had a heavy beard and a full head of hair.

To remedy the discrepancy, a leading member of the Anti-Masonic party, Thurlow Weed, editor of a Rochester paper, present at the inquest, was accused of having had the corpse shaved and hairs plucked from his forehead to thrust into its ears and nostrils. Result: a verdict that the body was Morgan's. Publicity about the verdict, as it brought on another wave of anti-Masonic outrage in the country, also brought to Oak Orchard Harbor the widow of a man, Timothy Munroe, who had fallen from a boat and drowned. So minutely did the widow describe the clothing worn by her husband and so accurately did the details tally with marks she said were identifiable on his body, that another inquest was ordered and the verdict reversed. The corpse was declared to be that of Munroe.

Of Morgan, nothing more was heard, and though stories continued to be circulated that a group of Masons had drawn lots to dump him in the river with a weight around his neck, Masons stuck to the story that Morgan had been taken across the river to Canada, where Canadian Masons near Hamilton, Ontario had given him $500 to make himself scarce—after which he had disappeared without a trace.

Not that the disappearance of Morgan did anything to halt publication of what was purported to be his book, put together by Miller, his contractual publisher, from manuscripts in the possession of his widow. To arouse sympathy and to publicize the book, Miller even appears to have set fire to his printshop, for which he was then indicted.


MORGAN'S
FREEMASONRY
EXPOSED AND EXPLAINED:
3
A KEY
ABDUCTION AND MURDER OF THE AUTHOR.
BY CAPTAIN WILLIAM MORGAN.
Price, 25 Cents.

The book, quickly pirated, sold by the hundreds of thousands of copies, adding fuel to the anti-Masonic blaze.

That one such disappearance could bring down the wrath of a whole country on the Brotherhood of Masons, whereas the Church could historically be held responsible for several million agonized deaths under torture and execution, seemed to Masons unaccountably unequitable, especially as no other "ritual murder" could be attributed to American Masons, who pointed out that by their own code of ethics, they, above all, were bound to obey the law of the land, "with respect for God, country and their fellow men."

Clearly, the Morgan incident had only been a spark, like Marie Antoinette's affair of the diamond necklace, which lighted a well-prepared pyre designed to destroy the fraternity. Social, racial, religious, and political forces had been working beneath the surface to capitalize on the frenzy of the anti-Masonic movement.

Conventions of anti-Masons convened throughout the country, to sweep anti-Masonic candidates into office. Again the principal ammunition at these conventions were the works of Barruel and Robinson, freely excerpted and produced as the sacrosanct evidence of history. Illuminism, said Ethan Smith, chairman of the Committee on the Connection between French Illuminism and the higher degrees of Free Masonry, at the 1832 anti-Masonic Republican convention in Massachussets, was designed to bind the world with invisible hands, and had been infiltrated into America well before 1786. "Both Robinson and Barruel," said Smith, "testify to the fact. Barruel mentions a lodge of this order in Portsmouth, Virginia, and two lodges as having descended from it. Illuminism exists in this country; and the impious mockery of the sacramental supper, described by Robinson is acted here." Smith then quoted from Christoph Girtanner's book on the French revolution: "active members of the propagandists in 1791 numbered fifty thousand, with funds of thirty millions of livres. They are extended over the face of the world, having for their object the promotion of revolutions, and the doctrines of Atheism. And it is a maxim in their code that it is better to defer their attempts fifty years, than to fail of success through too much precipitation."

Smith also quoted from a printed sermon of a Reverend Dr. Morse, who assured the public of an official communication from the Illuminated lodge Wisdom, of Portsmouth, Virginia, to the Illuminated lodge Union. "The letter," said Smith, "was intercepted. In it were the names of their officers, and the number of their adepts; being then 100, mostly French. In this letter, it appeared that there were thousands of such Lodges of Illuminism in the world; and many in the western world." Smith came to the point of all the fuss: he produced the same charge which had been leveled against Pico, Ficino, Dee, and Cagliostro: Illuminism had been most secretly planted by the side of Speculative Masonry to indulge in *gross infidelity and licentiousness*. Here, at last, was the note needed to enflame a "Christian" opposition.

The churches joined in the general attack, barring Masons from their pulpits as "irreligious." Ministers preached the "satanic nature of the Masonic lodge" and called it incompatible with the Christian faith. Baptists were told to dissolve their ties with Masonry or risk having "the Hand of Christian Fellowship" withdrawn from them. Other denominations announced they would support no Mason for any office in either town, country, or state. Masons were stricken from jury rolls; hostile crowds formed to prevent Masonic meetings; and individuals were so persecuted that in many cases they were driven to emigrate. In the early 1830s, of 227 lodges in New York State, only 41 remained. New York's membership dwindled from 20,000 at the time of the Morgan incident to a mere 3,000. All the lodges in Vermont surrendered their charters, and it was the same in all the other states of the Union. As one historian sums up the carnage: The Temple of Masonry was shattered, the brotherhood scattered.

Many politicians campaigned on an anti-Masonic platform and rose to eminence, such as Millard Fillmore, who worked his way up to the White House, and William H. Seward, governor of New York and a United States senator, who narrowly failed to occupy the White House, but was to become Lincoln's secretary of state. There was a slight respite when Andrew Jackson, Grand Master of Masons in Tennessee, was elected president for a second term; and then gradually the halls of Masonry once more began to throng with candidates who, after the lesson of Morgan, were more warily chosen from among those whose "pure lives and characters would make them an ornament to the order." As the lodges multiplied, Grand Master James Willard was able to announce that thanks to the constancy of members, Freemasonry was once more held in respect and honor in the country, as was the memory of its founder, George Washington.

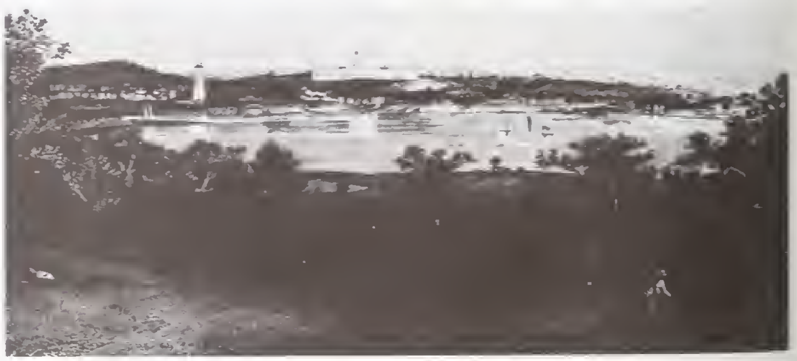
In Washington, D.C., what was described as "a number of patriotic citizens" assembled to revive the plan for erecting a national monument, asking for voluntary contributions from all the people, rich and poor, in the amount of

Washington, D.C. in the 1830s, showing Navy Yard and Capitol

$1 each. That this group, which called itself the Washington National Monument Society, was fundamentally Masonic is evidenced by its first president, Washington's brother Mason, Chief Justice John Marshall.

Ads were placed by the society to elicit designs from American artists for a monument "harmoniously to blend durability, simplicity and grandeur" at an estimated cost of $1 million. As to form, there was no limitation, but, as might be expected, a committee selected the design of Freemason Robert Mills for a 600-foot obelisk surrounded at its base by an olympian rotunda.

By 1847 the society had collected and gained from judicious investments a total of $87,000, and seemed on its way to success. A liberalizing trend in the country echoed a similar trend in Europe, especially with the election to the papacy in 1846 of Giovanni Maria Mastai-Ferretti. As Pius IX, the new pope auspiciously inaugurated his reign with a political amnesty and several badly needed reforms in the judicial and financial systems of the Papal States, proverbially the worst run in Europe, cutting down ecclesiastical graft. Censorship was mitigated and,



Peaceful capital of the United States at a time of revolutionary ferment in Europe.

Architect Robert Mills's design for a grandiose Washington monument, with an expensive circular colonnaded building (250 feet in diameter and 100 feet high) from which a 70-foot-wide obelisk was to rise 600 feet above the city. The columns were to stand 45 feet high, 12 feet in diameter, surmounted by an entablature 20 feet high, the lot crowned by a massive balustrade.

in March 1848, wonder of wonders, the pontiff promulgated a constitution with a parliament consisting of two chambers, to which many Italian Masons were elected.

In this happy atmosphere the United States Congress passed a resolution authorizing the Washington National Monument Society to erect the obelisk designed by Robert Mills, granting them, as a suitable site to build on, a 30-acre lot overlooking the Potomac south of the White House. There beautiful marble from the Symington Beaver Dam quarries in Baltimore County could easily be brought by water or by rail. The estimated cost of construction was $55,200 for the obelisk and $1,122,000 for the entire job, which Congress agreed to provide.

Mills was authorized to contract for the required material and to have a rail line laid right up to the base of the monument. And so thoroughly had the atmosphere changed that the laying of the cornerstone—a 24,500-

pound block of Maryland marble donated by Freemason Thomas Symington—could be performed with a suitable Masonic ceremony scheduled for July 4, 1848.

Stands were built around the site to make a vast sloping amphitheater of seats. Near the Fourteenth Street Bridge (then called Long Bridge), a triumphal arch was decorated with the same live eagle, now forty years old, which had hailed the arrival of Freemason Lafayette when he had visited the capital twenty years earlier. A parade of carriages led by President James Knox Polk was followed by the Masonic fraternity, headed by their Grand Marshal, J. B. Thomas; and the ceremonies were opened with a prayer led by the Grand Chaplain of the Grand Masonic Lodge of Maryland.

It was a lovely day. Recent rain had laid the dust and turned the sod a fresh green. Bells tolled solemnly as close to twenty thousand people crowded around for the ceremony, fares having been reduced by rail and stagecoach lines into the city.

Among the spectators were past and future presidents Martin van Buren and Millard Fillmore, as well as Mrs. Alexander Hamilton, Mrs. John Quincy Adams, and a delegation of Indians with whom George Washington had originally signed treaties of peace. Benjamin B. French, Grand Master of the Grand Lodge of Free and Accepted Masons of the District of Columbia, deposited articles in a cavity beneath the stone using the same gavel and wearing the same Masonic apron and sash worn by George Washington when he laid the cornerstone of the Capitol in 1793.

Having applied the square, level, and plumb to see that the stone was "well laid, true and trusty," the Grand Master placed on the stone the ancient Masonic elements

Masonic ceremony laying the cornerstone with the same silver trowel used by Washington to start the capital in 1793 of consecration: corn for plenty, wine for joy, oil for health. He then turned to his brother Mason, Robert Mills, and presented him with the square, level, and plumb, the working tools he was to use in the erection of this monument, saying: "You, as a Freemason, know to what they morally allude: the plumb admonishes us to walk upright in our several stations before God and man, the square to square our actions with the square of virtue, remembering that we are traveling upon the level of time to that 'undiscover'd country from whose bourne no traveller returns.'"

The Honorable Robert C. Winthrop, Speaker of the House, then delivered an address which reflected the encouraging political mood of the times, alluding to the rash of liberating revolutions of 1848 as the "mighty movements which have recently taken place on the continent of Europe, where events which would have given character to an age have been crowded within the changes of a moon." In these changes, said Winthrop, "we see the influence of our own institutions . . . we behold in them the results of our own example. We recognize them as the spontaneous germination and growth of seeds which have been wafted over the ocean, for half a century past, from our own original Liberty tree."

Handsome, but epileptic, Pius IX managed by his Jesuitically enflamed "ultramontanism" to concentrate all ecclesiastical power in the person of the Roman pontiff. By 1870 the Vatican Council had squashed all the independent power of the bishops, who lost their autonomous standing and became mere papal delegates. Pius then proclaimed the dogma of the infallibility of popes and the much-disputed notion of the immaculate conception of the Virgin (to whom he wished to raise an obelisk but instead erected a great pillar opposite the Office of the Propagation of the Faith).

That the occasion was intentionally and intensely Masonic was unmistakable from Winthrop's words: "Everywhere the people are heard calling their rulers to account and holding them to a just reponsibility. Everywhere the cry is raised for the elective franchise, the trial by jury, the freedom of the press, written constitutions, representative systems, republican forms." And in an unusual tribute to Pius IX, Winthrop continued: "In some cases, most fortunately, the rulers themselves have not escaped some reasonable symptoms of the pervading fervor for freedom, and have nobly anticipated the demands of their subjects. To the sovereign pontiff of the Roman States in particular belongs the honor of having led the way in the great movement of the day, and no American will withhold from him a cordial tribute of respect and admiration for whatever he has done or designed for the regeneration of Italy. Glorious indeed on the page of history will be the name of Pius IX if the rise of another Rome shall be traced to his wise and liberal policy."

But this was not to be. In November of that same year Pius fled from the republic of Rome to the Kingdom of Naples, and there, completely reversing his liberal policy, threw himself into the arms of the Jesuits, calling on France and Austria to help him back into power. Rein-

Column raised by Pius IX in honor of the Virgin Mary

stated in Rome with foreign bayonets in April 1850, Pius inaugurated as violent an antiliberal reaction as had occurred after the defeat of Napoleon in 1815 and one which was to swing the political pendulum to the farthest opposite extreme. Absolute autocracy was restored in the Papal States, and anyone could be thrown into Castel Sant'Angelo without a trial.

By 1851 Pius showed the absolutist direction he was taking by proclaiming Roman Catholicism as the sole religion of the Spanish people, to the exclusion of all other creeds, a principle which was then applied to Latin America with the hope of doing likewise in North America. By 1854 Pius, well on his way to announcing his stunning dogma of the infallibility of popes—an idea strongly disputed by a great many Catholic bishops—defied the whole trend of liberal thought by branding as false the basic beliefs of democracy and liberalism. Reinforcing his predecessors' bans against Masonry, Pius attacked public education, free libraries, and the right of men and women to choose their own religion, claiming for the Catholic Church control of all culture, all science, and all systems of education, declaring: "The pontiff neither can nor ought to be reconciled with progress, liberalism and modern civilization."

Arguing that the Son of God had established one religion and imposed on all men the obligation of embracing it, Pius branded all Protestants and Jews as heretics, doomed to damnation, there being no salvation outside the Roman Church. Catholics were forbidden to read certain books or to discuss their religion without approval of a priest, who, in turn, could be reprimanded and punished for proposing mercy for heretics. Catholics were to be held to the dogma that hellfire was real, and that the unfortunate non-Catholic damned would never lose consciousness of their torment throughout all eternity.

Unashamed, the pontiff declared himself to be Father of Princes and Kings, Ruler of the World, Viceroy of the Lord Jesus Christ, claiming for himself absolute political power and declaring it to be the duty of all states to carry out orders from Rome, that only the Roman Church could decide whether a law was "good" or "bad" and that obedience to a law unpleasing to the pontiff was not binding on the citizens of any state.

Summed up, these clearly expressed political principles of the Roman Catholic Church, to which was applied the epithet *ultramontanism,* appeared formidable to American Masons. According to Pius IX's famous *Syllabus Errorum,* the ultimate source of law and government in the United

States lay not in the people but in the "will of God as interpreted and expressed by the Pope." The primary and ultimate functions of the government of the United States were to carry out the principles of the Roman Church as promulgated by the pope. Freedom of speech and the press were to be permitted only to the extent they did not interfere with the principles and activities of the Roman Church. Public funds were to be used to support the Catholic Church and its schools. Most alarming, Catholics who were citizens of the United States owed a primary political allegiance to the Roman Catholic pontiff who could lawfully use force to overthrow their government. Catholics were not to approve a policy of separation of Church and State, and states had no right to legislate in matters such as marriages, only to be recognized by the Church, which forbade contraception and abortion even if required to save a mother. A leading Jesuit writer in the United States classed with prostitutes those American wives who used contraception, and called them "daughters of joy," maintaining that birth control resulted in sin which was no more than mutual masturbation.

All of which, not unnaturally, was unpalatable to American democrats, especially when the Catholic clergy insisted that the laws of Rome superseded the laws of the republic, and that Catholics were duty-bound to force all people into the pattern laid down by the Church. What made the system intolerable to its opponents was the fact that Catholics in America had no say whatsoever in the choice of their own priests, bishops, or cardinals, all of whom were appointed from Rome to perpetuate the system of management and control, bishops being deliberately selected for their subservience to the Vatican. The country began to be flooded with Catholic immigrants—as many as 300,000 a year, mostly poor, illiterate, and superstitious—Irishmen fleeing the potato famine, or Germans escaping crop failures and political persecution, all under the control of foreign priests. American Protestants found themselves faced with an army officered by disciplined bishops under a single omnipotent commander in chief whose chiefs of staff were the Jesuit generals. Whereas at the time of the founding of the republic there had been perhaps 1 percent of Catholics in the colonies, now there were as many as 10 percent who could effectively influence elections in which Yankees could even find themselves reduced to minorities. As the established Protestants saw their longtime position of privilege being eroded, religious intolerance flared up to a degree almost comparable with the horrors of the Counter-Reformation.

The country was flooded with salacious literature accusing priests of seducing their pretty penitents.

Protestant ministers rose in their pulpits to denounce Catholics as un-American because they were obliged to take orders from an autocratic, antidemocratic foreign power. These ministers, believing in human sinfulness and predestined damnation, became, in the words of historian Carleton Beals, "a band of neck-swollen, hate-mongering tub thumpers." In the streets scores of Protestant antipapist magazines began to appear, and masses of anti-Catholic literature were put out by Protestant Bible societies. As sex was the easiest and most obvious peg on which to hang an inflamed propaganda, religious presses gave free reign to stories of secret orgies in nunneries, the rape of young girls by priests, the killing of bastard babies, with headlines such as "Six Thousand Babies' Heads Found in a Nunnery Fishpond." Most popular were the "confessions" of escaped nuns who described being forced into carnal intercourse with priests. *Awful Disclosures* by Maria Monk, the joint effort of "a disordered whore and unprincipled religious demagogue," sold 300,000 copies before the Civil War.

When a Catholic priest in Carbean, New York, outraged at the distribution of Protestant Bibles to his parishioners, angrily burned several copies publicly, the whole country reacted. Nor did it help when Bishop Hughes of New York defended the act, saying: "To destroy a spurious corrupt copy of the Bible was justified and praiseworthy." Described by pro-Catholic Carleton Beals as "pretty much a Torquemada deprived of rack and screw and hot irons," Bishop Hughes gave an outrageous sermon in Saint Patrick's Cathedral, boasting that the pagan and Protestant nations were crumbling before the force of Rome.

"The true Church," thundered the bishop, "would convert all Pagan nations, even England, with her proud Parliament. . . . Everybody should know that we have for our mission to convert the world—including all inhabitants of the United States—the people of the cities, and the people of the country, the officers of the Navy and the Marines, commanders of the Army, the legislatures, the Senate, the Cabinet, the President and all."

To counter the bishop, his opponents made use of a firebrand named Allessandro Gavazzi, a former priest and teacher turned revolutionist who had fled from Italy to the United States under the auspices of The American and Christian Foreign Church Union, a scandal-making organization formed to fight the "Corrupting Catholic Church." Gavazzi wanted nothing but to annihilate the papacy, and swore to devote his life to "stripping the Roman harlot of her barb." Although a renegade, he wore a long monk's robe embroidered with a blazing cross. Six feet tall, with an "almost savage physical energy," he caused riots wherever he went.

Protestants turned against Catholics as they had against Baptists, Methodists, Shakers, and Quakers, using the same methods of "torture, whippings, brandings, arson and murder, looting and raping in the name of the democracy they claimed to support." Everywhere "native" American parties began to mushroom, waving the Stars and Stripes, and raising up mobs to burn Catholic convents, churches, houses; to assault nuns and murder Irish and other European immigrants. As the nation became torn with bitter sectionalism and seething social unrest, there was repeated rioting, in Boston, New York, Philadelphia,

Opening battle between the Bowery Boys (Know-Nothings) and the Dead Rabbits (Tammanies) from Beals's *Brass-Knuckle Crusade*

A contemporary print illustrating the Astor Theatre riot of 1849

Baltimore, Providence, Hartford, New Orleans, Saint Louis, Cincinnati, Louisville, and San Francisco.

According to Herbert Asbury in his *The Gangs of New York,* at least thirty thousand men in the city were active members of gangs, and not only men but women fought in the streets. "One notorious female," says Carleton Beals in *Brass-Knuckle Crusade,* his description of early fascism in America, "carried a tomahawk, knife, and gun and wore boots cleated with broken glass. Another sheathed her nails in steel and filed her teeth to needle point. *Hell Cat Maggie,* they called her." Tammany Hall's "Sons of Saint Tamina," started, as Beals says, "by hatchetman Aaron Burr who first made secret gangsterism into a political system," found themselves pitted against Protestant bully clubs who sought to control the polling booths with sticks, knives, and guns.

That the times were rough is evidenced by miscreants in New Jersey being branded on the cheek and given public floggings. A girl convicted of petty theft was sentenced to 210 lashes on her bare back. Joseph Smith, founder of the Mormons, taken by a mob from an Illinois jail, was murdered, as was his brother. Abolitionists were dragged through the streets at the end of ropes and frequently killed. Southern states imposed the death penalty for preaching to "blacks" or teaching them to read and write. And, although Washington, in his will, had emancipated his slaves and left a trust fund for their education and for the schooling of their children, the Bible Society refused to send Bibles to slaves.

As the whole country, aroused by the fervor of prejudice, prepared to square off for the bloodiest civil war in history, there came into being a secret society known as the Supreme Order of the Star-Spangled Banner. To avoid the Constitutional guarantee of religious freedom, its members pledged to vote only for non-Catholics selected by their secret upper tier caucuses, swearing never to betray the society's secrets, under pain of expulsion and implied penalty of death, and to deny affiliation by replying to the curious with the simple phrase: "I know nothing." Multiplying like rabbits, they soon numbered five million members, with new ones enrolled at the rate of five thousand a week. By 1855 they were a power in the land, controlling Maryland, Delaware, Kentucky, New Jersey, Pennsylvania, California, all but one of the New England states, and nearly every state in the South. Millard Fillmore became president standing on the Know-Nothing platform, and U. S. Grant rose to fame in the same way. But the proudest "claim" of the Know-Nothings was that George Washington had been the first of their party, citing his apocryphal words at Valley Forge: "Tonight let none but native-born Americans stand guard."

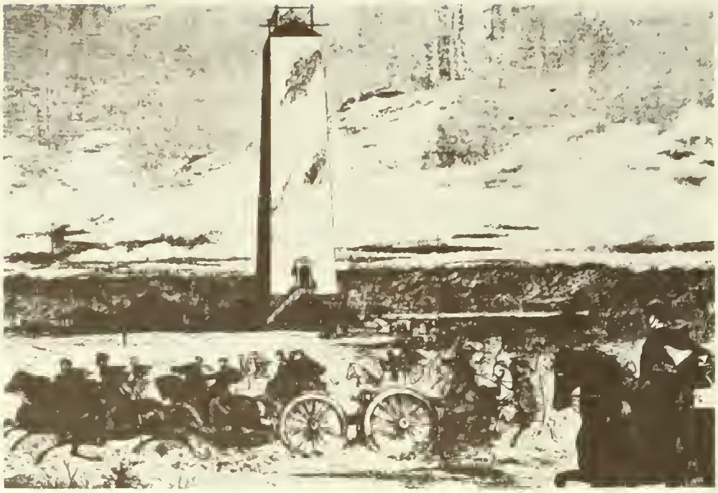
Unwittingly they were to do their assumed hero a gross disservice. By this time the Washington Monument had reached a height of 170 feet at a cost of $230,000. But the Washington National Monument Society, complaining that the turmoil of the times had dried up subscriptions, appealed for money to the various states. Alabama replied that it could give no money, but offered to contribute a stone of the requisite dimension—4 feet by 2 feet, by 1½ feet. Other states followed suit, including municipalities and associations, as did foreign governments such as Switzerland, Turkey, Greece, China, Japan, and the Vatican—from which Pius IX sent a block of marble, ironically taken from the Pagan Temple of Concord in Rome.

But even these contributions were nowhere near sufficient to do the job, and the society's board of managers appealed to Congress to take whatever action it deemed proper. A select committee recommended a subscription of $200,000, the exact sum originally voted in 1799, but never provided. It too was to be canceled, by the occurrence of an extraordinary event.

On March 6, 1855, between 1:00 and 2:00 A.M., a group of men rushed out of the darkness round the foot of the monument and seized the night watchman, whom they locked up in his shack, so as to break into a shed where the pope's stone was boxed. With skids, bars, and blocks they rolled the stone out to a scow in the nearby canal basin, then ferried it out into the Potomac almost to Long Bridge, and dumped it.

The men, nine members of the Know-Nothing party, had drawn lots for the job, announcing that the marble block represented "a designing, crafty, subtle scheme of the

Union artillery, horse-drawn past the abandoned monument as the country prepared for war



far-reaching power that was grasping after the whole world to sway its iron scepter with bloodstained hands over the millions of its inhabitants." The same night a group of about 750 members of the Know-Nothings, many of whom had surreptitiously joined the Washington National Monument Society, called a meeting and voted their own officers into control of the society, defenestrating the others. On the morrow Know-Nothings announced they were in possession of the Washington Monument. Congress's reaction was speedy. They tabled the recommended appropriation, effectively killing it.

The disappearance of the pope's stone angered "a large body of citizens" and also discouraged further contributions; so all construction ceased. Two weeks later Robert Mills died, and with him went what appeared to have been the last ray of hope for continuing the monument. During the next three years, as the battle continued between the old members of the monument society and the new Know-Nothings, only 13 courses, or 26 feet of masonry were laid, consisting mostly of rubble rejected by the master mason. By 1858, unable to raise any money—in 1855 they only managed to collect $51.66—the Know-Nothings finally surrendered all their records to the original society with the entire treasury of $285. As a national party the Know-Nothings were through.

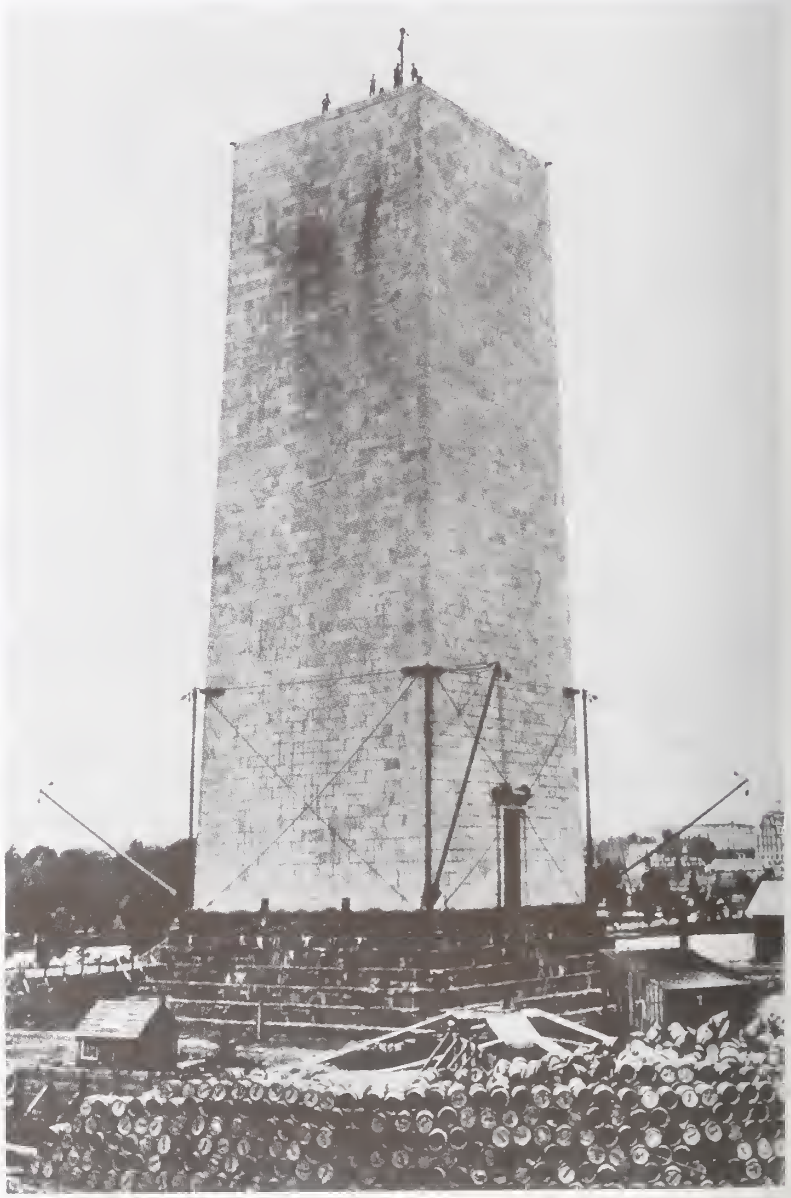
In February 1859, to prevent any recurrence of such events, Congress incorporated the Washington Monument Society with President James Buchanan presiding *ex officio*. But the Civil War was looming, and in all of 1860 the society was only able to collect $88.52, 48 cents of which came from Washington's native Virginia, and 15 cents from Mississippi. With the outbreak of war, the

Cattle grazing around the monument to supply Union troops

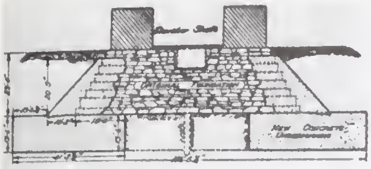
monument stood 176 feet high, less than a third of its prospected height. In the words of Mark Twain, it "looked like a hollow oversized chimney." All construction was halted during the war while the grounds on which it stood were used to graze cattle for the Union commissary.

Following the war these swamplike grounds came to be known as Murderer's Row—"the hangout of escapees, deserters, and other flotsam of the war"; and it wasn't until ten years later, with the approach of the first centennial of independence, that Congress once more went into action. But there was now a real question as to whether to try to continue the building or simply tear it down and write off the quarter of a million dollars already spent. The problem lay in the foundations—81 feet square and 25 feet deep, solid masonry—which was now considered too weak a base onto which to raise the projected 600-foot obelisk. It was feared the structure would sink into the swampy terrain or be blown over by the wind. In the House, there were complaints about asking the people of the United States for money to "finish this unsightly and unstable shaft upon this unsafe foundation . . . this ill-shapen badly put together structure of mixed blocks." It was said that "storms, the uncertain foundation, the swaying to and fro of such a column will sooner or later bring it to earth."

The ignorance of some of the politicians was exemplified by Representative Samuel S. Cox of New York, who pompously declared: "If you raise this obelisk which



Monument's surroundings as a dumping ground and storehouse



Engineers' plan to remove 70 percent of the old foundation and insert a new concrete pad capable of supporting an 82,000-ton shaft

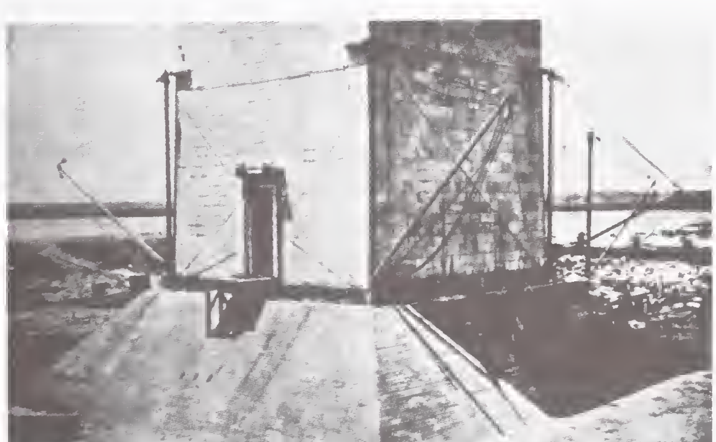
First, the center section of each side was removed and replaced by fresh concrete.

Next, the corners were filled in.

Thirty-six feet beneath the surface, the new foundation weighed 37,000 tons and covered more than three times the previous area.

comes from Egypt, a barbarian country that never had art, I don't believe it will succeed in impressing the American people in a proper way with the virtues and greatness of George Washington." Representative Jasper D. Ward of Illinois argued that the monument had been stopped because "when the unsightly column reared itself so high that they could see it they (the people) did not feel like contributing more to it." John B. Storm of New York, on the other hand, declared that though he might have preferred it had the monument never been started, he was "unwilling that the hundredth anniversary of our existence as a nation should dawn upon us with that monument standing there as a testimony that republics are ungrateful." R. C. McCormick of Arizona agreed that "no greater disgrace, certainly no greater calamity, could possibly befall than that the shaft after once being completed should fall to the ground," but argued that the chief reason for adopting the simple obelisk was its permanency and imperishability. Norton P. Chipman of the District of Columbia backed him up, suggesting there was something special in such a simple, majestic obelisk, "eminently proper as commemorational of the character of Washington, aside from the fact that the early fathers preferred it. . . ."

In the end, Congress appointed an engineer to study the problem and give an estimate for completing the job of raising a simple obelisk, abandoning the expensive pantheon at the base designed by Mills in favor of a massive terrace with a balustrade for statuary, which would cost only $65,000. When the first engineer gave an unfavorable report, the matter was allowed to slide; and only when the actual centennial was at hand did Congress decide to hire another engineer, who after much probing beneath the monument finally agreed it would actually be possible to raise a 600-foot obelisk, provided Congress was willing to



The monument, in 1874, as depicted in *Leslie's Weekly*. Trams were horse-drawn, and the canal was busy with water-borne commerce.

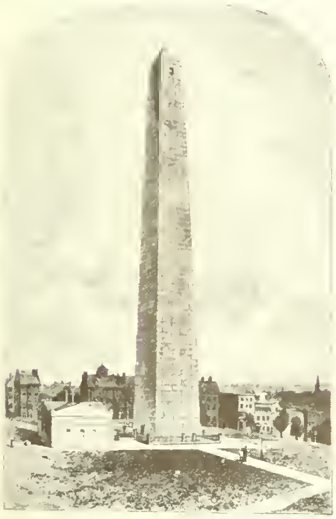
spend the extra money needed to put a whole new foundation beneath the present one. But by now Congress had delayed so long, the centennial was upon them and no real progress had been made.

Not until the first day after the centennial, July 5, 1876, was Senator John Sherman of Ohio able to introduce a resolution asking for $2 million to complete the monument. On August 2, the House dutifully passed the bill to retake possession from the society of the 30 acres and its truncated shaft and appropriate the necessary money to complete the monument.

Some consideration was given to alternative designs, especially one suggested by the American sculptor William Wetmore Story, who wanted to build what he called "an ornamental Lombardy tower," which would have required demolishing 41 feet of the shaft already built, so as to insert several windows. But the advice of George Perkins Marsh, United States minister to Italy, prevailed, and the form of an authentic Egyptian obelisk was retained. However, as nobody knew exactly what constituted an authentic Egyptian obelisk, or in what proportion the pyramidion should stand to the shaft or at what angle, the State Department sent out a circular eliciting information. From Rome, Minister Marsh, an accomplished scholar who had previously been United States consul in Cairo and said he had made sketches of all the known standing obelisks in Egypt, came up with a reply. An obelisk, he warned, was not an arbitrary structure which anyone was free to erect with such form and proportions as might suit his taste and convenience, but that its objects, form and proportions were fixed by the usage of thousands of years, so as to satisfy the cultivated eye. Marsh laid down

The 1834 proposal for an obelisk half the height of the Washington Monument to stand on Bunker Hill. Horatio Greenbough's design was approved by Gilbert Stuart and Daniel Webster.

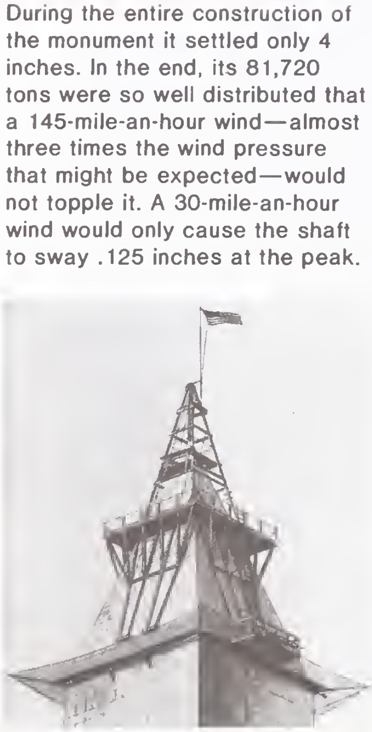
the law that the pyramidion should be one-tenth of the height of the shaft, with its base two-thirds to three-fourths the size of the monument's base. He was categoric in insisting that it would be as great an aesthetic crime to depart from these proportions as it would be to make "a window in the face of the pyramidion or shaft, both of which atrocities were committed in the Bunker Hill monument." If one had to have a window, said Marsh, it should be the exact size of one stone and be supplied with a shutter of the same color so as to be invisible when closed. "And throw out," he concluded, "all the gingerbread of the Mills design and keep only the obelisk." His advice was taken, and a joint commission of Congress was formed to oversee the completion of the monument as Marsh had suggested, $94,474 being voted to stabilize the foundation. Lieutenant Colonel Thomas Lincoln Casey, a forty-two-year-old army engineer, was hired to raise the monument to 555 feet, ten times the size of the base; architect Gustav Friebus was assigned to design the pyramidion with which to top the shaft. It was estimated that $677,000 more would be needed to complete the monument.



The completed monument drawn by Edwin A. Abbey and engraved by A. U. S. Anthony

On January 28, 1879, five boom derricks were erected on the top of the existing shaft with block and tackle and an 8-foot safety net to catch any workmen—none of whom fell or were injured. As a first step, so that building could start in July 1880, the top three courses laid by the Know-Nothings were removed. An iron framework 20 feet high went up first, around which the new courses of blocks

During the entire construction of the monument it settled only 4 inches. In the end, its 81,720 tons were so well distributed that a 145-mile-an-hour wind—almost three times the wind pressure that might be expected—would not topple it. A 30-mile-an-hour wind would only cause the shaft to sway .125 inches at the peak.



The pyramidion in place with security scaffolding and net ready for the Masonic ceremony of laying the aluminum capstone. This pyramidal capstone consisted of 3,765 cubic feet of dressed marble in 262 separate pieces which took thirty days to set. In December 1884 it was successfully raised without incident.

could be laid, with marble on the outside, and a granite backing. By the end of 1880, as Gorringe's obelisk was steaming toward New York, 22 feet of masonry had been laid, each course containing 32 blocks of marble and 24 blocks of granite, raising the monument to a height of 250 feet.

During 1882, as the shaft thinned, the number of blocks hoisted each trip was doubled and another 90 feet were added. In 1883 another 70 feet brought it up to 410. After the 450-foot level no more granite was to be used, only marble, so that during 1884 the shaft could be brought to 500 feet, ready for the 55-foot pyramidion whose 300 tons were to be lifted into place as one piece.

To finish off the obelisk at its apex, an aluminum capstone weighing 100 ounces—the largest single piece of aluminum cast to that time—was to be placed atop the pyramidion on Saturday, December 6, 1884. Placing the capstone required another appropriate Masonic ceremony, and a special scaffold was constructed on which the principal officials might stand. When the day came, a 60-mile-an-hour wind came with it, and thousands held their breath as they gazed up from the Mall at master mason P. N. McLaoughlin, the project superintendent, who successfully placed the capstone. The American flag was unfurled, and the crowd raised a cheer. Cannons brought from Fort Meyer, Virginia, boomed out a hundred-gun salute, and all was ready for the dedication on Washington's Birthday, February 21, 1885.

On dedication day, which dawned cold but clear, the obelisk stood majestic and serene, the tallest monument of masonry then in the world. A sharp wind blowing down the Potomac put a snap into the flags, and the marine band played patriotic tunes as troops and citizens gathered on the snow-encrusted turf around the base. A short address was delivered by Senator Sherman of Ohio. And Myron M. Parker, Most Worshipful Grand Master of the Grand Lodge of Free and Accepted Masons of the District of Columbia, began the Masonic ceremonies, reminding the audience that "the immortal Washington, himself a Freemason, had devoted his hand, his heart, his sacred honor, to the cause of freedom of conscience, of speech and of action, and that from his successful leadership the nation had arisen." As props for the Masonic ceremony there was the same gavel which George Washington had used to lay the cornerstone of the Capitol, the same Bible on which he had taken the oath as president, the same apron made by Madame Lafayette, plus a golden urn containing a lock of Washington's hair passed down by

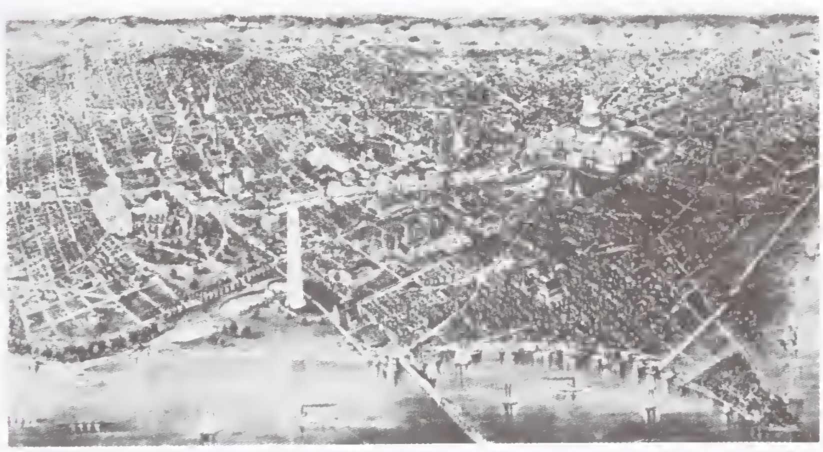
View of the ceremony seen by the crowd through binoculars as Colonel Casey holds his derby against the gale, and motions to Master Mason McLaughlin to cap the monument.

Tourists ascending the monument

every Grand Master of the Grand Lodge of Massachusetts. In conclusion the Grand Chaplain of Masons brought out the same ritual corn, wine, and oil. Then the official procession, headed by President Chester Alan Arthur, marched down Pennsylvania Avenue to the Capitol to hear an address written by former Speaker of the House Robert C. Winthrop, the same sponsor who had given the oration at the laying of the cornerstone thirty-seven years earlier.

Regretting that the monument could not have been hewn from a single stone, like an Egyptian obelisk, Winthrop said he nevertheless took pleasure in the idea that the united stones standing firm and square could serve as a symbol for the national motto, *"E pluribus unum."* John C. Palmer, speaking for the fraternity, declared that Masons were no longer builders of cathedrals and castles, "poems in marble and granite," but of human society whose stones were living men, "their minds enlightened with divine truth, their hearts radiant with discovering the joy of pure love, their souls cherishing—like the ancient Egyptian worshippers of Osiris—the hope of immortality."

Within a year ten thousand citizens had climbed to the top of the obelisk to look out across the tranquil Potomac at the gentle slopes of Mount Vernon, where Washington lay buried, but few among them realized—any more than did the admirers of the Chartres Cathedral or the great pillars of Karnak, except perhaps through a sense of awe—the phenomenal significance of the majestic work of masonry upon which they were supported.

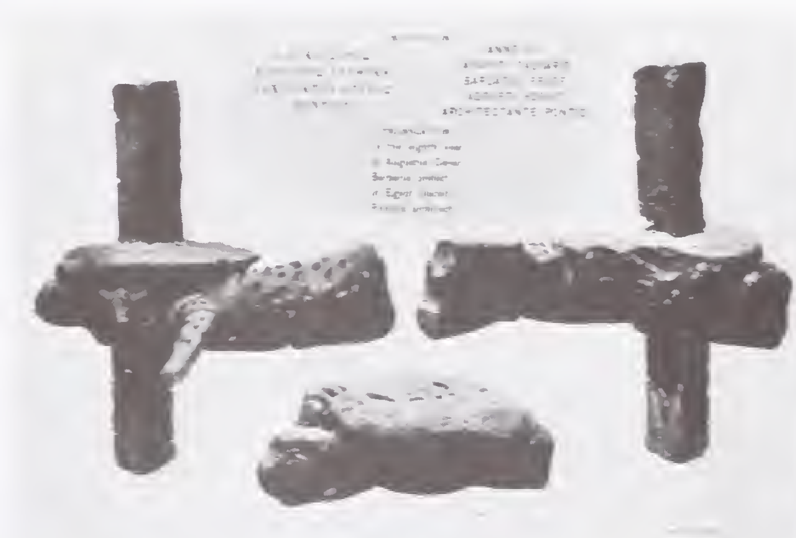



G. BELZONI ESQ.R

16. ATLANTIS IN AMERICA

In January 1880 the United States consul general in Egypt, E. E. Farnam, sent a dispatch from Cairo to the Department of State in Washington reporting that in the course of removing the foundations of the obelisk sent to New York from Alexandria, a "very important historical discovery was made relating to the order of Freemasons, confirming its claim of ancient origin." Farnam referred the department to a further report by the senior Masons Commander Henry Gorringe and Grand Master S. A. Zola, Sovereign Grand Commander of the Supreme Council of the Ancient and Accepted Scottish Rite; Past Grand Master of the National Grand Lodge of Egypt, confirming the discovery beneath the foundations of a granite block, the upper part of which had been cut in the form of a mason's square. Embedded in the mortar were also a mason's trowel of iron or steel, and two granite blocks, one polished, the other unfinished, "the perfect and the rough ashlars of Masonry," representing the master craftsman and the apprentice, all laid out in the correct position to indicate emblems of Masonry—something the report assured could not be the work of chance.

The added discovery of an inscription in both Latin and Greek on one of the bronze astragals which had held up the obelisk indicated it had been erected by the architect



The crabs found in Alexandria with this inscription in Greek and Latin: "Placed by architect Pontius in the eighth year of Augustus Caesar with Barbarus prefect of Egypt."

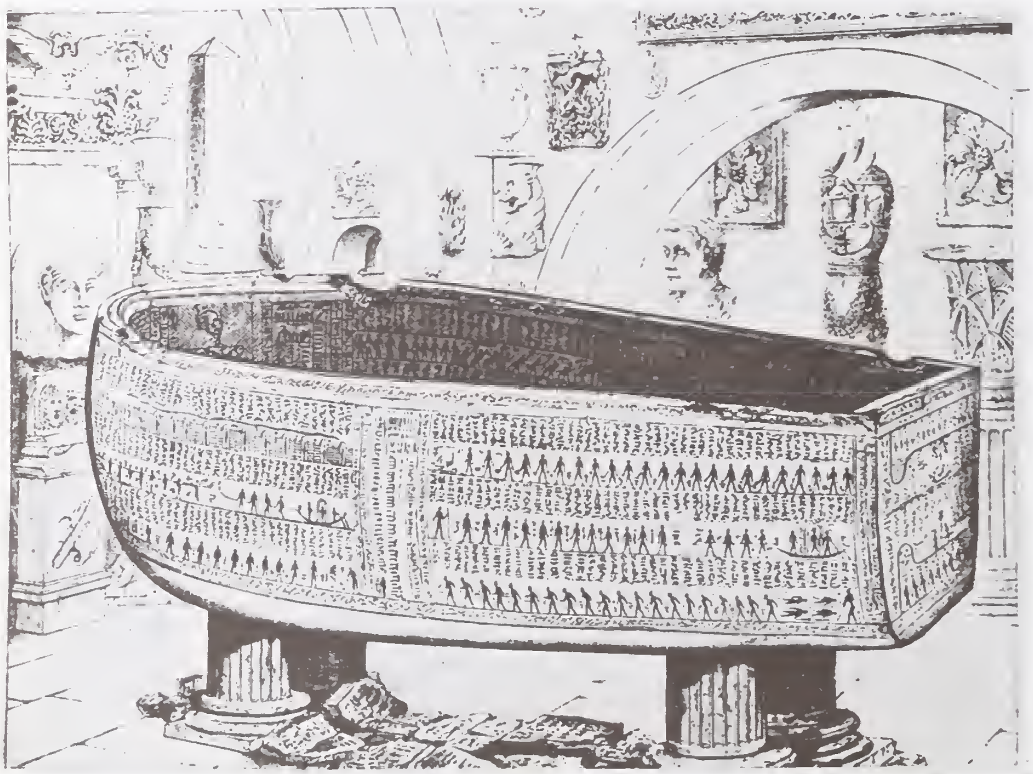
According to Weisse and Gorringe, the decorations on the walls of the mystery chambers in the rock-excavated temple of Seti I and of his son Ramses II (discovered by Belzoni) represent initiation to a Masonic degree. They believe that everything they saw in these structures "indicate the origin of modern Freemasonry for the attitudes, groups, rites, ceremonies, symbols, and signs, have a striking similarity both with Medieval and Modern Freemasonry." According to Weisse, the Isiac mysteries constituted the first Masonic degree among the Egyptians and the mysteries of Serapis, the second. "In the mysteries of Osiris the lesson of death and resurrection of Osiris was symbolically conveyed. The legend of the murder of Osiris was displayed to the affiliate in a scenic manner." All together Weisse and Gorringe describe nine different initiations throughout the thirteen highly ornamented mystery chambers of the temple.

Chambers of the Tomb of Seti

Pontius during the eighth year of Augustus's reign, with Barbarus as prefect of Egypt; and this led the New York Masons to conclude that the obelisk had been raised in Alexandria at the time of the birth of Christ by a group of practicing Masons of whom Pontius was evidently one.

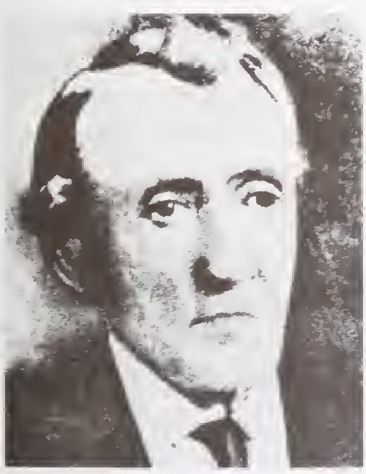
This amazing conclusion enabled Gorringe to launch into a campaign to prove that Masonry had flourished in Egypt at an even earlier period than had been believed. For evidence, he produced thirteen large colored illustrations showing in detail the carved stone panels of the rock-excavated Temple of Seti I (Osimandias) and Ramses II (Sesostris), painted *in situ* by Giovanni Belzoni in 1818. "No Mason," said Gorringe, "can look at the attitudes of this group of Grand Master, Guide, Candidate, and Assistant, without realizing that, if there are Masonic institutions now, there were similar, if not identical ones, about four thousand years ago, in the land of the Pharaohs, and that modern Freemasonry had its prototype in the Masonic Temple of Seti I and Ramses II, where applicants were initiated as Oriental and Occidental Masonic Orders initiate now."

This statement prompted an American Mason, John A. Weisse, to produce a book, *The Obelisk and Freemasonry,* in which he set out to show, among other points, that Masonry had existed in America among so-called Ameri-

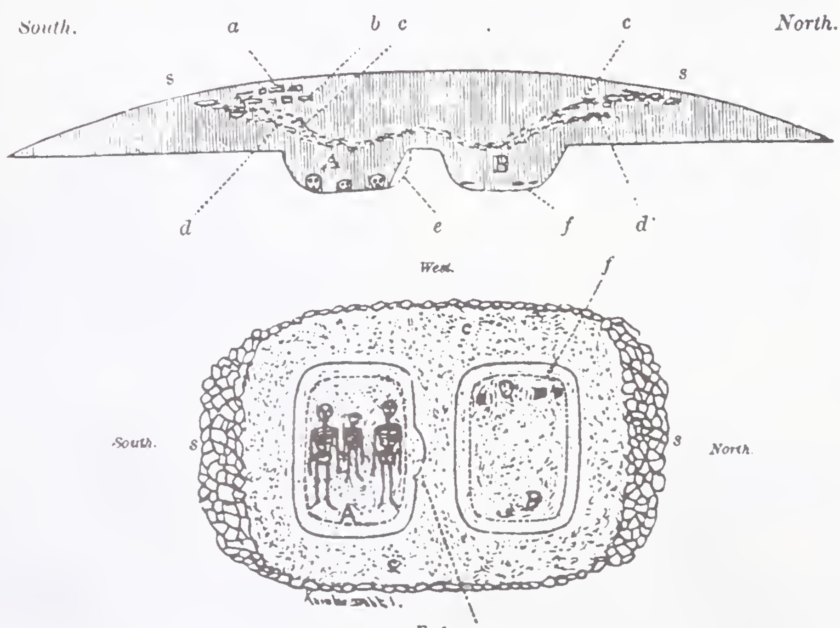


can Indians, long before the arrival of Columbus. Weisse quoted a letter from a William McAdams of Otterville, Illinois, dated April 25, 1880, to the effect that he had spent a considerable time exploring ancient mounds and earthworks, in which he was surprised to find well-known symbols of Masonry, such as circles, squares, and triangles; triangles with squares surrounded by circles; and a circle between parallel lines. "The triangle," wrote McAdams, "ever was and is now an important Masonic symbol. The equilateral triangle was adopted by most of the ancient nations as an emblem of the deity, and was regarded as the most perfect geometric figure. It occurs in Craft and Arch Masonry. In ancient and medieval magic it meant fire when the apex pointed upward, and water when the apex pointed downward."

Next Weisse told the story of a stele found in Iowa in 1877 which came to be known as the Davenport stele. Its history and its import were to make it as remarkable as Egypt's Rosetta Stone. On a cold day in January 1877, an amateur archeologist, the Reverend Jacob Gass, a German-speaking minister of the First Lutheran Zion Church of Davenport, was engaged in opening a small burial mound on what was known as Cook Farm. Aided by seven colleagues, several of whom were also clergymen, these "Sunday archeologists" dug through frozen ground for about 2½ feet, only to discover an intrusive Indian burial of obviously modern date. Later, as they descended into the mound, they uncovered the skeletons for which the mound had evidently been raised; two adults and a child. Beneath their bones the archeologists made an extraordinary find:

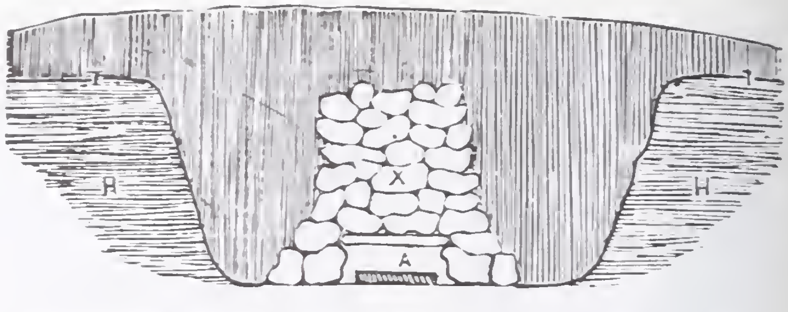


The Reverend Jacob Gass



Plan of Cook Farm mound cavity . . .

. . . in which the tablet was found



a bituminous shale tablet, about 13 inches square, engraved on both sides, as well as a smaller tablet engraved with what appeared to be a zodiac.

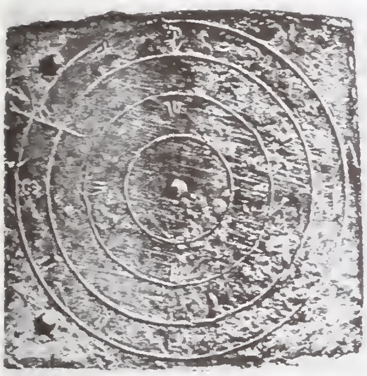
The large tablet showed several dancing figures in what was considered to be a "cremation scene." The opposite side showed Indians and animals around two obelisks pointing at an equilateral triangle. Strange signs, like lettering or glyphs, adorned the stele. Taken to the Davenport Academy of Natural Science (now the Putnam Museum), the tablets aroused great interest: they were believed to be the first discovered phonetic and astronomic monuments assignable to early inhabitants of America.

Charles E. Putnam, lawyer of the Davenport Academy, and later its president, was quickly committed to the validity of this rare archeological find, which he considered of worldwide interest. Encased in plaster casts, the tablets were sent to the Smithsonian Institution for appraisal, along with some background notes on the Reverend Gass, whom he described as of spotless character, "a good classical scholar, well grounded in Hebrew, with a scientific bend of mind." Also included were sworn affidavits from Gass's assistants confirming the manner in which the tablets had been found.

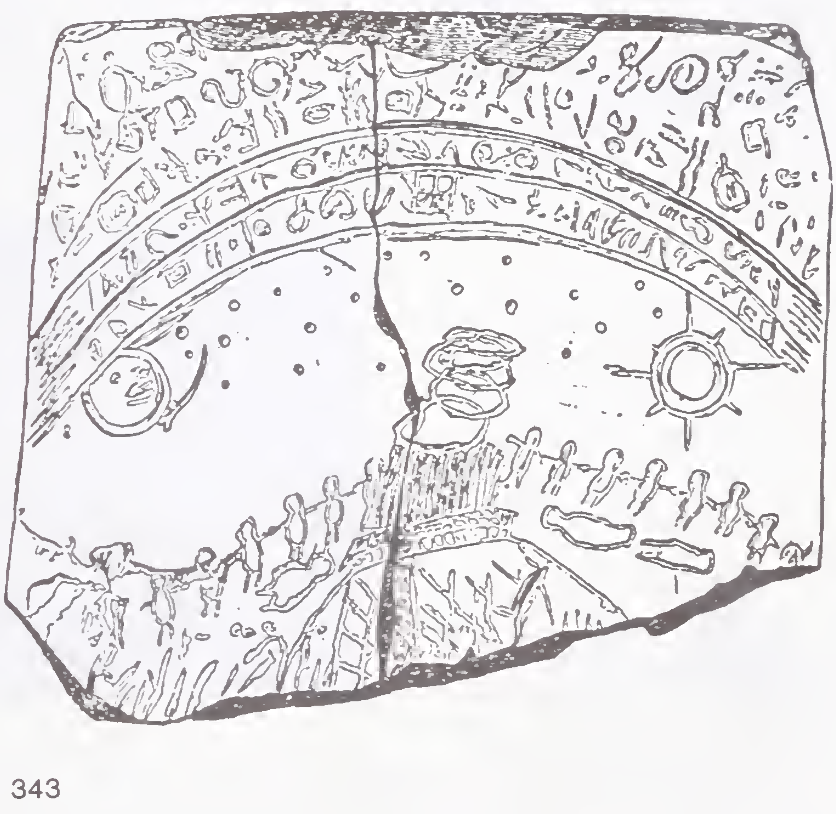
The Putnam Museum in Davenport, Iowa

The Smithsonian's first reaction was that the tablets were authentic and of great antiquity. But one of the institution's experts, a Dr. E. Foreman, on closer examination concluded that the so-called "cremation scene" depicted a disembodied Indian spirit going to "a place of probation before its final reception in the place of departed spirits," and that the works therefore "set forth the teaching of the missionary fathers of the Catholic Church, and must be of recent date." Ironically, he added that the Egyptians believed such an inquisitorial function was performed by Osiris, "but we are not apprised that the Indian mythology includes a functionary clothed with similar attributes."

The debate quickly degenerated into acrimony and was drawn out for several years in the columns of such prestigious magazines as *Science* and the *American Antiquarian,* climaxing in an official putdown from the governmental establishment when the Davenport Academy wished to exhibit the tablets at the Columbia Exposition in Chicago in 1894, "to give visitors from all parts of the world a chance to see something that has made a ripple in the scientific world and is only waiting, like the Rosetta Stone, for some Mariette to decipher the story hidden in its hitherto undecipherable hieroglyphs."


Calendar stone tablet

In a monograph in the annual report of the United States Bureau of Ethnology, Cyrus Thomas, its director of archeology, declared unequivocally: "A consideration of all the facts leads us, inevitably, to the conclusion that these


One side of Davenport Stele showing Djed pillar

relics are frauds; that is, they are modern productions made to deceive." Thomas suggested the source of the hieroglyphic inscriptions was none other than the 1872 edition of Webster's *Unabridged Dictionary*, page 1,766, which illustrated various Old World alphabets.

Scholars who had previously taken a favorable position were quick to reverse themselves, and the tablets were labeled frauds. In 1930, when Dr. Henry C. Shetrone, director of the Ohio State Museum, reexamined the tablets, he reconfirmed their fraudulence. And as recently as 1970, Marshall Bassford McKusic, an Iowa archeologist, in a pamphlet titled *The Davenport Conspiracy*, published by the State Archeologist of Iowa City, declared that "by now the fraudulent nature of the tablets should have been accepted by everyone."

For evidence, to prove a conspiracy which he said resulted in "an almost unbelievable degradation of scientific research," McKusic brought out what he characterized as "one of the most detailed case studies of this period of American archeology, and of the history of science in this country."

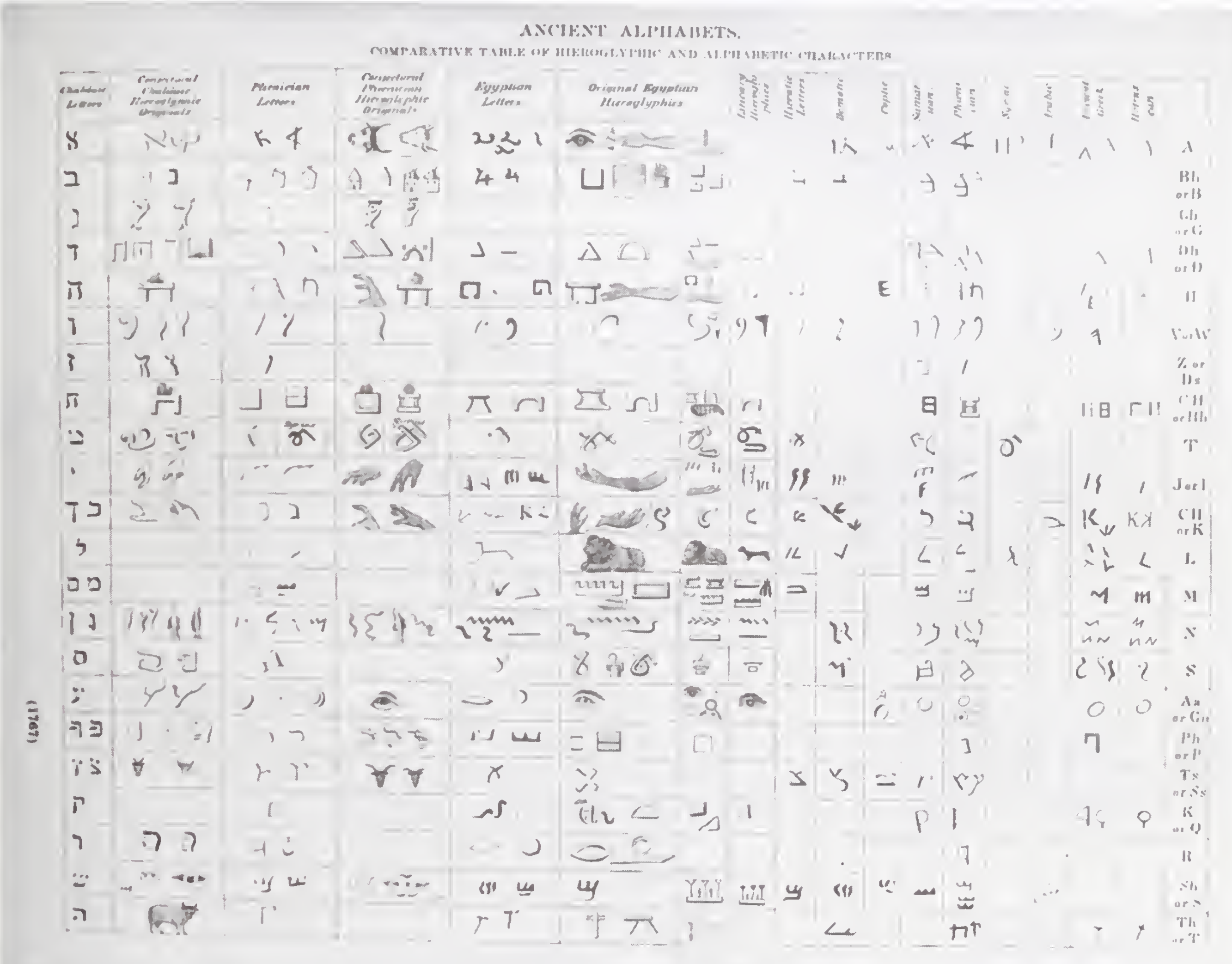
Judge James Wills Bolliger

In this opus, on careful reading, the new evidence turned out to be the drunken confession of a prominent Davenport attorney, Judge James Wills Bolliger, president of the Davenport Museum board, according to which the tablets had been taken from the roof of a whorehouse on the Mississippi River waterfront and then forged by himself and a gang of cronies who frequented the academy, in order to be placed in the mound for the Reverend Gass to discover. As the judge is reported to have told the story: "This group would go to the Academy and have a bull session because there wasn't any place else to go. They used to have a few drinks and just shoot the breeze.

Shingle from the old state house (courtesy of Marshall McKusic)

The janitor was in with us. We had two old almanacs, one German and one Hebrew and we copied out of them and inscribed the hieroglyphs on these slate tablets, and things. We just made up anything that would confuse them, especially Gass."

Ancient alphabets from *Webster's Dictionary* of 1872



Professor Barry Fell

That this confession, and not the tablets, is fraudulent, is now clear at last, thanks to the brilliant scholarship of a Harvard epigrapher, though the shakiness of Judge Bolliger's evidence should have been clear from the fact that at the time he is supposed to have planted the tablet, the judge was only nine years old, and the building in which the academy was to be housed was only dedicated and occupied the following year.

Conclusive proof of the authenticity of the Davenport stele has been adduced by Barry Fell, professor emeritus at Harvard, and president of the Epigraphic Society which he founded. Far from being a forgery, the stele is one of

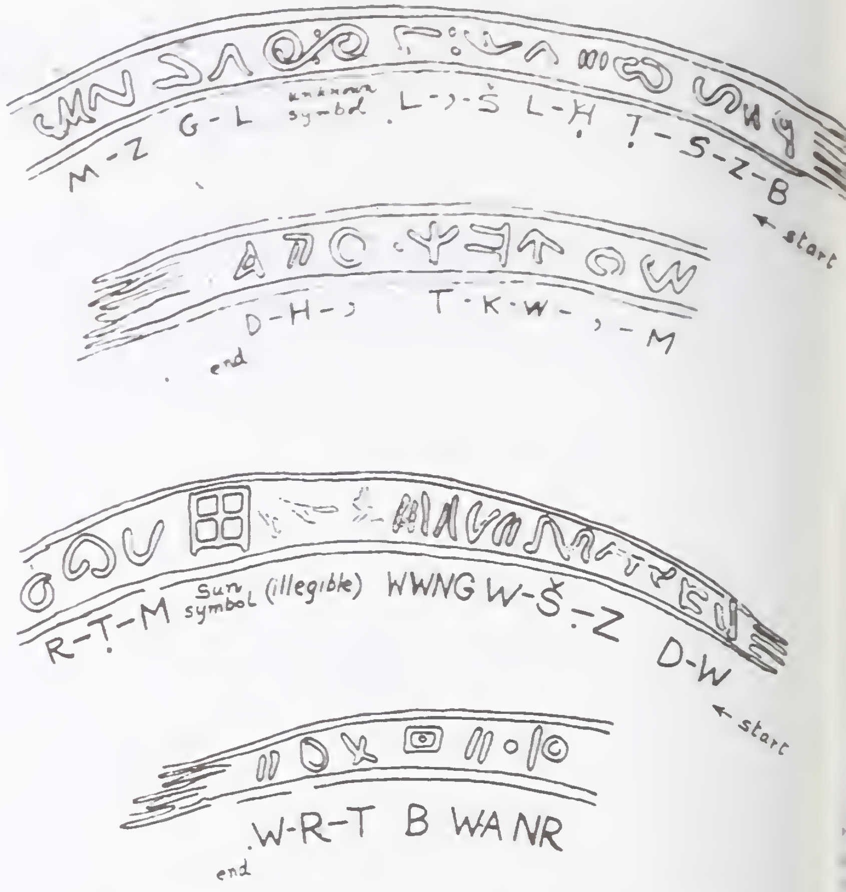
(Barry Fell translation)

Punic-Iberian text
B-Z-S-T
Set out
H-L
around [this]
S-i-L
is a secret

secret sign
L-G
Z-M
defining
[M]-i-W-K-T
the seasons
i-H-D
delimiting

Lybian text
W-D
The stone
Z-S
is inscribed
W-W
around
G-NW-T
with a record
(illegible)

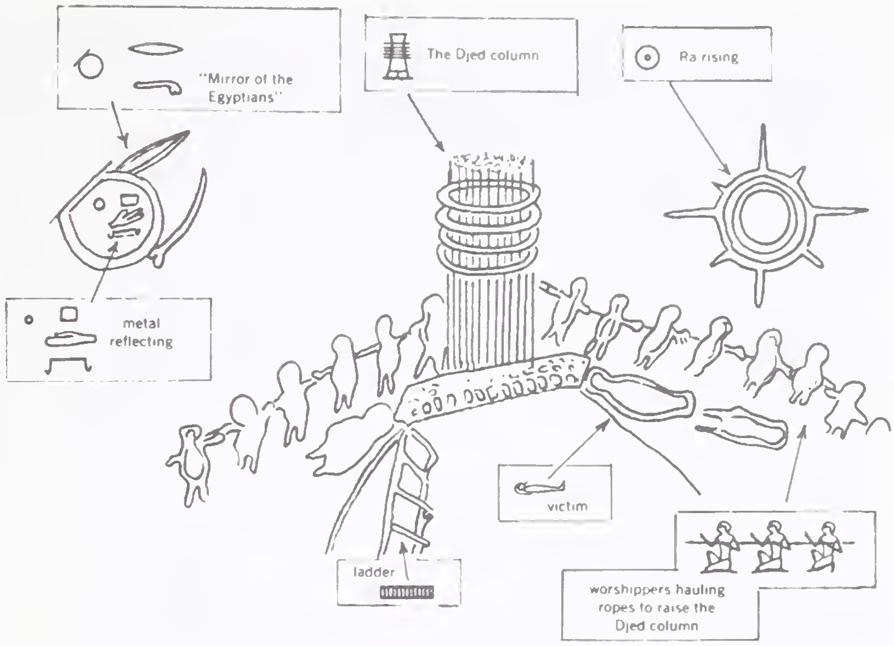
(sun symbol)
M-T-R
It reveals
R-N
the meaning
W-A
the length
B
the placing
T-R-W
of the sea-
son



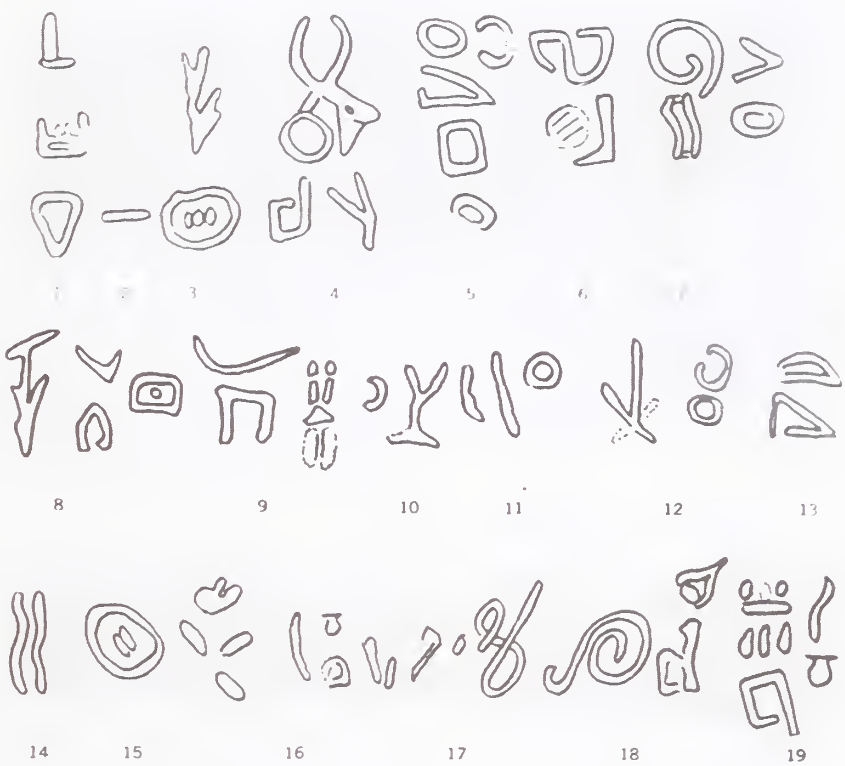
the most important ever found, amounting to an American Rosetta Stone, the only one so far on which occurs a trilingual text in the Egyptian, Iberic-Punic, and Libyan languages. As Fell points out, the Egyptian hieratic text could easily have been deciphered at the time of the tablet's discovery, but was evidently deliberately ignored.

Even more interesting is the content of the text, which elucidates the nature of the ceremony depicted. In the *Occasional Papers* of the Epigraphic Society, Fell gives a word-for-word translation of the Iberian and Libyan texts as they appear on the arched scrolls, each of which reports that the tablet carries a further inscription which will reveal the secret of how to regulate a calendar. This secret is contained in the Egyptian hieratic hieroglyphs, which Fell renders into English:

"To the pillar attach a mirror in such a manner that when the sun rises on New Year's Day it will cast a reflection onto the stone called 'The Watcher.' New Year's Day occurs when the sun is in conjunction with the zodiacal constellation Aries, in the House of Ram, the balance of night and day being about to reverse (the Spring Equinox). At this time hold the Festival of the New Year, and the religious rite of the New Year."



Identification by Fell of various Egyptian captions in the design of the stele



Fell's translation of the Egyptian hieratic text on the upper part of the stele (to be read from top down)

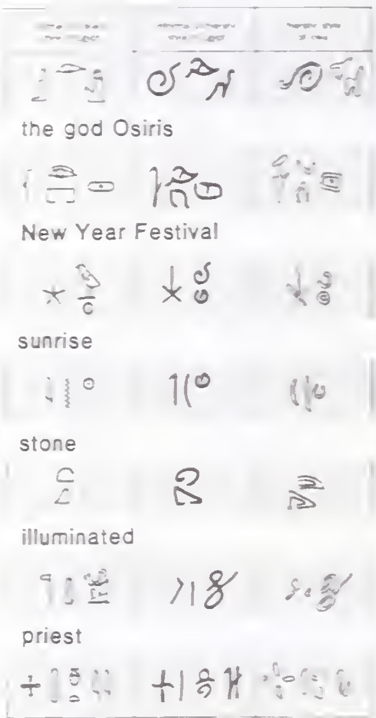
1. To a pillar/attach/a mirror
2. so that
3. at the New/Year/
4. the sun being in conjunction with the Ram
5. at the tilting of the balance (i.e., of night and day, the equinox) in the Spring/
6. the Festival
7. /of celebration of the first New Year
8. /and religious rites of the New Year
9. are taking place
10. /[when] The Watcher/
11. /Stone/
12. /at sunrise/
13. /is illuminated/
14. /by/
15. /the sun/
16. [signed] Star-watcher/
17. Priest
18. /of Osiris
19. /of the Libyan region/

More extraordinary is the depiction referred to as "the cremation scene." With the help of a panel found in a tomb from the Eighteenth Dynasty in Thebes, deciphered by Adolf Erman, Fell shows the scene to represent the Djed Festival of Osiris, the Egyptian celebration of the New Year, which occurs on the morning of the March equinox, now corresponding to March 21, but which Fell says occurred later in March in ancient times.

In this festival, as Fell describes it, parties of worshipers pulling on ropes ceremonially erected a special New Year pillar, called the Djed Column, made of bundles of reeds encircled at the top by rings, representing the backbone of Osiris, in whose honor the column was re-raised each year on the day of the spring equinox. On the left side of the stele is the carving of a mirror, with, beside it, as deciphered by Fell, the Egyptian hieroglyphs for "Mirror of the Egyptians." On the mirror are hieroglyphs that read "reflecting metal." To the right is the rising sun, with the hieroglyph *Ra* (for "Sun god" or "Sun") on the disk of the sun. Stars seen in the morning are above.

On the Erman stele the Egyptian record tells that the ceremony occurred in Koiakh, a word meaning "the month of March." On the Davenport stele, the Egyptian text goes on to say that it is the work of Wnty ("star-watcher"), presumed by Fell to be a priest of Osiris in the Libyan region.

Iowa glyphs compared to Egyptian glyphs, showing the identity between the formal hieroglyphic, the hieratic, and the Iowan signs.

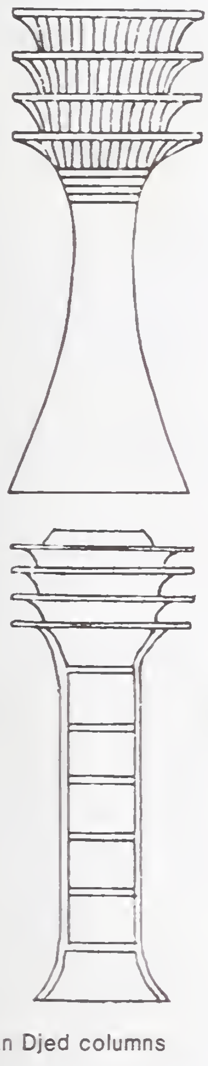


As to how the stele came to Iowa, Fell speculates that though the stone appears to be local, and engraved in America, it was perhaps copied by a Libyan or Iberian astronomer from an older model brought from Egypt, or more likely from Libya.

As to the genuineness of the stele, Fell points out that at the time Gass found the stone, neither the Libyan nor the Iberian scripts had been deciphered, which would have made it impossible for an impostor to produce texts consistent with the hieroglyphic text. Fell says the style of the Egyptian writing could be as old as 1400 B.C.; but he doubts that the stele itself celebrates a ceremony taking place in Iowa earlier than about 800 B.C.. because "we do not know of Iberian or Libyan inscriptions earlier than that date."

What is clear, says Fell, is that Iberian and Punic speakers were living in Iowa in the ninth century B.C., making use of a stone calendar regulator whose Egyptian hieroglyphs they could read. These settlers, says Fell, had presumably sailed up the Mississippi River to colonize the Davenport area; he then hazards the guess that the colonists came in wooden ships commanded by a Libyan skipper of the Egyptian navy, sometime during the twenty-second Libyan Dynasty, the pharaohs of which were energetic men who favored overseas exploration. With them, he says, probably came an astronomer priest, and either he, or one of his successors, engraved the Davenport calendar stone.

On the reverse face of the Davenport tablet the scene depicted is the corresponding equinoctial Hunting Festival, Hunting scene on the reverse side of the Davenport stele above and below two recumbent obelisks. Fell considers this the earliest known example of Micmac script. Unlike the Djed Festival, which is an Indian copy of an Egyptian original, this is the work of an Algonquin Indian dating back perhaps two thousand years. Fell roughly translates the text—which is replete with Egyptian features—as: "Hunting of beasts and their young, waterfowl and fishes." And: "The herds of the Lord (illegible) and their young, the beasts of the Lord."



Egyptian Djed columns

held in September, six months after the Djed Festival, marking the second half of the Celtic year; based, evidently, on the Egyptian year. Fell sees this side of the tablet as being copied from an earlier original by Algonquin Indians about 500 B.C., though possibly as late as A.D. 100.

In the foreground a hunting scene deals with the September butchery and smoking of young wildstock, including waterfowl and fish. In the upper part of the picture are the portions of wildlife left unmolested, labeled in the text "Herds of the Lord." These scenes are explained in a double line of letters running down the center of two prostrate obelisks. The letters read from right to left, toward the center, with the animals facing the reading direction, as is usual with Egyptian glyphs. But why two huge prostrate obelisks should be depicted on a stele in

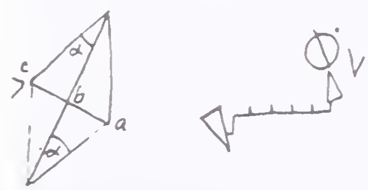
Geodetic functions of the two obelisks on the Iowa stele

Hu-ne
The sun's rays

(text missing)

go-no ne
at varying angles (or, at various latitudes)

sa-na
similar (tri-angles)



(text missing, but self-explanatory). If an obelisk at a casts no shadow, when one at b has a shadow bc subtending a zenith angle α, by similar triangles, α must also be the angle subtended at the center of the Earth's curvature by the line ab, for, as shown above, the sun's rays are parallel).

5. At Philae ( ), modern Aswan, the sun ( ) can stand overhead, casting no shadow. From Philae northward to the coast ( ) is a distance of 5 thousand stades.

6. When the sun casts no shadow at Philae, the shadow it casts at is (angular 2/100ths), i. subtends one fiftieth part of 360°.

Therefore the entire circumference of the earth equals ((5000 divided by 2) times 100) stades

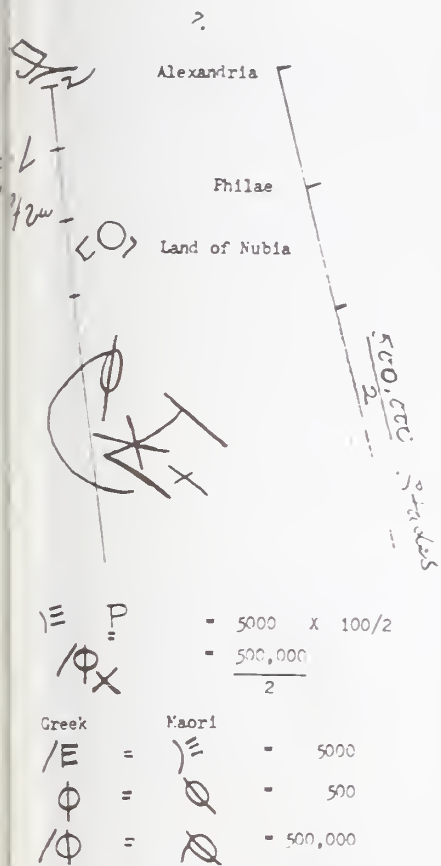
the middle of Iowa, and what was meant by the triangle at which they point, is left unsaid by Barry Fell. However, from another of his papers, dealing with Egyptian-Libyan hieroglyphs found on the wall of a cave in New Guinea, it is clear he understands that for the Egyptians the obelisk functioned geodetically as well as colendrically.

In 1937 an expedition from the Frobenius Institute of the Goethe University of Frankfurt am Main visited a series of limestone caverns on the coast of McCluer Bay, in northwest New Guinea. On the walls they found a number of inscriptions which they were able to establish as having been drawn between 235 and 225 B.C. The incriptions, as deciphered by Fell and his fellow epigraphers, are in ancient Maori, which Fell has shown to be based on ancient Libyan, with elements of Greek, Carthaginian, and occasional Egyptian hieroglyphs.

The writing indicates the author to have been a Captain Maui in the Egyptian navy acting as navigator and astronomer to the expedition's commander, a man named Rata. The expedition, though serving as a squadron of the Egyptian navy, was actually Libyan, says Fell, Libya then being a province of Egypt. As Rata and Maui correspond to the names of traditional leaders in Polynesian tales, the inscriptions also give an historical base to Maori legends. An eclipse, mentioned in the inscriptions as having taken place in November of the fifteenth year of the reigning pharoah, enabled Fell to identify the monarch in question as Ptolemy III, grandfather of the Ptolemy celebrated in the Rosetta Stone, in the fifteenth year of whose reign an eclipse occurred, on November 19, 232 B.C. From the fact that wives and children are indicated as being in the expedition, Fell infers that it was one of those sent out by Ptolemy III "to seek new sources of gold for his enormous gold coinage emission," with a secondary aim of circumnavigating the world, a goal barred to the voyagers by the west coast of America.

The most extraordinary of these inscriptions directly refers to Eratosthenes—then professor of mathematics in charge of the great library of Alexandria—as being an acquaintance of Maui who personally demonstrated for him his method of computing the circumference of the earth by means of obelisks. The glyphs on the walls of the New Guinea cave explicitly show the use of the shadow of an obelisk in determining the angle of the sun's rays, and, by similar triangles, the latitude of the location. The text speaks of how this particular theorem of Eratosthenes, "an astronomer of the Delta country in Lower Egypt," was disclosed to Maui. The text specifies that because the sun's rays intercept the atmosphere at varying angles, and therefore latitudes, when the sun stands overhead at Philae (or Syene), it casts no shadow at the solstice. The text also states that from Philae northward to the coast is a distance of 5,000 stadia. Thus, it explains, when the sun casts no shadow at Philae, the shadow it casts at the coast, 5,000 stadia to the north, is 2/100ths of a full circle; that is to say, 1/50th of 360°, or 7.2°. Therefore, if 5,000 stadia equals 7.2°, the entire circumference of the earth must be 5,000 stadia times 50, or 250,000 stadia.

The first mention of this theorem by the Greek author Kleomedes, about a century after the dating of the inscription in New Guinea, states that Eratosthenes read in a book in the library at Alexandria that on the summer solstice a reflection of the sun can be seen in the water at the bottom of a well at Syene (or Philae) at midday. An additional epigraphic fragment in Maori from Sosorra, as translated by Fell, says textually: "It is a fact that whenever the sun's image is seen in the water at the well at Philae in Egypt, the obelisk erected at Alexandria at that instant is observed to have a shadow."



Fell's translation of the Sosorra Rebus (with material of Joseph Roder and permission of the Frobenius Institut of Frankfurt am Main)

ntpw
it is a fact that

pwtrw
whenever

Rnwi nw
the sun's image is seen

nt hnmt
in the water of the well

Tmir
in Egypt

Ø I ∧ E
at Philae

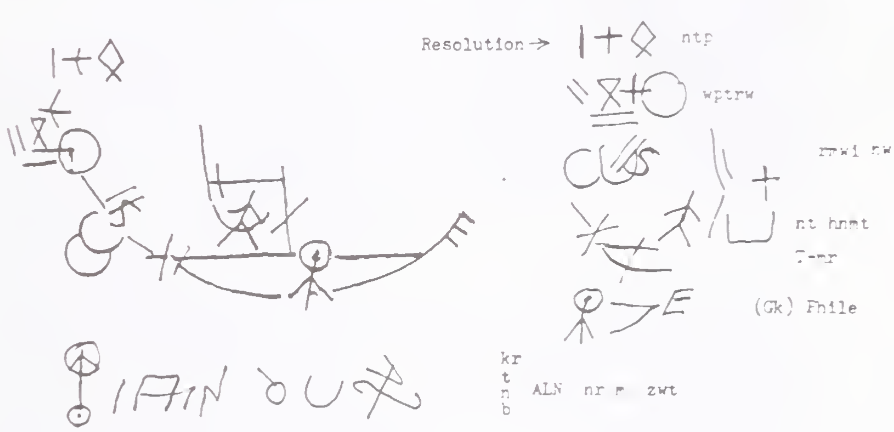
bn tkr
the obelisk erected

ALN (Greek letters)
at Alexandria

m
is with

nr
at that time

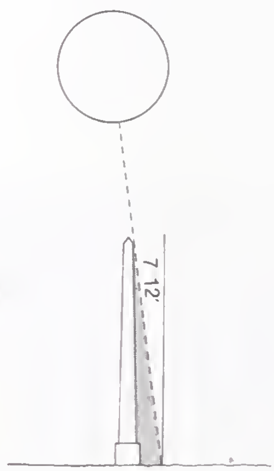
ZWT
shadow



Fell notes that in this section of the calculation, vowels are omitted, with the interesting result that the sequences of residual consonants correspond almost exactly to standard Middle Egyptian forms—where the vowels are similarly omitted. Thus, if the Roman-letter equivalents are inserted in place of the Maori alphabetic signs, the text can be translated directly from the standard dictionary forms of Egyptian as given by Faulkner.

Kirchner related how the Arabs called Heliopolis Ainschems or "the eye of the sun," and that in the temple of the sun there was a marvelous mirror, constructed with great art to flash back the rays of the sun. And the Arab chronicler Maqrizi tells of two obelisks in Heliopolis, one of which was still standing in the fourteenth century, 50 cubits high, tipped with shining brass or electron, whose functions were to mark the extremes of the solar passage at the solstices. "The moment the sun enters the first minute of Capricorn, that is the shortest day of the year, it reaches the southernmost of two obelisks and culminates at its summit. When it reaches the first minute of Cancer, that is to say the longest day in the year, it reaches the northernmost obelisk and culminates at its summit."

According to Professor Pochan, the observation well used by the ancient Egyptians to establish the moment of solstice was not at Elephantine but at Philae, whose latitude was 24° 1′34″. He says that Elephantine was on the Tropic in 3200 B.C., but by the time of Eratosthenes, the Tropic had shifted to 23° 44′8″. The cubit used by Eratosthenes, says Pochan, was the Philae unit of .5275 meters, rather than the Elephantine cubit of .52367. The distance between Alexandria and Philae, which Eratosthenes computed as 7.2°, or 5,000 stadia, was marked by two obelisks at Philae, and was the exact halfway point on the meridian measured by the Egyptians from Alexandria all the way to Meroë, deep in southern Nubia. It shows, says Pochan, that the Egyptians knew the correct dimensions of the planet at least as early as 4800 B.C.

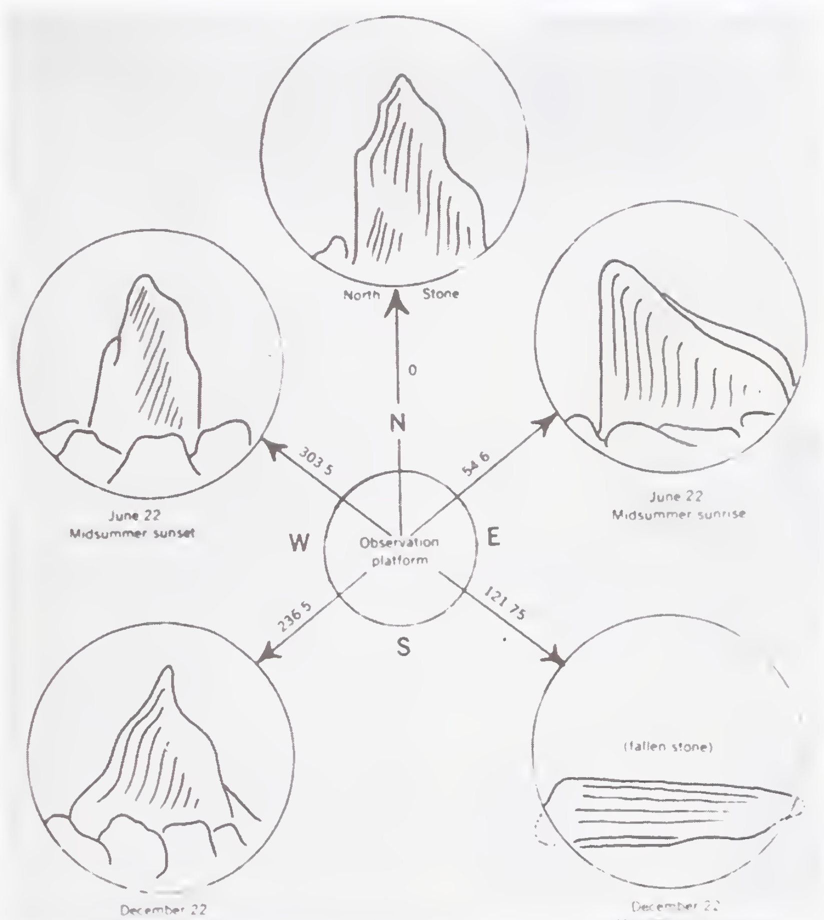


The French professor André Pochan, in a bulletin of the *Royal Geographic Society of Egypt,* points out that in this arrangement at ancient Heliopolis the equinoxial line passed exactly between the two obelisks and that as the sun reached this line it gave rise to the Egyptian word Ph or Pâque which means "reaching or touching the rising sun at Passover." Furthermore, says Pochan, the Egyptians had similar observation devices at Tanis, Hermontis, Esne, Edfu and Thebes, and the glyph for the festival of the Spring equinox was or BaRa(m)—the sun in Ram between two obelisks, or Djed pillars. From this, says Pochan, the Moslems got Bairam or Ramadan.

Thus, according to the French professor, the Egyptian astronomers and geodesists established the equinox with a Djed pillar and a mirror. That they also did so with a well and an obelisk is equally clear. But you have to start on the Tropic of Cancer, or better still exactly at Syene where, at noon of the summer solstice, the sun will pass directly overhead, causing no shadow in a well. And any obelisk, in the same location, of whatever height, will also cast no shadow at noon of the solstice.

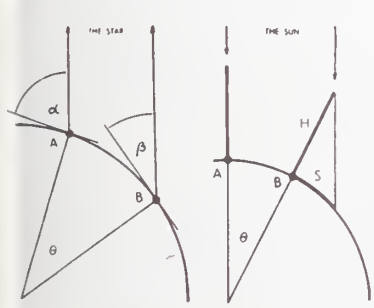
Why the Egyptians placed their sophisticated observatory at Syene at 24°06′ instead of at 23°51′, the actual line of the Tropic, is explained by the late Professor Livio C. Stecchini (in his appendix to *Secrets of the Great Pyramid*). By deciphering a common glyph of three short parallel lines which appears on virtually all the thrones of the pharaohs, Stecchini realized that the Egyptians calculated three different values for the tropic: 24° as a round figure for their mapping; 23°51′ for the actual path of the Tropic; and 24°06 for the actual point of observation at Syene. This, Stecchini explains, was because they knew that in order accurately to achieve the effect of the shadowless well, or shadowless obelisk, on one particular day of the year, they had to place their well or obelisk *half the diameter of the sun, or 15′,* north of the actual Tropic.

Once established that an obelisk casts no shadow at the Tropic at noon of the solstice, it matters not where the obelisk is raised; by knowing its height, and by measuring its shadow at noon of the solstice, the latitude can be established. To mark out a year's solar calendar, all that is needed is an obelisk; its shadow will automatically give the solstices, or longest and shortest days of the year, as well as the equinoxes and four intervening festivals, which can be marked out with horizon stones in a great circle as at Mystery Hill in Salem, New Hampshire, and elsewhere.



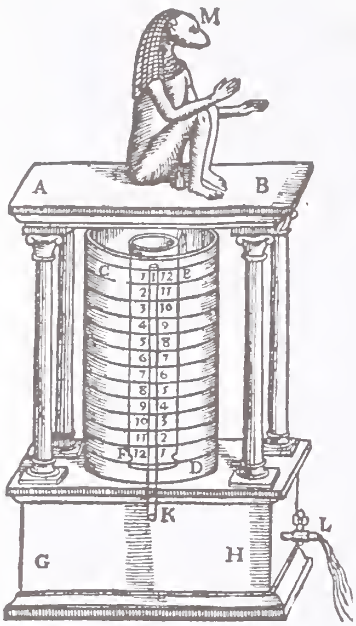
The Calendar Circle at Mystery Hill, New Hampshire, as drawn by Barry Fell and Osborne Stone, with the stone markers seen through a transit telescope from the observation platform marking the point of sunrise and sunset at the solstices and equinoxes

Berriman demonstrates how the circumference of the earth can be estimated by measuring a meridian length from *A* to *B* (between two obelisks several miles apart) and the length of the shadow at *B* when there is none at *A*. The same result is achieved by measuring the difference in angle of elevation of a star observed from two different points.

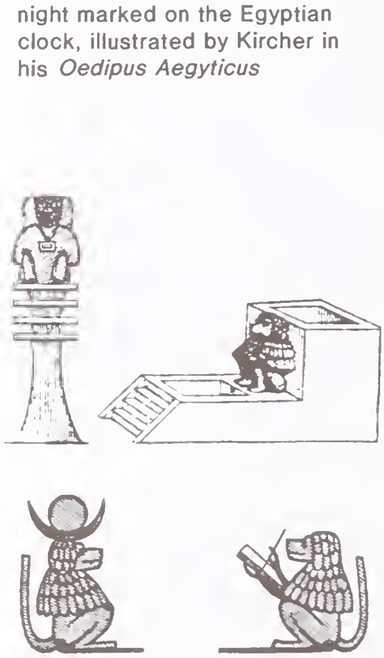


By measuring the distance between two obelisks on the same meridian and comparing their shadows as measured at solstice or equinox, it is simple, accurately, to extrapolate the circumference of the planet. Algernon Edward Berriman, in his *Historical Metrology,* shows that the same result can be obtained by measuring the difference in star angles between two obelisks at a known distance apart.

That the Egyptians used the Djed Column to establish the equinox and with it control their water clocks is clear



Urinating monkey with the twelve equinoctial hours of the day and night marked on the Egyptian clock, illustrated by Kircher in his *Oedipus Aegyticus*



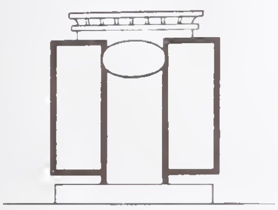
The Kaf-ape, known as the clicking cynocephalus, because its clicks are believed to have preceded human speech, was used to represent the god who taught mankind speech and the hieroglyphs which led to alphabetic letters. By natives in Africa the dogheaded ape is still regarded with respect because it is believed to have an intelligence of the highest order, and can be more cunning than man.

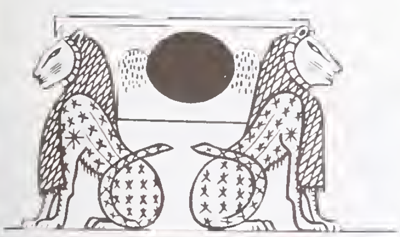
from a carving on the ceiling of the Ramesseion in Thebes which shows a Djed Column surmounted by a cynocephalous monkey producing water from its penis. Horapollo explained the symbol: "To signify the two equinoxes they—the Egyptians—depict a sitting cynocephalus, for at the two equinoxes of the year it makes water twelve times in the day, once in each hour, and it does the same also during the two nights; wherefore not without reason do the Egyptians sculpture a sitting cynocephalus on their Hydrologia (or waterclocks); and they cause the water to run from its member, because the animal thus indicates the twelve hours of the equinox. And lest the contrivance, by which the water is discharged into the Horologium, should be too wide, by discharging the water quickly, does not accurately fulfill the measurement of the hour, neither the one that is too narrow, (for against both of these cautions must be taken, for one that is too wide, by discharging the water quickly, does not accurately fulfill the measurement of the hour, neither the one that is too narrow, since it lets forth the water little by little, and too slowly), they perforate an aperture to the extremity of the member, and according to its thickness, insert in it an iron." Furthermore, as was shown on the base of the Theban obelisk removed by LeBas, the male cynocephalous was used as a symbol of the priest, worshiping the sun at rising, with arms and phallus erect, for which, as Kenneth Grant shows in his *The Magical Revival,* "Horapollo preserved a talisman or gnostic gem in yellow jasper, on which was engraved a cynocephalus, crowned with baton erect, adoring the first appearance of the moon."

In ancient Egypt the passage of time was also registered in the temples by the periodic fluxes of the sacred baboon, the female cynocephalous, or dog-eared ape. As Grant points out, "She was the first Mother of Time in the pre-human phase of symbolism, and the prototype of the clepsydral horologue"—or waterclock.

Horapollo also gives a vivid description of how the ancient priests of Egypt used both male and female cynocephalous to establish the moment of eclipses: "At the exact instant of the conjunction of the moon with the sun, when the moon becomes illumined, then the male Cynocephalus neither sees, nor eats, but is bowed down to the ground with grief, as if lamenting the ravishment of the moon. The female also, in addition to its being unable to see, and being afflicted in the same manner as the male, emits blood from the genitals; hence even to this day Cynocephali are brought up in the temples, in order that from them may be ascertained the exact instant of

Mexican relief in Palenque with the equinoxial lions, recognized by Masons as replete with Masonic symbolism





Equinoctial symbols identical in meaning with similar Mayan glyphs in Yucatán. The two lions represent Shu and Tefnut, guardians of the stability of the rising equinoctial sun.

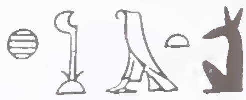
the conjunction of the sun and the moon. And when they would denote the renovation of the moon, they again portray a Cynocephalus in the posture of standing upright and raising its hands to heaven with a diadem on its head. And for the renovation they depict this posture, into which the Cynocephalus throws itself, as if congratulating the goddess, if we may so express it, in that they have both recovered the light."

A clue to the depth and subtlety of the Egyptian use of symbols, and especially animal symbols, to denote philosophic and cosmic realities is given by Grant in his *Cults of the Shadow,* where he points out, with reference to the periodic emanations of the female cynocephalous, that "Time is the menstruum in which all material forms arise, transform and finally dissolve."

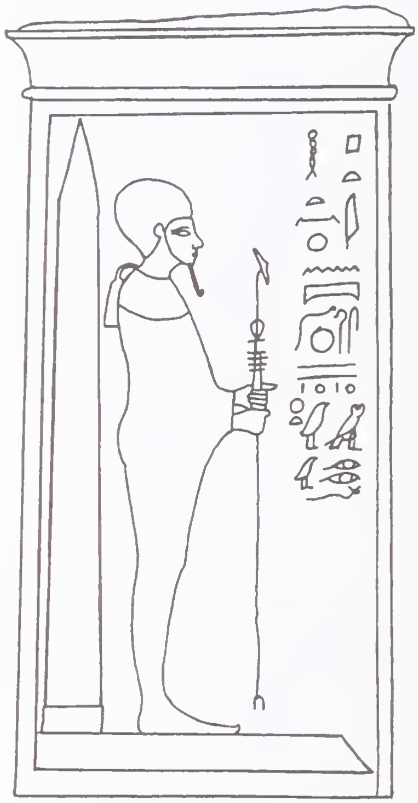
And so, at last, becomes clear the ancient purpose of the obelisk and Djed pillars in what could be called a precataclysmic era. Sometime far back in Egyptian history a geodetic view of the world and an astronomical view of the heavens were put together from a viewpoint that was located on the equator. Seen from this equatorial vantage, the earth was pictured falling off northward toward the North Pole and southward toward the South Pole, at each of which there appeared to be a fixed star for the heavens to revolve around. These poles were symbolized by two obelisks, one for Horus and one for Set, each of whom was considered to hold sway over half the globe, on either side of the equators. A similar division was made of the starry planisphere, from zenith to nadir, Horus charged with the northern half, Set with the southern, each equally responsible for twelve of the day's twenty-four hours—all of this, of course, long before any satanic, sinister, or evil character had been attributed to Set.

East and west, at the ends of the equatorial—and stably equinoctial—line, Shu and Tefnut, supporters of the sky, were pictured as the two lions of the "double-horizon," keepers of the balance between Horus and Set. This equatorial world—where there was obviously no solstice—was known as Apta.

The Jewish historian Josephus, who attributed to the children of Set(h) the invention of astronomy, preserved the tradition of two pillars erected in the land of Siriad, which Plato mentions in the *Timaeus,* but could not locate. According to John Greaves, who measured the Great Pyramid with Burattini in 1639, "these pillars of Seth were in the very same place where Manetho (the Egyptian historian priest of the third century B.C.) placed the pillars of Taht, called Seiread." Gerald Massey, in his two-



Zootypes of Set



Ptah as the universe's djed pillar of stability. Ptah, "the father of fathers," was considered creator of the universe. Fashioned of his own body in his own image was Ra, the Disc of Heaven. In *The Book of the Dead,* Ptah is said to have raised up the gods from inertness, meaning that all the gods were merely other forms of Ptah himself. As master architect of the world, Ptah fashioned the bodies of men on earth and in the Tuat, or heaven. He is depicted as raised upon the level of Maat, or justice, bearing the menat, symbol of well-being and sexual intercourse, the ankh of life, and the djed pillar of stability.

volume *The Egyptians,* says *Seri* in Egyptian is a name for the south, and is also "the mount that is figured as the twofold rock," equivalent to "the pillars of the two horizons, south and north." And, as Massey points out, Seri is also the name of the giraffe—a zootype of Set.

Clearly something must have happened to upset this balanced equatorial view and forced it to be exchanged for one seen from much further to the north. Either the scanners of the sky moved north, or some agency caused a tilt in the planet. In either case, or both, it is clear that the domain of Set was seen to fall away into the underworld. Set's fixed star of the South Pole vanished. Fewer and fewer of the southern stars and constellations still rose above the horizon. And the north celestial pole, as it rose in the sky, became imaged as a dominating mountain, a summit for the gods. But as the ancient priests of Egypt, says Jean-Louis Bernard in his most original *Aux Origines d'Egypte,* were mythologers and astronomers as well as geographers, in their equation Horus came to symbolize the boreal constellation as the home of the gods, while Set, rather than being merely the geographical south, became the fire in the center of the globe. Thus Horus became the cold of the cosmos and Set the telluric heat of the earth.

The story of the two pillars, and the disappearance of the southern one, was kept alive in the Greek myth that tells of the temple of heaven being raised high by two brothers, Trophonios and Agamedes, followed by the sinking of Trophonios into a cave, corresponding to the engulfing of Set as the disappearance of the South Pole below the horizon. Travelers from the equator arriving in the valley of the Nile, 3,000 miles north, apparently continued the device of dividing their new land into two realms, a northern one for Horus, a southern one for Set, staked out by two obelisks.

Legend states that two pillars were reerected at Annu as symbols of the northern and southern poles. Massey says the original meaning of *Annu* or *On* appears to have been "the place of the pillar, or stone, that marked the foundation which preceded the ⊕ (equatorial) sign"; and, notes Massey, a relic of the two poles may be recognized in the two Egyptian cities of Annu—called by the Greeks Hermonthes and Heliopolis. The line between the two obelisks, as Pochan has demonstrated, marked the equinoctial Passover. Further legend relates that eventually the two pillars of Set and Horus were united into the Tat or Djed Column raised at the winter solstice. But here the legend becomes spiritual and eschatological, for it is said in the *Book of the Dead:* "When Osiris-Ptah had built his mansion in the double earth, the two horizons were united. Two pillars at the gateway to his house were Set and Horus." These pillars were portrayed as the double Tat or spiritual Djed stones of eternal stability in the making of Amenta, the Egyptian world of the dead.

Amenta as described by Massey "was the secret but solid earth of eternity opened up by Ptah when he and his followers, the seven Khnemmu, erected the Tat pillar that was founded in the winter solstice as the figure of a stability that was to be eternal." Some further clarity may be obtained in this apparent confusion if the mythological, astronomical, and eschatological views are kept separate, even though the characters and symbols appear and reappear in every scene. Whereas in the myths the Tat pillar represents the sun at the winter solstice, a sun which has the power of returning from the lowest depth and thus completing its eternal round, in the eschatology the Tat column is the god himself in the person of Ptah-Sekeri, or Osiris, the backbone and support of the universe.

The figure of Amsu-Horus rising in the resurrection, or "coming forth" with member erect, has a dual character, says Massey: one in the mythology, one in the eschatology. In the mythology, he images the phallus of the sun and the generative force that fecundates Mother Earth. In the eschatology, the image of erection is repeated as a symbol of the resurrection; and in this phase, the supposed phallic god, the figure of regenerative force, is typical of the resurrection or reerection of the mortal in spirit.

Horus erecting the Tat in Sekhem (Sekhem being the glyph for potency or erectile force) was the raising of Osiris from the sepulcher; it was the father reerected as the son, or the typical resurrection and continuity of the human spirit in the afterlife.

The figure of Amsu-Horus resurrecting or "coming forth," with member erect, had two characters, one in the mythology, one in the eschatology. In the mythology he images the phallus of the sun and the generative force that fecundates Mother earth. In the eschatology the image of the erection is repeated as a symbol of resurrection; and in this phase the supposed phallic god, the figure of regenerative force, is typical of the resurrection or reerection of the mortal in spirit.

From this world, geodetic point of view, further clarity is obtained by postulating some real life cataclysmic event, or even a chain of such events, which affected the mythological characters in their astronomic settings, putting an end to what may have been the legendary and evidently equinoctial Golden Age of Saturn, in a land of "welling waters" where food came of itself and was perpetually renewed with little need for labor.

As the astronomer geodesists moved north, in a world whose axis may have tilted, they seem to have reproduced their former system with its former mythological, astronomical, and eschatological characters, but in a new geodetic and astronomic setting. Upper and lower Egypt were divided into seven nomes (each 1° of latitude) under the starry circle of the Great Bear, the goddess Apt, Taurt or Khept, symbolized by a big-titted female hippopotamus, mother of the cycles of time, with the *meanit,* or bull-roarer by her womb to represent the great generative source of life. Behind her stood a crocodile for the constellation Draco. No wonder the general picture as reconstructed from glyph, text and legend is not always pellucid, and often appears garbled, no doubt by the passage of several thousand years. But the central points remain.

Egyptian star-gods near the north pole. The hippopotamus, or Apet, with the crocodile over its shoulder corresponds to the constellation of Draco, the good dragon that coiled about the pole of heaven to protect the fruit of the Tree of Life. Stecchini says the line held by the figure of Horus marks the earth's polar axis terminating in the bull, Egyptian glyph for the Great Bear. E. A. Wallis Budge saw Horus as "attacking the Great Bear," and despite the overwhelming evidence before him of the vast and sophisticated astronomical science of the Egyptians, he continued to maintain that the Egyptians had "borrowed their knowledge of the Signs of the Zodiac, together with much else, from the Greeks."

The raising of the Djed, or Tat, Column, from a geodetic and astronomic point of view, was the restabilization of the axis of the world, and of the sky. As Livio Stecchini has pointed out, both poles, one for the earth's polar axis, and one for the sun's polar axis, were clearly known to the ancient Egyptians, who differentiated them in their designs, aware that the one formed a small circle around the other, causing the equinoctial point in the heavens, as observed from earth, to advance each year for the twenty-six-thousand-year cycle of the Precession of the Equinoxes.

In the myth in which Shu-Anhur lifts up the heaven from the earth, the Egyptians explain that the pillar of heaven was first erected. This pillar of heaven was envisaged as standing upon the earth; but when, in mythology, the earth was "hollowed out by Ptah," there was formed another earth below, in which the pillar had to be reerected. This pillar of "the double mount" was represented by the double Tat of Ptah as the backbone of that god, who later became Osiris. Eschatologically, when the sky was re-suspended by Ptah in the other world of Amenta, the act was symbolized by raising up the Tat type of stability and support. This not only sustained the sky of the nether world, it also imaged the divine backbone of the universe.

As Gerald Massey, who has the most scholarly, extensive, and intuitive approach to this view, points out in *The*

Egyptians, "knowing as they did that the earth rotates on its axis, afloat in space, the two poles of the earth were signified by the two-fold tat-pillar of Ptah, doubled when Amenta was founded. . . . The two obelisks, then," he notes, "imaged the thrones of the two worlds, the double earth, or earth and heaven, and in Amenta the two pillars form the doorway from the one world to the other."

The power that sustains the universe is Ptah in one cult, Osiris in the other. God and cross are one. The deceased arises from the tomb as Tat for eternity in what is known as the mystery of Tattu.

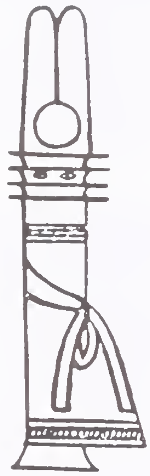
The ceiling zodiac removed from the Temple of Denderah, analyzed by R. A. Schwaller de Lubicz. It shows the circumpolar constellations spiraling rather than circling the pole of the ecliptic, indicating an understanding of the circular wobble made by the earth's north pole around the pole of the ecliptic, which causes the phenomenon of the precession of the equinoxes, whose ages are here identified on the zodiac by special markers on the perimeter.

When Queen Hatshepsut erected her two pillars, she said she had made two obelisks "for him who is the lord of the thrones of the two worlds—of earth and of heaven." The double obelisk, according to Massey, is a cotype of the twofold mount (of the poles) and the two pillars of Tattu, the place where it was shown that earth was fixed and heaven made stable forever on the two pillars of Set and Horus, which had once been the two poles in Equatoria.

The Tat, says Massey, was a figure of the pole, and the four corners, which united "five supports," the fivefold tree of the Egypto-gnostic mystery. Otherwise stated, it was a symbol of the power that sustained the heavens with the supporting pole and the arms of the four quarters. This power was personified in Ptah as well as figured in the Tat.

The tree was first of all a sign of sustenance when the sustainer was the Great Mother, Apt. On this, the type of Ptah was based as the Tat-image of a power that sustained the universe. Osiris-Tat then typified the power that sustained the human soul in death. This symbol Tat was buried with the mummy as a fetish in the coffin. Thus a cult of the cross was founded many thousands of years ago. And thus, says Massey, the genesis of the legend of the cross, like that of the Christ, can be traced in Egypt to the cult of Ptah at Memphis, where the religion of the cross originated; and to Annu or On where it was continued in the cult of Atum-Ra with Ie-em-hetep as the Egyptian Jesus.

Iu-em-hetep, says Massey, was the god Iusa, brought out of Egypt by the Jews—for thirteen thousand years the bringer of goodwill and peace and plenty to the world. "The Christian doctrine of the crucifixion, with the human victim raised aloft as the sin-offering for all the world, is but a ghastly simulacrum of the primitive meaning; a shadowy phantom of the original substance." Fundamentally, according to Massey, the cross was astronomical, a



The raising of Djed, or its "awakening," has been called the mystery of mysteries, or the secret of resurrection. The human body is described as an illusory solid, perishable, but what caused it was a real solid: the original djed, or "word" of Amon-Ra-Ptah. This djed "word," or pillar of Osiris, is described as the base of relative stability, and principle of whatever is durable in the fluctuating Osirian world of becoming and return. Man's job is to learn to make his own djet—or inborn word—secure against destruction. When awakened, man's djet becomes his incorruptible body. It is said to remain a prisoner of earth and Osiris unless Ra comes to deliver it by "untying the rope" or "undoing the knots." The two principles of Ra-Osiris are seen as the life-givers to the human djet, symbolized by the souls of Ra and Osiris shut up in the djed, or pillar. As such they are the two currents of universal life whose source is one, though they are two in nature. This duality is the cause of terrestrial continuity and the endless metamorphosis of the Osirian way. To escape from such slavery the soul of Ptah-Ra must absorb the Osirian: the universal must vanquish the particular.

figure of time, as is any clock. It is a measure of time made visible upon the scale and in the circle of the year instead of the hour. A cross with equal arms denotes the time of equal day and night, a figure of the equinox. Another cross, †, like the Christian cross, with one elongated stem, is a figure of the winter solstice. It is a modified form of the Tat of Ptah on which the four quarters are more obviously portrayed in the four arms. This elongated cross, or Tat, was reerected annually in the depths of the solstice when the darkness lasts some sixteen hours and daylight only eight.

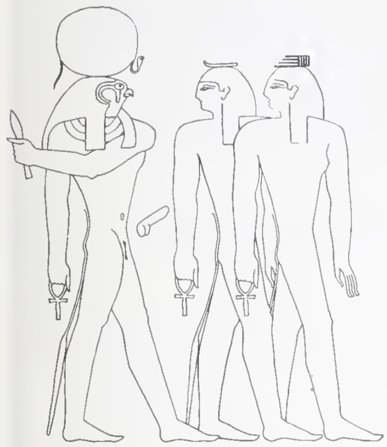
The Tat cross is a type of the eternal Tattu. It was the figure, says Massey, of the all-sustaining, all-renewing, all-revivifying power that was reerected and religiously sought for hope, encouragement, and succor when the day was at its darkest and things were at their worst in physical nature—when the sun was apparently going out.

The Tat—for the time being—was overthrown. The deity suffered and was represented as dead. The god in matter was inert and breathless. Then they raised up the Tat, portraying the resurrecton of the god. "Let the mummy-type of the eternal be once more erected as the mainstay and divine support of all." It was thus, says Massey, that the power of salvation through Osiris-Tat was represented in the mysteries.

The work *Djed* in ancient Egypt meant "stable" or "durable." But it was used not only to represent a cosmic pillar, or sky support; it was also a symbol for revival and resurrection.

At their mystery festivals the Egyptians represented the passion of Osiris, the scandal of his death, and the miracle of his resurrection to a radiant immortality. As E. A. W. Budge points out, the Djed was in very primitive times the symbol of a god to which human sacrifices were offered, and the ground in front of it was "watered" with the blood of human beings, sometimes foreigners, sometimes warriors taken prisoner alive. The victims were slain before the Djed pillar, symbol of Osiris, and their blood was dug into the earth to make it fertile again. Osiris's death was commemorated by eating the body and drinking the blood—later the eucharist or mortuary meal at the Easter equinoctial festival of death and rebirth.

In the previous eon the Great Mother was sacrificed—comparatively young, says Massey, to preserve her from the effects of age, disease, and decrepitude. Her flesh was torn to pieces and her blood drunk to give life to her children. Salvation in this eschatology came from the virgin blood in which Horus was incarnate and made flesh.



According to the Egyptian myths, the divine pair Hu Saa came into the world when Ra in his solitude cut off his sexual organs. The two deities arose from the blood of the sun god.

Later the ritual was performed symbolically with bread and wine in lieu of the body of Osiris-Horus; later still with Jesus. As Massey points out, the Egyptian Horus was continued by the various sects of gnostics under both the names of Horus and Jesus.

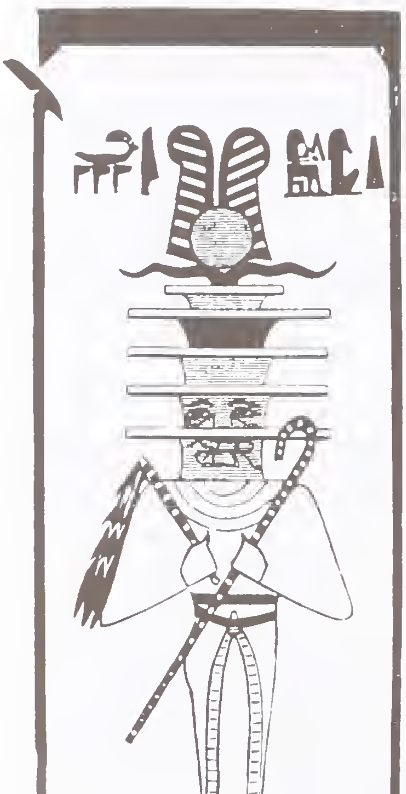
Egypt, says Massey, had anticipated Rome in attaining the "unbloody sacrifice" that was represented by the wafer, or loaf, of Horus as the bread of heaven, which took the place of flesh in the eucharistic meal, while retaining the beer or wine, as substitute for blood, representing the female element.

The earliest form of god-the-father who became a voluntary sacrifice in Egypt was Ptah in the character of Sekari, says Massey. As a solar god he went down into Amenta. There he died and rose again, and this became the resurrection, and the way into a future life as the founder of Egyptian eschatology. Atum, son of Ptah, likewise became a voluntary sacrifice as the source of life. The father who was blended with the mother in Atum, is portrayed as the creator of mankind by the shedding of his own blood. In cutting his member, Atum showed that he was the creator of the blood shed in a voluntary sacrifice. Later, this was ritually done to Attis, Adonis, Tammuz, Bacchus, Dionysus, all facsimiles of Osiris, all castrated on the tree of life, their testicles still glittering on today's Yuletide trees.

The agape was the way of celebrating the resurrection. But death came first. In the Nile Delta, at Busiris, known as "the city of the Djed Column," a great annual festival took place during the last month of the inundation of the Nile when the waters fell off—that is, in September, at the autumn equinox. The ceremony consisted in the dramatization of the death, vigil, and resurrection of Osiris. The final and most sacred act was the erection of the Djed Column, symbol of the backbone of Osiris. When raised upright it meant that Osiris had risen. But not, apparently, in the flesh; in the spirit.

As Rundle Clark, author of *Myth and Symbol in Ancient Egypt,* puts it: "The idea of the Djed Column is that it stands firmly upright—for to be upright is to be alive, to have overcome the inert forces of death and decay. When the Djed is upright it implies that life will go on." The greatest religious achievement of the Egyptians, says Clark, was to take this general fertility god and make him into the savior of the dead; or more exactly, the savior from death. "It was in the soul of Osiris the Egyptians believed they would live on." The rising of Osiris was the central fact in the structure of their universe; this they

There can be little doubt says E. A. Wallis Budge, "that the is a conventional representation of a part of the backbone of Osiris, namely the *sacrum* bone, which, on account of its proximity to the sperm bag, was regarded as the most important member of the body." Tet is the name of a very ancient god whose worship was merged with that of Osiris, and his symbol, says Budge, was the sacrum bone, , placed on a pedestal, which then took the form of the Djed pillar, "which was during the whole of the Dynastic period in Egypt regarded as the backbone of Osiris." The Djed, Tat, or Tet pillar was also the emblem of stability represented by Ptah, "the fourfold support of the universe."



signified by the raising of the Djed, or stability, Column.

Osiris, Clark notes, did not rise up and leave the tomb or underworld. It was his soul that was set free into the life forces of the next year. He was the spirit of Life manifest in sprouting vegetation, in the seed of animal and man, the "orgone" of Wilhelm Reich.

Yet the raising of the column was not the final act of the drama. A loincloth was tied around the middle of the Djed Column, and feathers were stuck in its top. The resulting symbol was treated as a living god, so much so that in the later examples a pair of human eyes were painted onto the column to make the identification with Osiris more emphatic. Around the Djed was tied what Clark calls "a strange object known as a Tit, a knot of cloth or leather." This was the emblem of Isis, or the Mother Goddess. It is the symbol of the blood of Isis, when she gave birth to Horus.

Clark has trouble with this symbolism: "It is presumed that this combination of emblems denotes the Union of Isis and Osiris. . . . This union of male and female obviously has some meaning, but it is impossible to see how it links up with the rest of the symbolism."

Massey has less trouble. He explains the mysterious rag attached to the raised Tat: "It is the feminine garment, or apron, called the garment of shame because it was the garment of impurity to be trampled underfoot when the male and the female were to be made one in spirit, as spirit." And the same feminine garment, Massey points out, "is still worn without shame as the bishop's apron," an apron he traces back to the feminine loincloth first worn by that sex, for what he calls "the most primitive and pitiful of human needs at the time of puberty." The bishop in his apron, says Massey, "like the priest in his petticoat and the clergyman in his surplice, is a likeness of the biune being who united both sexes in one."

So the equinox came to be considered a symbol of equality, of all things being on a level. And promiscuity was a mode of making things fair and even in the sexual saturnalia. High and low, rich and poor, young and old commingled "on the mound, the hill, the high places." To symbolize this equality, a pair of scales was also erected at the equinox, "for with them the equilibrium of the universe was dependent on eternal equity."

The mystery of reproduction was enacted at the festival as a vicarious means of fecundating the Great Mother by the bountiful sowing of human seed. The ritual survived as the agape, or love feast, of the early Christian cult. The phallic festivals were then repeated at both equinoxes; at seed time and at harvest time. The desire was to produce an unlimited supply of food; and the rites of promiscuous sex were designed to help reproduce the fruits of earth and drive away inimical influences of drought and famine.

The women, being the begetters and regenerators, pleaded that their wombs might be replenished, as Isis and Nephthys had done with Osiris's corpse. Women are described by Elie Reclus in *Curious byways of anthropology; sexual, savage and esoteric customs of primitive peoples,* as losing all feeling of modesty, of becoming raging Bacchantes, wild with debauch. "At the Spring equinox," says Reclus "divinized Mother-earth had to be stirred from her winter sleep by lascivious spectacle to excite the spirit of fecundity represented by young women who danced and frolicked or lay down and scraped the ground with their heels . . . so many naked Danaes wooing the fertilizing sun . . . bursting out of all disguises, trappings, ties, and stays of civilization, running amok in all the nudity of nature."

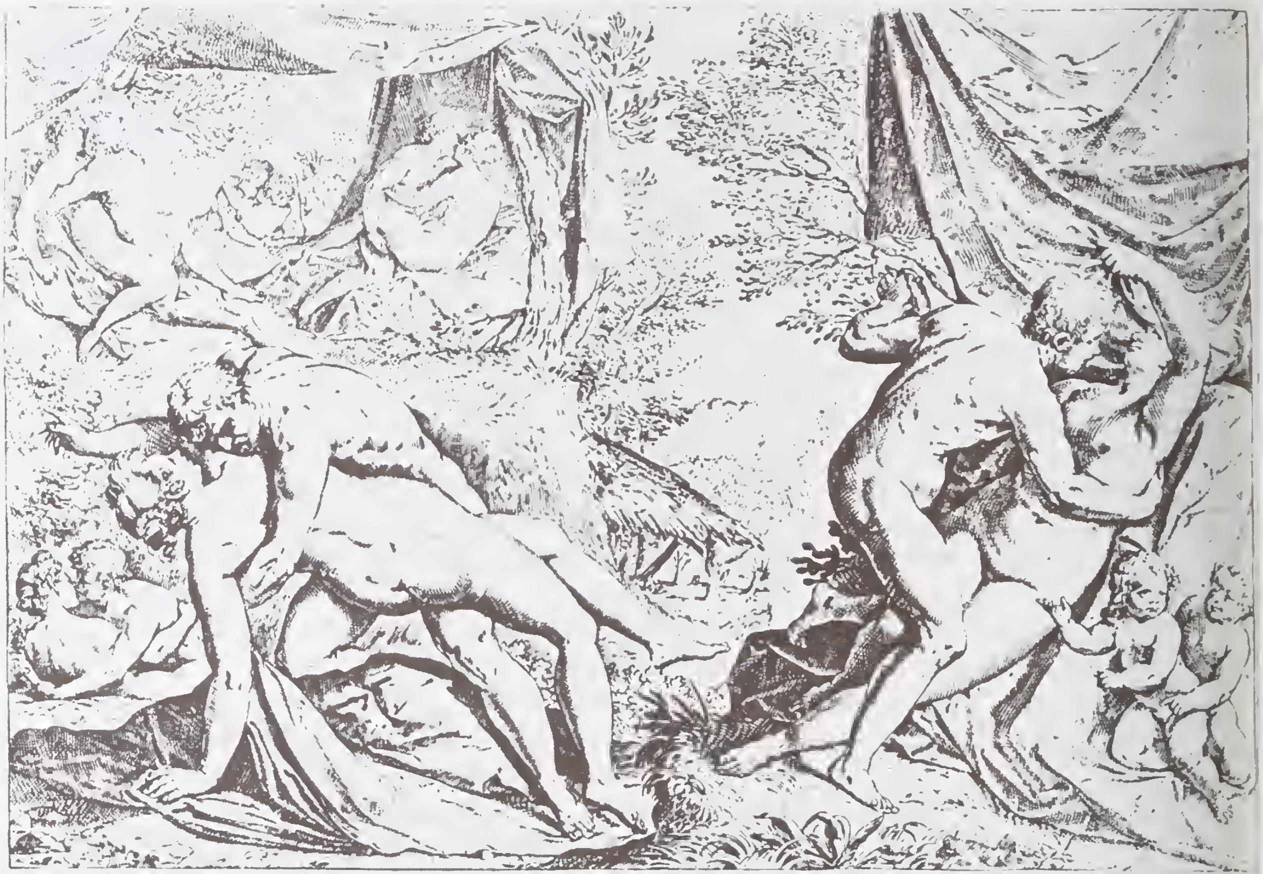
Herodotus reports that in the Delta city of Bubastis 700,000 people assembled to celebrate the annual Festival of the Great Mother, Bast, goddess of strong drink and sexual passion, and that women exposed themselves on boats to watchers on the shores, signifying they were free to all comers, for that occasion only, in service of the goddess, the lioness of heat.

The phallic festival of promiscuous intercourse survived when the mysteries had become religious in Egypt, Greece, and Rome. In Rome the Saturnalia, which was intended to commemorate the carefree era of sexual promiscuity that had once obtained, was a mode of celebrating the fundamental equality of all at the equinoctial period, by means of various leveling customs, in which men and women exchanged their clothes to show the equality of the sexes.

All over the world tribes have reverted to utter promiscuity to celebrate the phallic festival, when "the only law was that of all for all." Reclus describes how with members of marital associations among the Eskimo, each wife must lawfully couple with the man to whom her husband would willingly lend her, and who would lend his own wife in return, holding that "all were made for all, and that sin was for a lawful wife to seek connubium with a bachelor."

In southern India, says Reclus, the Thodigars, at the Festival of Sowing Seed, improvised shelters by the roadside and stocked them with provisions for their wives, calling upon passersby to "procure the public good and ensure an abundance of bread."

Bast has been described as the gentle and fructifying heat of the sun, the very soul of Isis. Not only a pleasure-loving goddess who reveled in music and dance, Bast was protector of pregnant women and of men against disease and evil spirits. But the Hebrew prophet Ezekiel threatened that the joyous young participants of the rites of Bubastics would "fall by the sword and be carried into captivity for their worship of Bast."



Come la palma indicio è di uittoria,
Cosi d' Amor conuenente è il frutto

Quella dolcezza, da cui uien produtto
Il seme, onde Natura, e'l ciel si gloria.

In the world of totem, the raising of a pole served to announce the transformation of pubescent girls into the state of womanhood. The pole, raised high immediately after the ceremony or operation of introcision, was a signal for men from as far away as the pole could be seen to come and enjoy a festival of sexual promiscuity, one at which the freshened girls were "welcomed into communal connubium by the whole totemic group of grown-up males." On this occasion the girls were considered open and accessible to all the males of the group, each of whom had the right to ravish any or as many of the girls as he was able. As Massey explains it, the ritual was a revival of the ancient pretotemic days of totally permissive sexual freedom, free from all taboos.

What has been lost sight of by both the prurient admirer and puritan denigrator of these rites is their spiritual basis as practiced by the Egyptians. The agape, or phallic feast, with its sexual orgies, was a mode of celebrating not only the raising of Osiris, the return of sunshine and revival of vegetation, but the rerising of Horus, prince of Sekhem; Sekhem being the realm of the Akh or "bodies of light," comparable to stars. Horus, erecting the Tat in Sekhem was raising Osiris from the sepulcher; it was the father, reerected as the son in the typical resurrection, and continuity of the human spirit in the afterlife.

The love feast at the equinox on earth symbolized, as Massey explains it, the triumph and regenesis of the soul in Tattu. And the enactment of the "holy kiss," or blending of the sexes in the feast of love, was a dramatic rendering of the union between human nature and the divine, of the original brother and sister, Shu and Tefnut. The "pair of souls" were blended in the Horus of the soul that was to live forever.

According to the mystery of Tattu, in blending back into one the two halves of a soul that was dualized in sex, and dualized in spirit and matter, there was a return to the type beyond sex, from which the soul had bifurcated in the human creation. Thus the two halves of the soul, male and female, Shu and Tefnut, were reunited forever in Tattu.

17. NEEDLING MOTHER EARTH

All over the world, amid all its peoples, in all known ages, obelisk, column, tower, steeple, and menhir have been understood to be phallic symbols, not just of the erect male member, but, as the nineteenth-century English Freemason Hargrave Jennings expresses it, of a "supersensual, superessential, divinely operative celestial 'fire'" —a force which makes things grow, harden, and rise against gravity, fecundating the universe, producing all beings and all life.

Among the Greeks, the most appropriate emblem for the power exercised by this "fire" was considered the dart or arrow—hence the word *obelos*. Every obelisk was a representative in stone of a ray or beam of "far-darting, operative, vivifying fire." It was likewise with the pagodas of China, the towers of India, the minarets of the Muslim, the cairns of Carnac in France, the biblical Jacob's stone, Saint Paul's Cathedral: all, says Jennings, symbolic of the power of creation. And the apex, whether it be the piercing pyramidion of the obelisk or the egg-shaped top of the minaret, represents the glans. The purpose of these phallic symbols, their justification for existence: to venerate the power behind generation, behind production and renovation.

In a 500 page opus on *Phallicism,* and in a 100-page booklet entitled *Obelisks,* Jennings chided his fellow Victorians for believing their science was more advanced than that of the Egyptians, and put forth his view that whereas obelisks, towers, and steeples were representations of the male principle, pyramids, circular forms, rhomboidal or undulating, and serpentine shapes, denoted the female power. Yet all alike, said Jennings, represent the natural motive power which causes and directs the world. Together, the male and female symbols represent the idea of swelling, rising, extending, to be consummated in what Jennings calls "the movement for that grand human act and holy sacrament which secures everything." The pudenda in both male and female he calls magnets, "and their natural, deliriously delightful presentment to each other is magic-magnetism." These phenomenal organs, Jennings observed, "superb and miraculous in their special address and use," are "positive-negative" in man, and "negative-positive" in woman. "Yet both are corporeally and sexually one, in complete coition, or double-tie, or identification of 'two singles' into temporary, absolute 'one single.' "

In these *avant garde* views, Jennings was apparently strongly influenced by Richard Payne Knight's remarkable volume *A Discourse on the Worship of Priapus,* published at the time of the French Revolution, which set out to show that the worldwide worship of generative powers was neither obscene nor depraved. Designed to sell privately, it caused such an uproar in Victorian England that many copies had to be destroyed, so that for almost a century it was hard to find, until recently reprinted. From its sober scholarship Jennings became convinced of the value of the pagan concept that sexuality is the fundamental power of life which animates the universe and brings forth nature in all its beauty and wonder. He also got inspiration from a contemporary, a colonial officer in India, Edward Sellon, described by his Victorian compeers as a "minor pornographer" and by modern commentators as an "industrious lecher," whose booklet, *Annotations on the Sacred Writings of the Hindus,* is, in fact, an equally sober and scientific anthropological description of the mysteries of Tantric sex as practiced in India. In it Sellon describes the religion of the Hindus as being based on the deity Bruhmatma, worshiped through an emblem, a black stone in the shape of a phallus, or Linga, symbolizing the procreative power of nature, which fructified the earth and which manifested in three forms: as the creator Brahma, the preserver Vishnu, and the destroyer Shiva. To create the world, Brahma is described as making himself androgynous, the right half male, the left female.

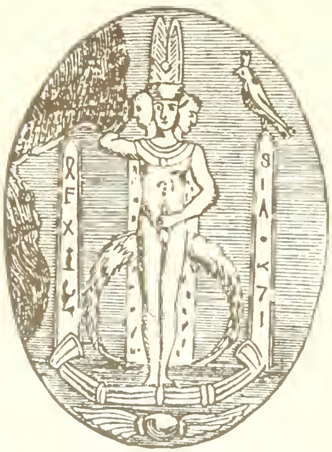
A close analogy was found by Sellon between the rituals of Hindus and those of the Egyptians. He equated Shiva with Osiris, and Sacti with Isis, represented by the same equilateral triangle with a dot in the center, the same emblem of the generative power—two coexisting principles of nature, active and passive, linga and yoni.

Sellon describes Hindu Tantric sexual rituals as being performed with naked temple courtesans or *yoginis,* young and beautiful, representing the goddess Sacti, or power, reciting mantras, becoming sexually excited and inducing promiscuous orgies among the votaries which he qualifies as "very licentious" but constituting a mysterious initiation. He further describes Sacti as represented *in coitu* sitting on Shiva's erect member, just as Isis "the goddess who grants all desires" did with the dead Osiris. Similarly, a statue of Minerva at Sais, who Sellon says was invoked by the union of X and O, or phallus and kteis, he found bore a striking resemblance to Prakriti, the Hindu deity of generation.

In India temples were adorned with the most exquisite of couplings, and everywhere the phallus was worshiped publicly in the form of the linga, the vulva as the yoni. Twelve huge phalli are still objects of veneration today, regularly asperged and strewn with flowers. One, of basalt, at Benares, requires six men to encircle with their arms outstretched. In the villages there were once many small upright lingams as described by Dr. Thomas Inman in his *Ancient Pagan & Modern Christian Symbolism Exposed and Explained;* on these women lowered themselves "having first adjusted their dress so as to prevent interference with their perfect contact with the miniature obelisk." At the time of the Muslim invasion of India, the worship of the linga was still common all over the country, but many were destroyed by the reforming invaders. The most notable lingam, a polished black stone at Somnath in Guzerat, was demolished by Mahmud of Ghezni, but fragments of it ended up in the Kaaba in Mecca, an ancient pre-Islamic geodetic and holy spot.

King Solomon, said Jennings, devoted his energies and wealth to raising phallic or "fire" shrines over high places, and especially in front of the temple in Jerusalem. Though the temple was only 120 feet long, 40 broad, and 60 high, its portico was a large tower 240 feet high, which to Jennings represented an obelisk. On each side of this great spine, at the temple's entrance, were two more handsome phallic columns, over 50 feet high, capped with pomegranates, to represent the Queen of Heaven, or a gravid uterus. To the initiates of Eleusis, who, according to Arnobius, venerate the female yoni in their mysteries, the pomegranate was sacred to Demeter and Persephone, representing the hidden riches within divinized earth. The two columns outside the Temple of Solomon, called by Masons Jachin and Boaz, represent "the fundamental divine polarity which underlies all manifested nature, the two opposites whose union constitutes the symbolic great Work of Alchemy." And to Jennings these columns are the equivalent of the Buddhist pillars erected by their dagobas, or the pillars of Hercules beside Phoenician temples. In Syria the counterpart of these "pillars of Hiram" was the great phallus described by Lucian in *De dea Syria*. According to General J. G. R. Forlong, the image of gold set up by Nebuchadnezzar on the plain of Dura, in the province of Babylon, was also a phallic obelisk, 60 cubits high by 6 in diameter.

Irish round towers, and Osiris swearing by his power



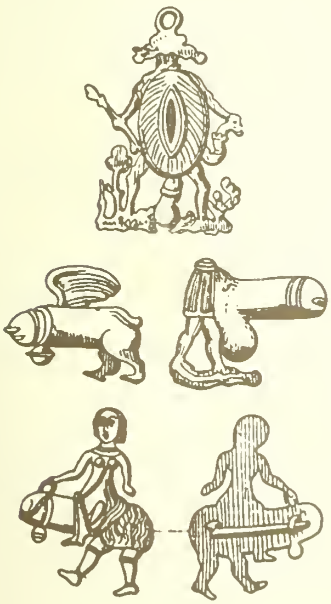
The round towers of Ireland, says O'Brien, author of a book by that title, were all phalli, raised in adherence to the ancient fire-worship of Persia, for the purpose of worshiping the sun, or male principals in the universe, and for studying the revolutions and properties of the planetary orbs.

As for the worship of the lingam in Britain, according to Forlong: "The generality of our countrymen have no conception of the over-ruling prevalence of this faith and of the number of lingam gods throughout our islands. We have been hoodwinked by the unjustifiable term 'crosses' applied to the ancient symbols which were always in the form of obelisks or columns, erected on prominent places." Forlong points out that the Nevern shaft at Pembroke could pass for a Mahadeva lingam in any part of India; the Cheddar shaft on the Mendip Hills and the Chipping column of north Gloucestershire are clearly lingams such as the Assyrians revered. So are the large obelisks of stone found in many parts of the north, such as at Rudstone in Yorkshire, which Pliny says was sacred to the sun. It is 24 feet long above ground and 6 feet broad, weighing 40 tons.

Michael Harrison in *The Roots of Witchcraft* recounts how in England just after World War II he was astonished to discover a widespread cult of the lingam dating back to medieval Britain revealed to him by Professor Geoffrey Webb, formerly Slade Professor of Fine Arts at Cambridge and then Secretary of the Royal Commission on Historical Monuments. Commissioned to survey ancient churches for aerial bomb damage, Professor Webb, an authority on medieval church architecture, was amazed, while studying the interior of an altar whose top slab of stone had been

shifted by an explosion, to find in the interior, unmolested and possibly unseen since the eleventh or twelfth century, a large stone lingam. Later, Professor Webb found that ninety percent of all the churches he examined dating up to the middle of the fourteenth century contained a phallic symbol of the fertility cult concealed within the altar.

Priapus, with an enormous erect member, was placed by Greeks and Romans in gardens as a magical aid to the growth of plants.



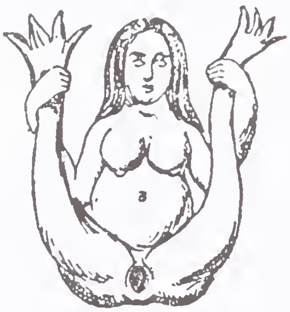
Jennings's fellow Freemason, Godfrey Higgins, author of *Anacalepsys,* considers Stonehenge phallic in its design, possibly a temple built during what he calls the post-Atlantian "First Dispersion." Its upright stone, known as the Friar's Heel, is a lingam or phallus, says Higgins, dedicated to Freia, the Friday lady, or Venus-Aphrodite. "And there to eastward of the holy pointer is the Os Yoni over whose apex the first ray of the rising god of the midsummer solstice shines into the center of the circle."

As a modern lady witch describes the scene at the summer solstice: "It is still thrilling as the sun rises above the phallic monolith, the Friar's Heel or Hell Stone: its rays strike into the feminine womb shape of the so-called 'horseshoe' of great trilithons, making a *hieros gamos,* or Sacred Marriage of heaven and earth."

Throughout Britain there are stones of Neolithic origin believed to possess the ability to promote fertility in barren women, who embraced them in the hope of having offspring. In Carnac childless couples would run naked around a special standing stone, though modern dowsers believe the power that once manifested in that region of trance has since shifted.

In the French Pyrenees, reverence for the phallus in the form of a menhir is still alive today; elsewhere in France, apart from the well-known bishop of Lyons, honored as Saint Foutin, patron of *foutre,* or frigging, there stood near Brest the chapel of Saint Guignole, whose phallus consisted of a long wooden peg traversing his statue and stretching out in front. With scrapings from this peg, votaries made infusions as an antidote to sterility. As the peg was worn down, a blow from behind with a mallet brought it to its pristine prominence.

In Italy, the phallus—also called the *fascinum* because it exercised such a power of fascination by sight alone that it drew all glances to itself—was everywhere in evidence, until the reformed Church. Thereafter a hundred thousand phalli were knocked from pagan statues and rural herms, and in architecture, as Jennings lamented, "the lingam of yore was thickened and wholly encased into a column, so veiled by ornate architecture that none but an awakened and practiced and educated eye could detect the old symbolism."



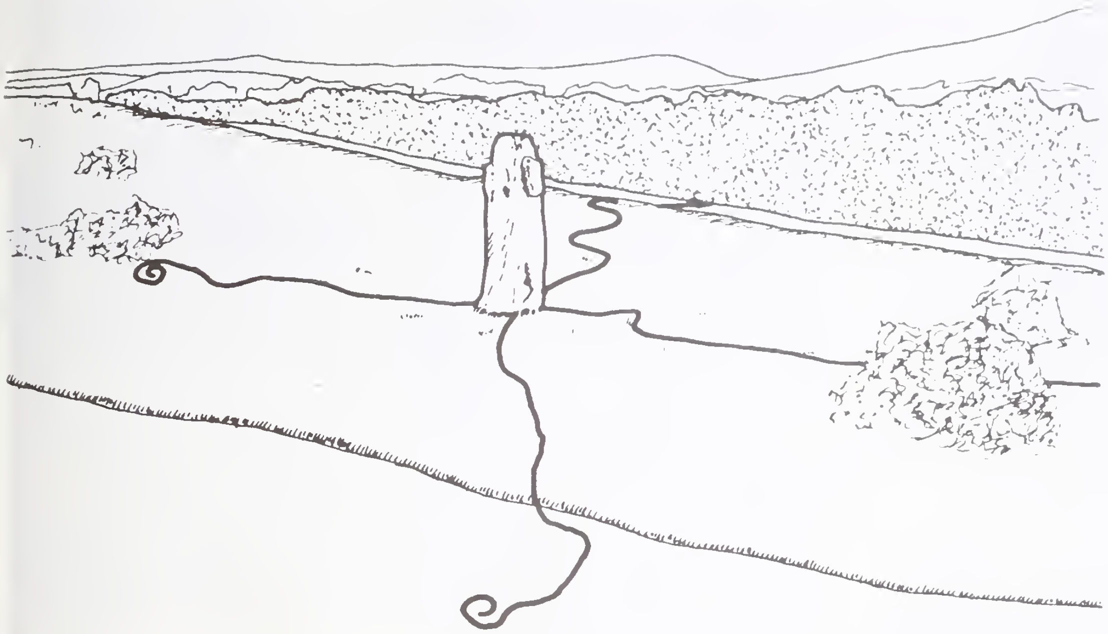
These naked females, representations of the great Fertility Goddess known as Sheila-na-Gigs, strikingly similar to the Yonis venerated by the Tantrics in India, indicate by their frequent appearance on Christian churches, that the old religion was still alive.

Elsewhere the phallus was reduced to a mere charm or amulet against the evil eye. To escape the attention of reformers, yet maintain the magic power of such an amulet, symbolizing coition of the sexual organs, it was tamely reduced to the least explicit of symbols: the hand.

Now modern authors have taken the whole subject of phallicism a step further to show that standing stones, both ancient and modern, are not only phallic symbols, but actual sources, or accumulators, of a power that is real—sexually and psychically stimulating, among its other varying qualities.

Guy Underwood, a dowser, and author of *The Pattern of the Past,* who has devoted a lifetime to unraveling the mystery of cosmic and telluric forces operating in and around the ancient temple sites of Britain, has demonstrated by means of various modern techniques of dowsing for water that the standing stones of the ancients are almost invariably positioned over important hidden sources of water, or "blind springs," as they are known to dowsers—a blind spring being the proper site upon which to sink a well. Not only upright menhirs, but flat supported dolmens, invariably mark blind springs of considerable telluric importance.

Brigadier General William Sitwell, author of *Stones of Northumberland,* describes the majority of standing liths



Waterlines crossing beneath a standing stone as depicted by Tom Graves in *Needles of Stone*. The Welsh water-diviner Bill Lewis has noted a force issuing from these stones which waxes and wanes. His work as an electrical engineer led him to conclude that water moving through a tunnel of earth, and particularly clay, creates a static electric field, and that two streams crossing, even at different levels, increase the field, and that a stone placed over the point of junction acts as an amplifier.

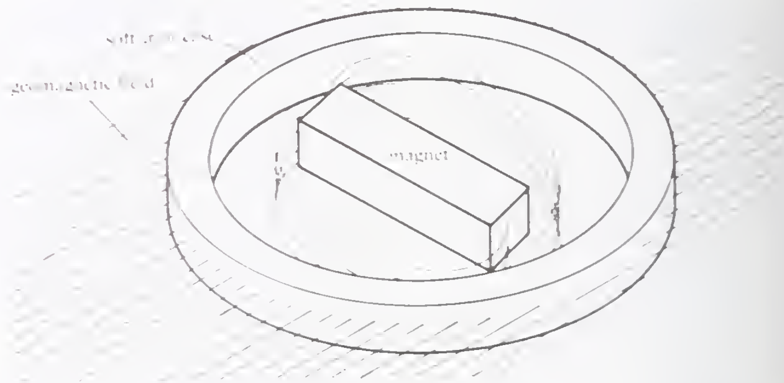
as "magnetic," by which he means that if one places a hand on them one receives the astonishing sensation that they vibrate. Other standing stones give off a tingling sensation of varying intensity, even amounting to an unpleasant shock which also seems to carry with it a shock to the psyche. Tom Graves, another professional dowser, author of *Needles of Stone,* has observed that some monoliths, if you lean against them, feel as if they were rocking slowly backward and forward; others seem to buzz.

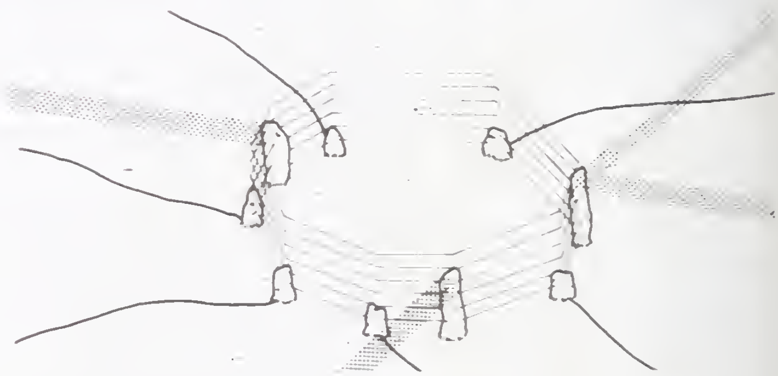
Sitwell has observed that most of Carnac's standing stones have been raised with their smaller end buried in the ground. By measuring the flow of observed current with a sensitive dowsing instrument, Andrew Davidson, in his *Silbury Hill,* found that stones raised in a circle show a predominantly positive or negative current, each one oppositely charged to its neighbor. Davidson further discovered that the polarity changed with the phases of the moon. Dowsing by pendulum at the time of a polarity change, he found that the pendulum would slowly stop, then gain momentum in the opposite direction, the whole process regularly taking several minutes.

John G. Williams, another dowsing researcher, from Herefordshire, showed on TV the power emanating from the stones as a spiral-like force which builds up in the body with the effect of propelling the investigator away from the stone. He says that most standing stones, including the Stonehenge uprights, if properly tapped for their energy, can cause a person to be thrown from them.

Graves describes being knocked flat by a sudden burst of energy from a circle of stones at Rollright in Oxfordshire: "Some kind of energy, possibly derived from the blind spring, at the center of the circle, and implied by the concentric haloes round the center, spread outward from the center and was collected at the perimeter of the circle, to be stored there by 'spinning' the energy from stone to stone." Graves also tells of inserting a small amount of energy into one of what he calls the "gate-latch" stones—which released all the stored energy in one go. "That was what flattened us in its passing." The interesting point, adds Graves, "was that the pulse of energy, whatever it was, seemed to leave the circle at a tangent to the line of the stones, traveling in a dead straight line. I think it went about six miles to the south-west, to a stone called the Hawk stone, and then split off in two different directions from there—or that's what the dowsing results implied."

Tom Graves illustrates the shock a man can receive from a standing stone. "The energy released," he says, "triggers off a violent reflex contraction of the back muscles, throwing him backward as much as ten or fifteen feet."





Graves makes an analogy between the change in a magnetic field caused by a soft-iron shield ring around a magnet and the effect produced by waterlines and overgrounds meeting a "shield ring" of stones. The ring, says Graves, allows the energy to bypass the area, isolating the outside world, as in a Faraday cage, from whatever may go on inside the circle.

That megalithic man must have learned about such accumulations of energy at mounds, standing stones, and circles is clear to modern dowsers who believe these particular spots were used for spiritual benefit, to increase energy and fertility, and to heal—practices which were consciously or unconsciously followed by later builders of churches and cathedrals on the same spots.

Monument found at Nîmes in 1875

Louis Charpentier, in his *Les mystères de la cathédrale de Chartres,* expresses the opinion that the orientation of churches and cathedrals springs from the ancient knowledge of the mysterious forces of earth which he calls "telluric currents," symbolized by the earth serpent, or dragon *vouivre.* The cathedral stands on a large prehistoric mound over a buried chamber, the natural meeting place, says Charpentier, of several powerful streams of telluric current, once the site of a great Druid college. And Juan G. Atienza, in his *Los Supervivientes de Atlantida,* shows that the Templars who helped liberate the Iberian peninsula from the Moors did so on condition that they receive outright ownership from the kings of Spain and Portugal of *all* the major megalithic sites, specifically selected because of some mysterious quality known to the Templars but apparently not to their donors.

Druids, Templars, and witches were clearly aware that some sort of mysterious power emanated from these locations, and the direct physical use of this power appears to have been their secret specialty. As these holy centers were taken over by the Church, and the magic often reduced to superstitious rote, followers of the old religion took to the wilder parts of the country, there to carry on their vivifying rituals.

Modern dowsers claim they can actually see the effect of nighttime dancing around standing stones. Graves describes how the pillars pick up the energy generated by the dancers. "They all glow with the same blue fire. The energy created by the ritual spreads the blue, the color of healing, throughout the countryside, that surrounds these

The central axis of the world, symbolized by the maypole, came to be regarded as a tree with the circumpolar stars—or souls—perched on its branches. Next, it was imaged as a pole with guidelines. "The great god lives fixed in the middle of the sky upon his support, as the universe, symbolized by the guide ropes, revolves around it."

ageless sacred sites." But not all the energies created by the ritual, he says, are necessarily physical. "They can be made physical by the way in which they affect people's attitudes, and thus their actions."

In a report on the perdurance of fertility rituals in Elizabethan England, the Puritan propagandist Philip Stubbs wrote: "Against May, Whitsonday, or other time, all the young men and maides, olde men and wives, run gadding to the woods, grooves, hills and mountains, where they spend all the night in pleasant pastimes," adding that he had heard it credibly reported "that of fortie, three-score, or a hundred maids going to the wood over night, there have scaresly the third part of them returned home again undefiled."

The maypole, as a phallic fertility symbol, used to stand in every village square in England until savagely torn down by sex-hating Puritans. In villages throughout Germany it is still at the ready. The energy produced by dancing around a maypole—a living needle of wood—has to be primed, says Graves, to work toward fertilizing the area. He notes that it is primed and directed by the state of mind of those participating in the dancing: "and what better way of framing a 'fertility' state of mind than spending the night in the woods, engaged in 'pleasant pastimes'?"

The sacred centers, by their accumulation of what Wilhelm Reich called orgone, may have helped to produce mass orgasms, therapeutic, in Reichian terms, to the whole person, as well as the whole countryside. And the suppression by the various churches of these pagan fertility rites may have stunted not only the natural sexuality of those who could no longer enjoy the ritual, but stunted great parts of the land. As Graves puts it: "The enforcement of a 'civilized' life has resulted in the destruction of the countryside and produced the meaninglessness of the life we suffer today."

Paul Screeton, an Englishman from Hastlepool who has written widely on the ancient wisdom, suggests that in prehistoric times the land may have been much more fertile, producing several crops a year, fertilized through fertility rituals. And modern witches, such as Doreen Valiente, author of several books on witchcraft, believe that a certain magical current commences at the equinox or solstice, reaches its peak at the following sabbat, and then declines, until the next station of the sun, when a new magical tide commences, and so on. Thus the tide set in motion at the spring equinox peaks at the witches' May Eve, then slowly ebbs until the summer solstice, when a new impulse commences.

Screeton, in his delightful *Quicksilver Heritage,* points out that the earth's magnetic field is estimated to have been 50 percent stronger in A.D. 500, and could have been even greater in megalithic times. Other observers believe that in earlier times man had a less dense body, more easily attuned to natural sources of power. And megalithic builders may have known how to draw extra energy from the sun—by the use of stone machines. Screeton suggests that prehistoric man, with his megalithic sites, gained control of terrestrial currents through manipulation of solar power, thereby producing a better environment. As the sun passed over the natural centers, it could cause an extra surge of energy, especially at noon, with differing effects at zenith, equinox, and solstice—the main festivals of Bards, Ovates, and Druids along with intervening festivals of Candlemas, Beltane, Lammas, and All Hallows.

John Michell, an avantguardist viewer of this magical world of antiquity, is poetic in his re-creation of the ancient magic: "At certain seasons of the year the dragon passed overhead down a straight line of country, drawing in his wake the fertilizing powers of life. Astronomers observed its passage, astrologers predicted the moment of its appearance, geomancers marked its course with alignment of mounds and stones."

Modern occultists such as Geoffrey Hodson suggest that "etheric rays" from the sun may have helped raise the level of consciousness of participants in rituals, helped cure disease, healed wounds both physical and emotional. Merlin is quoted as saying to Aurelius: "Laugh not so lightly, King. . . . For in these stones is a mystery and a healing virtue against many ailments."

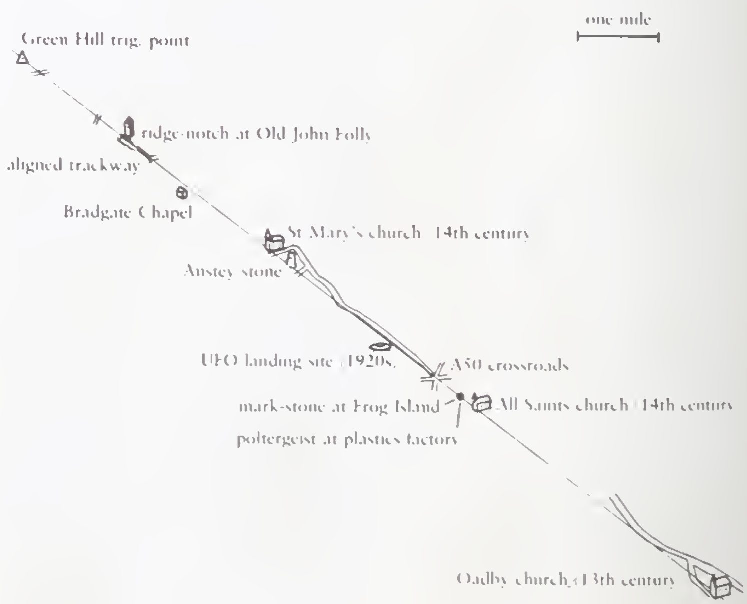
Iris Campbell, a remarkable English psychometrist, believes that in megalithic times the distribution of the colors of the sun was different, with less violet and more blue rays, blue being the color attributed to the etheric or orgone energy. She suggests that in ancient healing centers the monoliths must have been carefully positioned in accord with the solar rays in order to bring about an accurate influx of solar force to the body, not too strong to overwhelm it. Did megalithic man harness cosmic rays, asks Screeton? Were they concentrated, stored, and channeled at stone circles?

The megalithic builders' great interest in eclipses may have been connected with the fact that the sun, in addition to altering the atmosphere's properties, alters the nature of the earth's magnetic currents. An eclipse of the moon has no apparent physical influence on the earth other than the effect it produces on the level of terrestria magnetism.

Jean-Louis Bernard in *Aux Origines de l'Egypte* makes a very good argument that the ancients had learned to capture from outer space and make use of what he calls a "green ray," a ray too intense for humanity to use directly, which needed the science of Toth to be assimilated by man—which could, of course, mean by reflection from the moon! The assimilation was apparently done with megaliths and ultrasonics. The repercussion by stones of the ultrasonic waves caused a vibration in the cerebro-spinal column, says Bernard, and especially at the nape of the neck, which made it very easy to go into trance. The ray was best captured, apparently, on mountain tops or on top of stepped pyramids or ziggurats.

Bernard also finds evidence for a race of giants who opposed the green ray with a telluric force derived from the center of the earth. Coming up through the soles of the feet it affected their legs and their pelvis, rising like static electricity up the cerebro-spinal column. With this telluric force the giants are said to have had the power of paralyzing their adversaries, as a snake does a bird. The result, says Bernard, was a cosmo-telluric war that hastened the biological decline of the giants, ending their stay on earth sometime about 10,000 B.C. coincident with a series of cataclysms which changed the inclination of the earth's axis, shifted the poles, caused the glaciers to withdraw and brought an end to the civilization of the Atlantean archipelago.

All the evidence from the remote past, says John Michell, points to the inescapable conclusion that the earth's natural magnetism was not only known to men



Forty dowsing and electronic experts recently organized the Dragon Project to make a scientific study of the phenomena of the ancient leys in England.

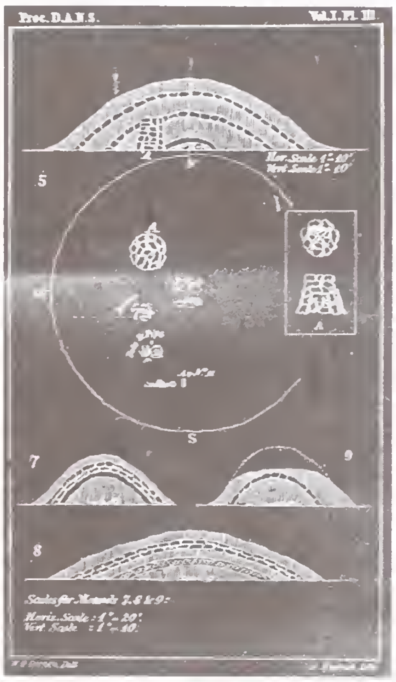
some thousands of years ago, but that it provided them with a source of energy and inspiration to which their whole civilization was tuned. In his words: "From the rocks, mountains and headlands a mysterious current once flowed down avenues of standing stones over mounds and earthworks towards some central hill dedicated to Mercury, the terrestrial spirit. Below the hill an instrument of solar generation produced the spark by which the current became animated and recoiled in a wave of fertility through the hidden veins of the land, urged on by the music and clamor of the rejoicing people."

Much research has recently been done, especially in England, by dowsers and "ley hunters" who claim to have established the existence of power channels linking one megalithic site to another in vast networks of what they call "ley" lines, which they differentiate from the track line, the water line, and the acquastat. Ley lines are straight, point-to-point lines which ley hunters have traced all across Britain, set out with what they describe as the accuracy of a modern surveyor, with alignments precise between standing stones. The existence of leys, they insist, is as obvious as that of electricity, and can be felt by anyone who can feel electricity. Screeton says that leys bear a geometrical relation to each other, either in parallel, or forming isosceles or equilateral triangles, with regularly recurring angles of intersection and standard distances between points. He explains the leys as avenues of "etheric" energy, made visible by trees with spiraled or double trunks, by the flow of what Kipling called "the mysterious earth currents which thrill the clay of our bodies."

A comparison between etheric energies and orgone energy, says Screeton, shows such great similarities it would be surprising if they were not identical. Both are everywhere, and both can be accumulated. Orgone energy as described by Wilhelm Reich is an energy which operates most noticeably on the emotions, but with physical and physiological effects—a sort of basic life force. In constant flow, he said, it provides the medium through which magnetic and gravitational forces manifest their influence. To Michell there is no doubt that the natural flow of force related to the earth's magnetic field is the orgone energy rediscovered by Reich, present everywhere in the universe, mass free, and consequently hard to isolate, except that it appears to be susceptible to being channeled and accumulated.

By placing standing stones on ley lines and their crossing points, Screeton believes, the ancients managed

Herms were raised in the ancient world on every highway and at the corners of any property.



Barrows were discovered to be almost invariably built up of layers of organic and inorganic material—a storehouse, as Graves points out, for the energy known as od, odyle, prana, or Reich's orgone.

to channel, increase, and control the current. Underwood, in his *The Pattern of the Past,* says old walls, hedges, and roads are aligned on track lines which made it possible to divide the land into parcels of convenient size, with precise, unalterable limits, apparently easily divinable and redivinable by priests, as in Egypt after the flooding of the Nile. Since the greatest antiquity, these geodetic lines and patterns have been clearly assigned topographical markings, making them distinguishable to persons initiated into the code. Throughout the Roman empire the limits of lots were identified by standing "herms" mostly with phallus erect.

Screeton notes that where ley lines cross are centers of power associated with magic, the life forces, fertility, "getting high" or tripping, and the appearance of phantoms. Though some of the lines appear to be on a more refined plane than is easily perceived by our basic senses, animals seem to have sensory organs which enable them to perceive such energies.

Other ancient structures associated with standing stones and blind springs are mounds of earth in circular or elongated shapes, known as barrows, believed by archeologists to be mere tombs, but which, in fact, may be "enliveners"—initiatory chambers designed, as is reputed of the Great Pyramid, to awaken the spirit from its hypnotic trance within the body. Whether or not they contain a sepulcher, barrows are built of alternating layers of organic and inorganic matter. Varying from 15 to 150 feet in diameter, there are more than twenty thousand round barrows in Britain alone, though many have been destroyed by farming. On the crest of the hills surrounding Avebury there were once fourteen such round barrows. In the Americas there may have been a hundred thousand.

Long barrows in Britain are dated by archeologists from Neolithic times. About two hundred survive. They are mounds of earth and chalk, 4 to 20 feet high, mostly from 100 to 300 feet long and 30 to 100 feet wide. Set over one or more blind springs, they are mostly oriented east and west, to face the rising and setting sun at the equinox.

Michell believes that chambers in these barrows, made of alternating organic and inorganic material, which is the requirement for a Reichian orgone accumulator, once served that purpose and were used for healing and for expanding consciousness. He and others have noted that these ancient sites are linked in a network that covers all of Britain in a multidimensional ramification of forces—mercurial, or quicksilver lines, as they are called, the domain since antiquity, of Toth, Hermes, Mercury, or Saint Michael.

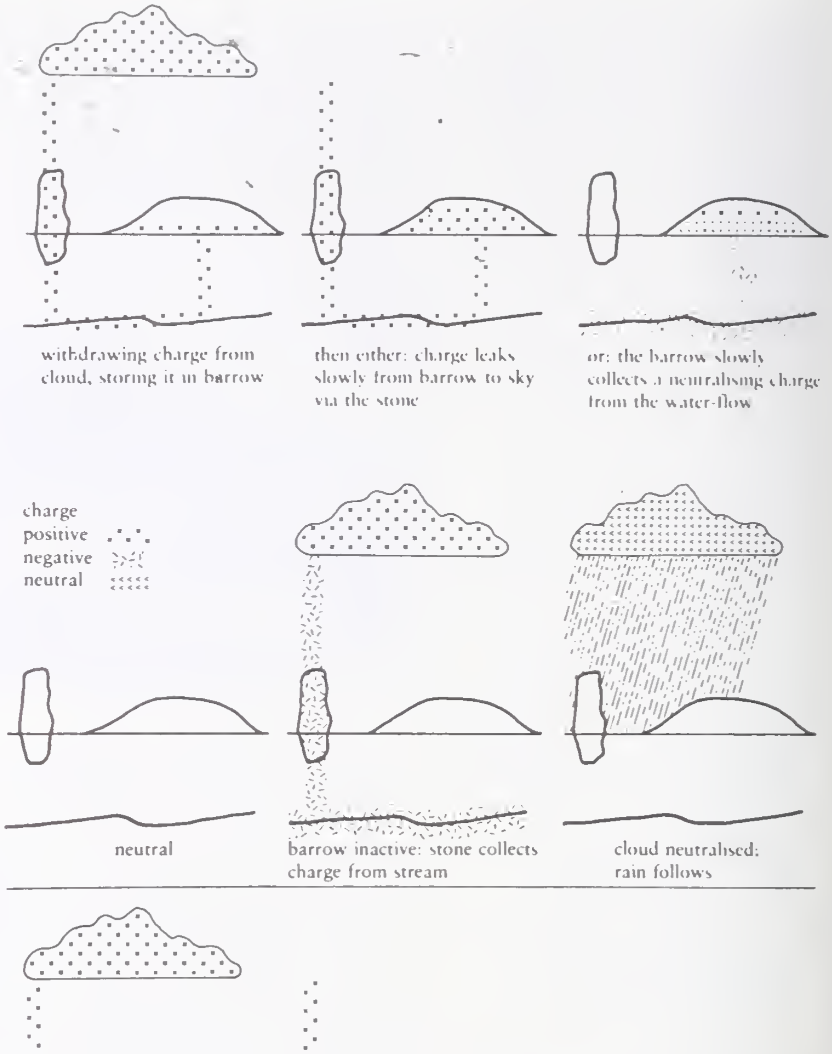
American mounds are, or were, wonders comparable to the pyramids of Egypt, their origin almost as mysterious today as when they were first discovered by immigrants traveling west. Atlantean experts such as Egerton Sykes and Henrietta Mertz are convinced that at least the eastern United States was once part of the Atlantean Empire and that the extraordinary artifacts found in American barrows were the product of descendants of refugees from sunken Atlantis—a notion as quickly derided by conservative archeologists as has been the incontrovertible evidence produced by Barry Fell and his fellow epigraphers of the presence in "Lost America" of Phoenicians, Libyans, Egyptians, Celtiberians, Hittites, and a whole chain of European and Mediterranean followers. Silbury Hill, the largest such mound in England, which, like the Pyramid of Cheops, served, among other purposes, to mark the equinoxes and solstices, is estimated by Richard Atkinson to have required the carefully directed work of 500 men for fifteen years—"a fraction of the gross national product at least as great as that devoted by the United States of America to the whole of its space program."

The Washington Monument attracting a bolt of lightning

Graves has also noted a distinct correlation between megalithic sites and weather patterns—particularly of rainfall and thunderstorm activity, as noted from the weather distribution maps of Britain. He says that he has observed during a thunderstorm that standing stones and church spires gain a visible nimbus, becoming actual glowing points in the landscape. He believes this happens because they collect charge from the springs and streams below them. He says that standing stones have a thunderstorm-control ability similar to lightning conductors. He even plays with the notion that the energy of thunderstorms may somehow be stored in barrows, as energy reservoirs. This may clarify why witches were traditionally credited with the ability to control the weather, and particularly to raise storms.

Graves goes further, believing that standing stones and circles not only controlled thunderstorms in the past; they still do. Megalithic sites, he says, are in the right places, and their shapes and semiconductor properties are such as to help the production of an "electric wind." Dowsers have certainly found that lightning usually strikes directly above the intersection of two or more water lines. Dowsers say that a conductor, placed directly over or even close to a water line, or, better, at an intersection of water lines, should be able to collect charge from the whole area underlying the stream. The effect of a lightning conductor connected to water lines would be to change a potentially violent thunderstorm into an ordinary rainstorm.

Graves illustrates two ways in which thunderstorms may be controlled by the stone-and-barrow system. In the upper drawing a stone collecting negative charge from an underground stream attracts the positively charged cloud, which is neutralized by releasing its rain. In the lower illustration the subterranean stream draws charge from the cloud and stores it in the barrow, which either leaks it back slowly into the sky through the stone or collects a neutralizing charge from the water flow.

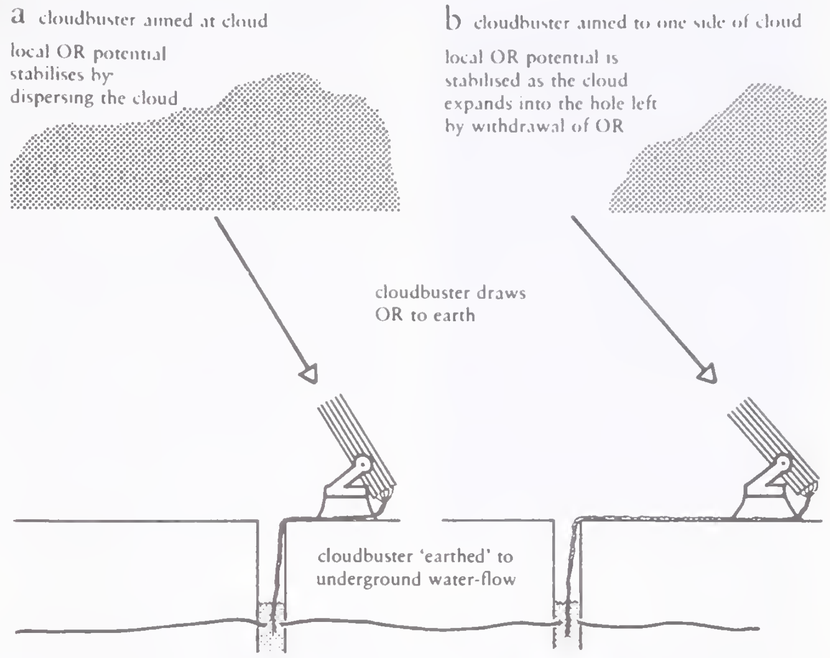


All of which was incontrovertibly demonstrated in real life in modern times by Wilhelm Reich, who showed the relation between lightning and vivifying orgone. In the most scientific manner he accumulated and dispelled great clouds, at will, producing rain where it was wanted; and in the quantities required, or turning the sky back to blue.

In the course of the these experiments, Reich discovered that the orgone energy assumed two forms, "orgone radiation," or OR, and "deadly orgone radiation," or DOR. The former, the healthy manifestation, can be sensed according to Reich as a feeling of "life" and brightness in the atmosphere, visible as bright fast-moving dots of light, or a haze of blue. DOR, on the other hand, is responsible for "dullness" and bleakness in the atmosphere, of the sort that builds up on days before a big storm.

In Chinese geomancy, or *feng shui,* energy flows along the earth's meridians in an interplay of the two prime

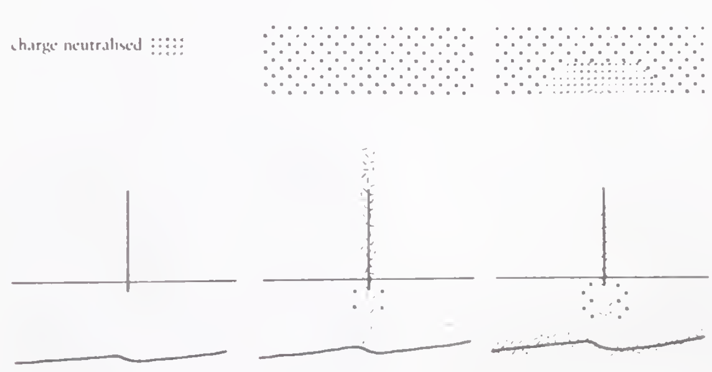
This adaptation from Wilhelm Reich's *Selected Writings,* (Noonday Press, 1960) shows the cloud-buster system he developed at Orgonon, Maine, where he accumulated and discharged rain from a cloud by pointing directly at it 10-foot hollow steel tubes mounted on the back of an old anti-aircraft gun carriage, grounding the received energy into a running stream. If the tubes were aimed near, but not at the cloud, they would cause it to expand and hold more moisture. It was Reich's premise that a hollow tube will push or pull "orgone" energy, which can then be carried away by running water.



forces of yin and yang; the product is know as either *ch'i* or *sha*. The former occurs when yin and yang fuse together in harmony. The latter occurs where they are out of balance, where the primal energies are separated and stagnant. What is this but Reich's chief cause of neurotic ailments in humans—sexual stasis—applied to Mother Earth?

A clear parallel between the British system of standing stones and ley lines and a combination of Chinese *feng-shui* and acupuncture, is drawn by British dowsers. To Graves, Britain's geomancy has every indication of having been a system of earth acupuncture with sacred sites as acupuncture points on energy channels, both sinuous and straight, with standing stones as massive needles, designed to promote a healthy, sexy, fertile earth.

Michell, again, is poetically specific: "These upright stones were essential to the great work of alchemy, which



Graves demonstrates how a lightning conductor placed over a waterline can collect charge from an underground water flow and "literally spray charge up into the sky," causing the same Saint Elmo's fire which so distressed the sailors on the *Cleopatra*.

Tantric tradition describes over 300,000 nadis, or channels of vital force permeating the physical form through which solar and lunar energies ebb and flow to animate the subtler body. Connected to these nadis, the seven chakras are seen as receivers and distributors of the negative lunar and positive solar energies which spiral around the spinal cord, along the path used to raise the kundalini.

formed the climax of all prehistoric ritual, the introduction of solar or atmospheric energy into the terrestrial life current. It is well known that flashes of lightning have an effect on the nitrates of the earth, through which they can be absorbed by plants, thus ensuring the seasonal return of fertility. This process, regarded in the past as the act of union between the earth and the heavens, is indeed necessary for the continuation of life; for if there is no lightning, the earth becomes barren. In order that plants should grow, it is necessary to fuse the electrical current of the atmosphere with the streams of terrestrial energy." In man, energy permeates the body by flowing along the twelve meridians of the acupuncturist from one to the next in a set sequence, making a complete cycle in twenty-four hours, controlled by the sun whose rays are reflected by the moon.

Because the landscape has no obvious organs, no arms, legs, or head, dowsers assume there must be even more meridians or energy lines on the body of earth than on the human body, and that they would be laid out in a far less obvious way than in human acupuncture. In such a system of earth acupuncture, what, asks Graves, could be a more obvious "needle" than a standing stone? Noting that it could be dangerous to use stone needles to heal the land without a suitable and safe means of disposing and dispersing the collected *sha* or DOR drawn up through an earth stake, Graves suggests that the barrow-and-stone weather-control systems were, in fact, designed for just such a dispersal.

But the employment of needles is only part of acupuncture, which also uses moxibustion, or controlled fire. Our civilization, says Graves, has completely concealed the ancient magical use of fire—the beacon fires on Old Beacon Hills. Graves tells of having been with a ley-hunter team at the Dunstable bonfire festival where he enjoyed an extraordinary sense of unity, of nonverbal communication—"so rare in our civilization"—which he and the others felt as each bonfire was lit and linked with the others. Michell describes the scene: "From hilltop to hilltop, the light struck straight across the country, reflected in ponds and moats, transmitted by flashing mirrors, celebrated with music and singing, the whole line illuminated by the flames and by the heavenly light."

As in acupuncture, most of the problems in our modern landscape, says Graves, stem from blockages and disturbances of energy flows, arising from insensitive man-made causes: motorways, high-voltage lines, mining and quarrying. Modern organization has the noxious effect of blocking a natural flow in the energy matrix. Electric pylons appear to have an especially deleterious effect on the fertility of the land.

Another function of the standing stones may have been to communicate from point to point. Analyzing the forces at play on a standing stone, Graves notes that as well as the flow of orgone to and from a needle, underground water flows can produce a regular mechanical vibration in a stone, which can be used to carry a signal.

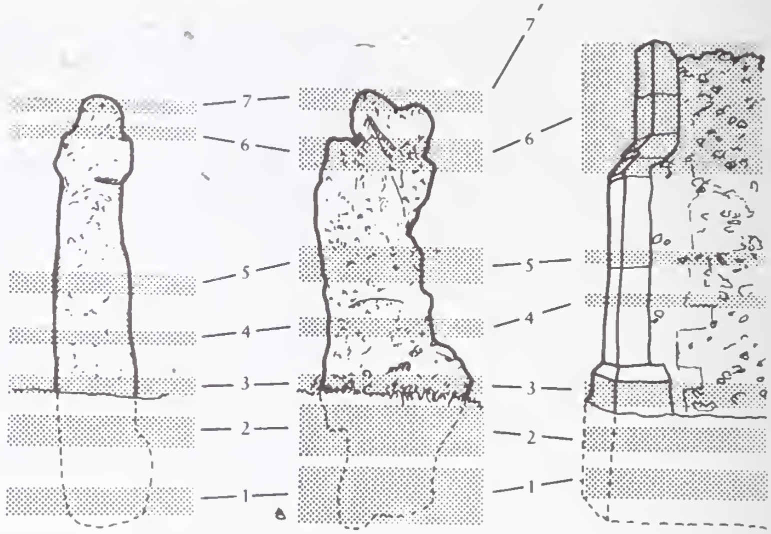
Screeton visualizes the ancients as transmitting messages on standing stones by tapping. He says that in order to pick up the modulated currents, they would use the palm of their hands against the stone, retransmitting the signals by their nervous system to the pineal gland. In other words, they would transmit the message to the mental receptive consciousness and then to the spiritual consciousness.

A number of correspondents, says Graves, have told him that the transmission of complete mental images, or telepathy, is much easier between sacred sites than elsewhere. Graves describes how the King Stone at Rollright was linked to more than a dozen other stones and believes that, if all the minor and irregular links are included, as many as a hundred more could have been linked into Rollright, creating a vast telephone exchange of stone circles and standing stones; from which it would appear that telepathic communication in the present, and clairvoyant communication with the future or the past may be effected through the same occult medium.

The presence of certain types of quartz in standing stones, and most especially in the granite obelisks of Egypt, leads Graves to postulate the possibility of their acting as a sort of stone maser or, as he puns, "leyser." Quartz, in its smallest unit, consists of three molecules of silicon dioxide, arranged in a spiral or screw form, either right- or left-handed. It has the power of rotating in either direction the plane of polarization of light.

Graves finds a parallel between the quartz "seeds" in limestone and the chrome atoms in a ruby, from which a laser can be fashioned. He suggests that it might be possible for the mechanical vibration from the stream of water below a standing stone, or the spiraling energy flow around the stone ("and note," he adds, "the analogy with the old laser spiral flash-tube"), or both, to provide energy to be stored in the quartz "seeds." As with a ruby laser, says Graves, this energy storage should reach a critical or supercritical state, at which time a suitable stimulus could set the whole thing off. He considers a

Graves describes seven energy bands as appearing on standing stones as well as on buttresses. In the illustration (a) is a "Christianized" stone near Postbridge in Devon; (b) is at Rollright; and (c) is the northeast buttress of nearby Knowlton Church. All are drawn to scale, and all, says Graves, are tapping points into a spiral release of some sort of energy. He describes the narrow bands as a "double strength geomagnetic field running horizontally across the stone at various heights." The bands are said to move up and down, following what appears to be a lunar cycle. Two of the bands are usually below ground level; the top one is very close to the peak of the stone.



suitable stimulus to be a gravitational alignment of sun, moon, or planets, which could result in a massive pulse of energy traveling in a straight line—just such a pulse as he accidentally released at Rollright, and which appeared to travel away at right angles to the standing stone.

A German dowsing magazine, quoted by Graves, warns that it is important to beware of quartz in buildings when dealing with "earth engines," for they "change the plane of the radiations from the vertical to the horizontal." Thus, says Graves, if quartz can turn its own "radiations" from the vertical to the horizontal, we would appear to have our "leyser."

The frequency of a crystal's resonance depends on its size, shape, and cut. Were the Egyptian obelisks, which are largely quartz, deliberately cut and shaped like a wireless crystal to vibrate synchronously with another transmitter, the vibrations transmitted through earth like a system of telegraphy? Or were they wireless, going from point to point on ground leyser beams pulsing from quartz?

Such a system would explain how the ancient Egyptians could have used a row of obelisks stretching from the delta to the cataracts—if not to the equator—to transmit instant information of great help in geodetic and astronomical observation. Used east and west, they would resolve the mystery of how the ancients plotted longitude with such extraordinary accuracy, as is evident from a whole series of mysterious prehistoric maps.

Other dowsers describe overgrounds and waterlines as able to carry a code or modulated signal. There are several dimensions in which water can carry a coding, the most obvious being with physical substances, either in solution or suspension. The key, says Graves, is the bent structure of the water molecule. Water that has been blessed or affected by a psychic (such as was demonstrated by the healer Olga Worrall when she changed the molecular structure of water by irradiating it with her hands) is recognizably different, and at some level may be a carrier of nonphysical or metaphysical messages.

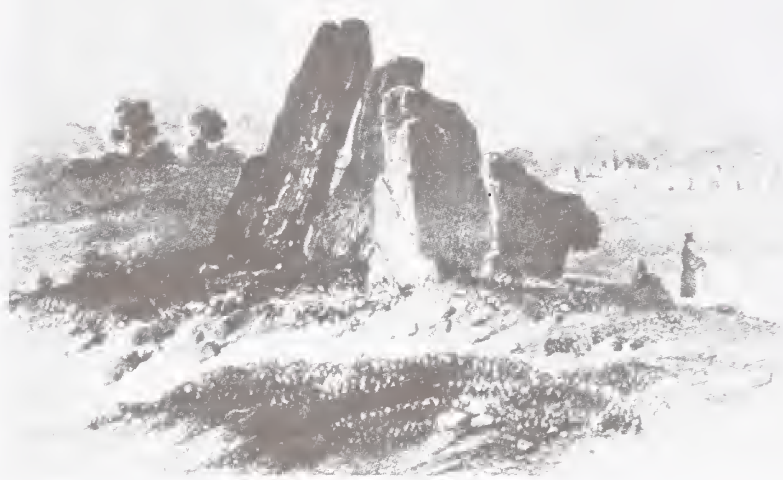
Carlos Castaneda describes what he calls his personality traveling along water courses, apparently for hundreds of miles; which suggests to Graves that water lines as well as overground leys could be used to assist astral traveling. A modern magician told Graves that astral traveling, or projection of the inner personality, is made easier by hitching a ride on the energy that passes along "ley lines" and "overgrounds." And the *feng-shui* concept of "spirit paths," or clearly marked pathways on which the spirits of the dead may travel, suggests, as the Egyptian *Book of the Dead* elaborates, that astral traveling is as much for the dead as for the living.

Did the witches astrally ride the ley lines to their midnight sabbaths at megalithic sites?

18. DIANA AND THE HORNED GOD

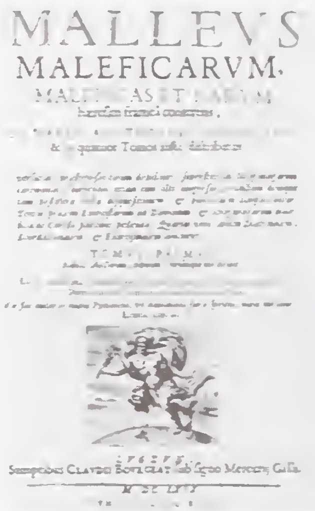
The large phallic stone at Rollright stands on a lonely Cotswold hill by a prehistoric yonic circle 20 miles from the villages of Long Compton and Chipping Norton. In a nearby field, as a witness, stands a cromlech of large stones called by the natives Whispering Knights, silent now except in a high wind. For centuries, if not millennia, Rollright has been a gathering site for witches. On a recent night of full moon, with the soft scent of summer, a coven of witches was dancing around the standing stones to celebrate their sabbath—it was May 12, 1949. Eyewitnesses tell of men and women chanting and dancing under the direction of a leader wearing a goat-bearded mask. An even more recent ceremony at Rollright was described with pictures in *Life International* of May 1964.

The Rollright Stones



Witches performing at Rollright from an article in *Life International* of May 1964

Such ceremonies were possible, after almost half a millennium of witch-burning, because in England, on January 3, 1951, the law against witchcraft was stricken from the books. It had been a long, painful siege since that December 5, 1484, when the appointee of the butcher, Torquemeda, issued a bull, as Innocent VIII, in which he deplored the prevalence of witches and empowered two Dominican monks, Heinrich Kraemer and Jacob Sprenger,


MALLEVS
MALEFICARVM,

Innocent VIII (1484–1492) issued the papal bull *Summis desiderantes effectibus,* which served as justification for pitiless persecution. The bull was prefixed to the Inquisitors' textbook, *Malleus maleficarum,* and called on the wrath of God Almighty against all who did not comply. In his last months, Innocent was kept alive by sucking milk from a young woman's breast, and an attempt to rejuvenate him by blood transfusions resulted in the death of three boys. Contemporary Catholic chroniclers note that he kept a mistress by whom he had two children—a boy who married into the Medicis, and a girl whom he married to his papal treasurer.

to launch a holy war against "this satanic sect." Kraemer and Sprenger were ordered to be given every assistance by bishop, priest, and lay authority. As guidelines for the monstrous pogrom of witches that was to ensue, the two holy brothers produced a primer, the *Malleus maleficorum,* which went into details as gruesome as possible to enable dutiful Inquisitors to force confessions from a tortured body. It became the standard manual for witch-hunting and witch extermination. Michael Harrison, in *The Roots of Witchcraft,* adds the cynical note that the two Dominicans, unable to obtain for so horrid a script approval from the Cologne University censors charged by the Pope with vetting it, resorted to the same device used for the Donation of Constantine: "Nothing daunted, this precious pair of rascals proceeded to forge a document which purported to show the approbation of the Cologne faculty."

As an incentive to the Inquisitors to ferret out their heretical bunnies, it was decreed that the property of a condemned witch was to be divided, after the costs of the trial had been deducted, between Inquisitors and State, with a bonus for informers. And not all witches were poor. The first one condemned in England, Dame Alice Kyteler of Kilkenny, was of considerable means. For the rest, there was that depraved compulsion, described by Wilhelm Reich as the "emotional plague," whereby a pox of sexually malfunctioning "armored" individuals, unable to enjoy the pleasure of natural lovemaking, set about relieving their pent-up sexuality through ripping, tearing, and burning the very flesh they could neither kiss, caress, nor inflame with pleasure.

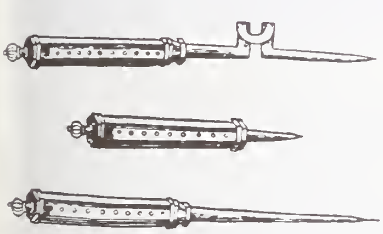
The *Malleus* gave detailed instructions for the selection of suspected witches who could then be tortured until they confessed. If a prisoner muttered, looked at the ground, or did not shed tears, he or she was suspect. As most of the witches were shes, the administration of torture to their frail bodies was both easier and more rewarding.

According to the Church, somewhere on the body of a female witch, the "devil" left his mark, the most obvious of which was a supernumerary nipple—sure sign of dedication to the many-breasted goddess Diana, queen of the witches. And, as the modern medical profession estimates that three out of a hundred women have such vestiges, the chances of netting a witch were considerable. When nothing like a mole or birthmark came readily to finger, it was argued that the mark must have been applied in a subtler manner which required the investigator to indulge in closer scrutiny by totally stripping the suspect naked and subjecting her to a minute inspection, often in front of

Diana's supernumerary nipples were also frowned upon by the majority of moralists because the goddess, with her unbounded generative and nurturing power, could indiscriminately suckle one and all.

Kraemer and Sprenger in *The Hammer of Witches* based their authority for burning witches partly on the teachings of Thomas Aquinas, who maintained there were servants of the devil "more subtle and more dangerous than the heretics"—the witches; and partly on a totally specious reading of Chapter 15 of the Gospel according to Saint John: "If a man abide not in me, he is cast forth as a branch, and is withered; and men gather them, and cast them into the fire, and they are burned."

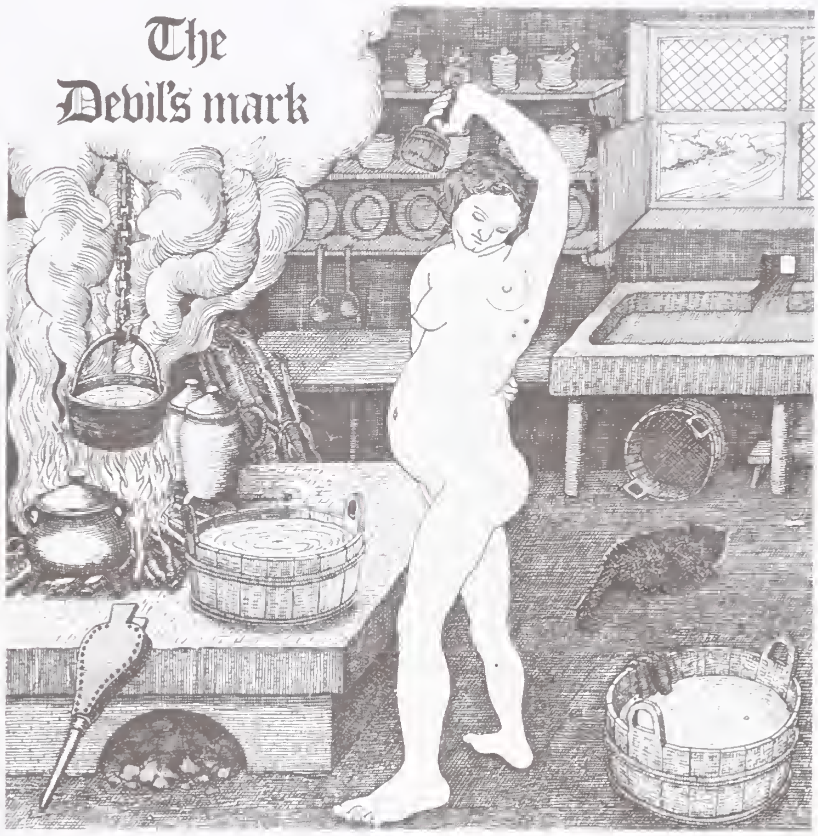
Any blemish on a woman's body—wart, mole, scar, or birthmark—could be used by the Inquisitor as a mark of the devil, sufficient to charge her with witchcraft.



Regular and retractable prickers

a crowd of pruriently curious onlookers, ostensibly impelled to the scene by their religious duty.

To increase the number of hits, the subtle notion was concocted that the devil's mark left a spot insensible to pain, only discernible by an inspector probing with a sharp prick. Thus was raised a whole guild of "witch-prickers," paid only when they discovered a witch, which led to the foolproof system of using an auxiliary retractable prick. The pricker, having painfully, and visibly, drawn blood from several spots on a naked victim, would painlessly plunge the substitute bodkin to the hilt, astounding the crowd, and ensuring his fee for a witch delivered to trial.



Placed in the hands of the actual Inquisitors, the women were scrutinized even further by having the hair of their pudenda shaved and the folds minutely inspected on the excuse that therein was likely to be hidden a small parchment with a magic sigil to use as a talisman against feeling the forthcoming pain of torture. Immediate and sadistic rape of the victim became so common that bishops had to pronounce against the practice. "The victims," report the chronicles, "were so barbarously used that modesty forbids to mention it."

And the chronicles are truly amazing. In 1599 at Dôle, in France, a woman named Antide Collas, found with an abnormality in her sexual conformation that was regarded as explicable only by her having had shameful intercourse with Satan, was repeatedly stripped and scrutinized by doctors and judges, until her disability was officially described as *"un trou qu'elle avait au dessous de sa parti gorrière."* Repeatedly put to torture, the poor woman confessed to having received the deformity from the penis of Satan, and was therefore ritually burned at the stake.

Matthew Hopkins, an unsuccessful attorney, with a pretended commission from Cromwell's Parliament naming him Witch-Finder General, spent two years running down women whose pets might incarnate witches' familiars. In England he revived round-the-clock torture and the medieval ordeal of tossing women into rivers to see if they would drown or if the devil would save them to be burned. He was responsible for several hundred executions before being brought to account for illegal profiteering.

In those rare countries where the torture of witches was illegal, as in England, confessions could still be obtained by the more modern methods of binding the suspect naked to a stool without food or sleep for as many hours or days as it took to break her will; or by walking the victim up and down for days until her feet blistered and

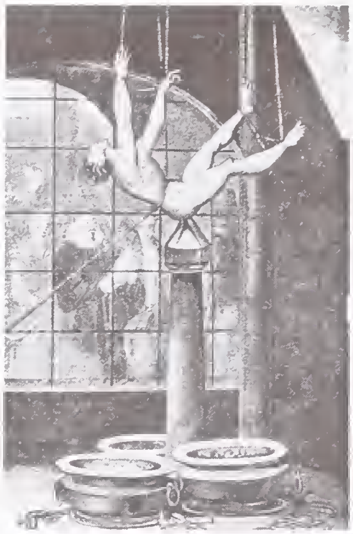
If a victim refused to confess, he or she was subjected to three grades of torture: by cord, by water, and by fire—all in the name of Most Merciful Christ. Torture by cord meant being raised and lowered in jerks to dislocate arms. If this failed to elicit a confession, the victim was flogged and then stretched on the rack till all his members were disjointed. The water cure consisted of having a silk ribbon stuffed down the throat and as many as thirty pints of water forced along it into the body, causing pain beyond description. As an alternative, a cloth was laid over the face so that water poured onto it virtually drowned the victim. Torture by fire meant having one's feet placed in stocks with the soles well greased, so that a blazing brazier could blister and fry them. More painful but less fatal than racking, this torture was in vogue for females, and for a child required to testify against its parents.

Torture was supposed to be administered only once, and be limited to one hour, but if the torturers stopped just short of the hour they could renew the torment indefinitely, varying the fare by inserting red-hot needles under finger and toenails, ripping out the nails with tongs, crushing thumbs in thumbscrews, or reducing the victim's foot to pulp in a leg crusher. Other subtleties were being broken on the wheel and being pierced by an Iron Maiden. To determine how long a victim could be tortured without risk of dying, a physician was present, usually a barber whose sole knowledge of healing was to let blood, apply leeches, or amputate a limb. If the victim confessed under the first bout of torture, he was allowed to be tortured again to ascertain his motives for confessing, and again to induce him to betray his accomplices or sympathizers, accusations which were in turn sufficient to convict a friend or stranger, irrespective of guilt or innocence.

her mind wandered. But of all the systems, the simplest—heads I win, tails you lose—was to bind the witch's thumbs to her big toes and throw her into deep water. If she floated—on the grounds that having rejected the water of baptism, the water now rejected her—she was considered a witch. If she sank, she drowned.

On the Continent, an accused witch could be given two hundred lashes on her bare back before being sent to torture. Teen-age girls were regularly stripped by notaries and scourged until they confessed or agreed to bear testimony against others, including their mothers.

What most interested the Inquisitors was a female victim's description of intercourse with an incubus—a male demon—which they believed to be of extraordinary voluptuous pleasure to the witch. The authors of *Malleus,* declaring such demons to be visible only to the witch, described how a bystander might yet be able to enjoy the sight: "The witches have often been seen lying on their backs in the fields or woods, naked up to the navel, and it has been apparent from the disposition of their limbs and members which pertain to the venereal act and orgasm, as also from the agitation of their legs and thighs, that, all



invisible to the bystanders, they have been copulating with Incubus devils; yet sometimes, howbeit this is rare, at the end of the act, a very black vapour, of about the stature of a man, rises up into the air from the witch."

As a result of the *Malleus*'s system of questioning, thousands of confessions were extracted from women, young and old, in exact conformity with the blueprint questions predetermined by the holy brothers Kraemer and Sprenger. All the judges required was that the victims, under agonizing torture, confirm what they were reported to have done. With no hope of surviving, they would confess, knowing that if they did so, they stood a chance of avoiding having their tongues cut out on the way to the stake, or their mouths scored with a red-hot poker; they might even be mercifully strangled as the fires were lit, instead of being burned alive—no small consolation when it took a minimum half hour to die from smoke and blistering—an ordeal which could be stretched to as long as a day by the application of slow-burning charcoal.

In Munich, of eleven victims on the way to the stake, six had their flesh torn with red-hot pincers, five had their limbs broken on the wheel, one woman had her breasts sliced off, and one man was impaled through the anus with a lance. At Chamonix, in 1462, a woman found guilty of prostituting herself to demons was made to sit naked on a red-hot iron for three minutes before being tied to the stake for burning. All of which was officially done *ad majorem dei gloriam;* and after the burnings, public dinners were held to celebrate "an act pleasing to God."

Various historians specializing in witchcraft, such as the Swiss authority Dr. Guido Bader, estimate that a hundred thousand witches were burned in Germany alone between the fourteenth and eighteenth centuries; the number of victims throughout Europe may be comparable to the millions of Jews far more charitably disposed of by Hitler.

From a Catholic point of view, this gruesome carnage was considered essential, since witchcraft was an overt manifestation of the old pagan religion, which threatened, if it were allowed to flourish, to sweep away the religion of Rome. For the truly believing Inquisitor to destroy a human body with fire was essentially an act of mercy if it meant saving a soul from the torment of eternal fire. To the Catholic, death of the soul through "sin" was worse than death of the body through fire, and sexuality, other than for strict procreation, preferably without pleasure, was the cardinal sin, whetted by all manner of life's desirable experiences, such as feasting, wining, dancing, singing, and being free and naked together. All of which were afforded by the witch's sabbat, a ritual which, when compared with the self-accusatory, misery-ridden worship

To historian Margaret Murray witchcraft was a highly organized "Old Religion" practiced and protected by French and English royalty (as late as under Henry VIII) and by many clergymen who secretly joined in the rites worshiping the horned god and the Mother goddess, even engaging in ritual intercourse and the indiscriminate copulation practiced by the ancient Egyptians and Gnostics, whose rites were precursors of the witches' sabbath.

of the Catholic symbols of pain and death on the cross, was welcomed by the older religionists as beautiful and exciting. Why else would so many witches have risked torture and an agonizing death to attend the sabbat? It was a spiritual, other-dimensional experience as well as a physical pleasure.

There were two kinds of sabbat: one with real bodies, which took place by moonlight in some desolate spot; and the other, to which the witch could travel out-of-body, usually thanks to some psychedelic drug, in what came to be known as the "astral plane," there to cavort with the goddess Diana and her playmates.

That the witches used a special salve to teletransport themselves to this second kind of sabbat has been known since 1600, when Giovanni Battista Porta, in his *Magiae*

The Roman initiate Lucius Apuleius, in his pre-Christian romance of witchcraft, *The Golden Ass,* described seducing Pamphile's maid Fotis to allow him to watch her naked mistress anoint herself with a magic unguent. That he got turned into an ass and had to eat the roses of Isis to be redeemed only adds to the Rosicrucian flavor of the allegory.

naturalis, gave the recipe which contained herbane, belladonna, and mandrake. The resulting ointment, known as "lifting balm," was said to be viscous, with a repulsive green-black color, and an offensive odor. Porta, founder of the Academy of Secrets in Rome, whose meetings were interdicted by the same Clement VIII who burned Bruno, was a teacher of science and inventor of the *camera obscura,* and is credited by John Weisse with being an Italian representative of the Rosicrucians.

Reginald Scot, in his *Discoverie of Witchcraft*, published in 1584, describes naked witches rubbing "all parts of their bodies exceedingly, till they look red, and be very hot, so as the pores may be opened and their flesh soluble and loose. . . ." Scot describes how, on a moonlit night, witches "believe themselves to be carried in the air to feasting, singing, dancing, kissing, culling and other acts of venery with such youths as they love and desire."

More specific are descriptions of witches applying the salve to their labia minora by means of an anointed

An ancient recipe for transvecting ointments is given in *Witchcraft and the Mysteries:* "Grind together into a paste of sufficient quantity to anoint the entire body of the following: *Acarum vulgare,* the blood of a bat, parsley cinquefoil, aconite, yellow watercress, belladonna, sweet flag and pure olive oil in equal parts of half a palm. When this ointment has been kneaded into the consistency of a viscous, light oil, massage it into the naked body covering all parts. Rub vigorously until the skin 'look red and be very hot, so the pores will be open and the flesh loose and pliable.' Finally, face an open window (or door, or lie flat upon a hearth in front of a chimney that is not obstructed to the top) and rub the limbs with pure olive oil, which will seal . . . the skin, that the force of the ointment may rather pierce inwardly, and so be more effectual." Ancient Druids, like modern shamans, claim to be able to accomplish magical flights out of the body. Following the dictates of Hermes Trismegistus, the witches sought to separate from their physical selves and travel

on the astral plane in what theosophists call their "Body of Light." To project the finer body and acquire the faculty of functioning in it, as well as to educate it to fulfill one's wishes was, and is, a fundamental practice of magic. But Israel Regardie, a Reichian therapist and adept of magic, points out that to leave the physical body bereft of its guiding intelligence "is tantamount to extending an open invitation to whatever astral entity, malignant or otherwise, is in the vicinity to take possession." The return to the body, says Regardie, must be attended to with care and precaution. "Upon entering the physical frame a few deep breaths should be deliberately undertaken in order to ensure the close conjoining of the two organisms." John Michell goes further and suggests that Druids and shamans appear to have been able to accomplish magical flights *within* their physical bodies, "often from those very mounds and hilltops where the great heroes of mythology achieved their apotheosis." He adds that there may be something about such places "which attracts those forces capable of modifying the normal influences of gravity, or which, alternately, reacts upon an intensified field of human magnetism to produce circumstances conductive to levitation." Michell then describes how the Druids may have flown. "On the eve of the day when the line, on which stood a chambered mound, became animated by the rising sun, they would enter the mound, seal the entrance and spend the night in accumulating a degree of energy by which the animal magnetism of their bodies became raised to an active pitch. The appearance of the morning sun, stimulating a current of terrestrial magnetism all down the line to the mound, would act on the body charged with energy, enabling it to levitate and to move along paths of a certain level of magnetic intensity." To which Michell soberly adds that as the suggestion has not been proved by experiment, it obviously still leaves a great deal unexplained.

"broomstick." Albert Barrere and Charles Godfrey Leland in their 1899 *A Dictionary of Slang, Jargon and Cant,* equate the term broom handle with the word *dildo,* and the word *broom,* or *plantaginesta,* with the female pudenda.

From various accounts it appears that the broom head was often carved in the shape of a phallus complete with a glans, discreetly disguised by the addition of the broom—a symbol and an artifact in one.

Discussing the greasing of the broomstick and the "nakedness of the rider" Michael Harrison suggests that the word *ride* in this context is but a euphemism for "sexual congress." He further suggests that such phrases as *between witches' legs* are also euphemisms for "inserted" between or within. "Here we have, in the fourteenth and seventeenth centuries," says Harrison, "one of the most ancient ritual objects to be found in religious celebrations, the "ὄλιδβος, olisbos, of boiled or moulded leather, that the sexually excited woman bore in the Bacchic processions; the less 'religious' but more personal surrogate—penis against whose use the German bishops thundered during the thirteenth and fourteenth centuries and, indeed, the artificial penis worn and used by the 'Devil' of the Sabbats."

By placing the anointed broom handle between her lips and prancing around, the witch may clearly have induced a psychedelic trance during which she believed she flew with Diana "to keep a tryst with the Incarnate God." Better to be affected by the salve, the witches appear to have rigorously fasted and abstained from sex for several days before a sabbat. The fifteenth-century author known as Abraham the Jew, writing in *The Book of Sacred Magic,* describes how he watched a witch anoint herself. He says she fell to the ground and lay there for three hours as if dead, and that on regaining consciousness, told him she had flown.

To establish the scientific veracity of this phenomenon, Dr. Erich-Will Peuckert of the University of Göttingen, in Germany, recently mixed up a potion of the salve as directed, with herbane, deadly nightshade, wild celery, and hog's lard, in order to perform an exhaustive experiment. He and a colleague—deliberately kept uninformed as to what might be expected—anointed their bodies with Porta's ingredients, and each fell into a deep sleep which lasted twenty-four hours. When they awoke, each separately wrote his report. To their mutual amazement, each found that he had enjoyed virtually the same erotic dream of flying to a mountaintop and participating in wild orgiastic rites with "demons."

The devil, or Satan, a Judeo-Christian idea, possibly borrowed from the Mesopotamians, was taken and turned by the Dominicans into a useful PR prop for their distorted propaganda. Onto the horned god of the pagan ritual—happy, sexy, wining and dancing and fluting—they foisted a harsh, evil, vindictive, scatological damning-with-hellfire monster—a reflection of their own tormented souls. As Reich has so remarkably documented, obscenity is all in the eye of the beholder, and unwilling or enforced sexual abstinence, far from leading to a Freudian sublimation, is more liable to turn into a self-castrating, voyeuristic compulsion to control, imprison, torture, and execute, the last at last affording the executioner the relief of a dispersal of energy in the form of a black "orgasm."

Occultists explain the experience of these *terre à terre* scientists sharing a similar dream by saying they "traveled" on the inner, or "astral," plane, a more rarefied world, whose substance is described as responsive to both thought and emotion, where one exists during sleep, trance, or after death, in what is known as the body of "desire," the ka of the Egyptian, the kama rupa of the Hindu.

Occultists see the universe as multidimensional interpenetrating worlds, vibrating at different frequencies, with what we call the physical only a restricted part of the spectrum. The energy in the astral world, they consider to vibrate at a higher rate than the physical; but once the adept, using his astral body, learns to handle the bodies of the astral world, they too become solid to the touch.

The secret astral world to which the witch flies in her astral body, by means of an ecstasy-producing unguent—while her physical body lies asleep or in a trance—is described as being divided into seven layers, the highest of which is said to be of extreme beauty, whereas the lowest is frequented by debased souls. Travelers are inclined to exist on the level to which they belong spiritually, like attracting like. It is a world filled by the occultist with many orders of spirits, some of a caliber lower than humans, others much higher. And it is the world of elementals, both "authentic" and "artificial," the latter being described as formed by thought or desire from the tenuous material of the astral plane, beautiful or hideous, protective or menacing, depending on the thought or emotion which has given them life. This they explain as the world of the witch's elementals, of the incubus and the succubus, created by desire, and rendered more or less sexy by the degree of the dreamer's desire. It is a world quite as real to psychologists as it is to occultists. Jean Marquès-Rivière, in his *Tantric Yoga*, says that through Prayoga, "it is possible to visualise and animate certain female entities who are called *succubes*." And Arthur Avalon, in *The Serpent Power*, corroborates that through Prayoga "commerce is had with female spirits."

Modern adepts of Tantric or sexual magic suggest that witches can indeed have "offspring" from their intercourse with incubi, but that these creatures are produced on the astral plane, where any discharge of energy from the physical plane invariably has an effect. Adepts claim that ejaculated semen, whether lodged in the womb or not, still manages to contribute to the creation of forms of a subtler nature. The flow produced by masturbation, sodomy, or fellatio is said by occultists to be taken up by astral entities to reinforce weak organisms already preexisting on the subtler plane. Thus are created the homunculi of the medievalist.

Kenneth Grant gives a simple formula for evoking a succubus: Sleep should be preceded by some form of *karezza* (or sexual intercourse continued without reaching orgasm), during which a sigil symbolizing the desired object is visualized. "In this manner libido is baulked of its natural fantasies and seeks satisfaction in the dream world." Grant adds that when the knack has been acquired the dream can be extremely intense and dominated by a succube, or shadow woman, with whom sexual intercourse occurs spontaneously. The modern expert on witchery, Doreen Valiente, tells of a girl she knows who was loath to have an incubus exorcised because it gave her such sexual pleasure and thrills as she had never experienced from a man. Osman Austin Spare, whose early drawing shows a psychic sexual transport, was said to be able to materialize atavisms from his subconscious and clothe them fleetingly in the sexual ectoplasm (or astral semen) of his "atmospheric copulations." Grant says that occasionally these entities could actually achieve a degree of density sufficient to make them visible and even palpable to other people. Spare called these apparitions "elemental automata" or "intrusive familiars," and says they "frequently copulated among themselves, engendering offspring simultaneously." With them he describes attending sabbaths. But the danger of such acts becoming obsessive or compulsive is indicated by Grant, who says that "such was his hunger that in one night he copulated with eighteen women, calling these outbursts: Dionysiac spasms of pansexualism in which he had visions of all things fornicating all the time." Even so, such transport may be less spiritually degrading than the burning of a witch or the torture of a wise one.

The actual live-bodied sabbat would have had as one of its purposes the initiation of a witch into the art of spiriting herself out of her physical body into the astral world of Diana and Pan. Having learned the ropes, she could apply the unguent at home and astrally meet with her playmates anytime she chose, freed from the miserable bondage of life in a Church-dominated Europe.

Goya's witches

With all this wonderland at the end of a broomstick, it is clear why the witch risked practicing the craft, and *knowing* herself to be, at heart, a spiritual creature with a whole world of similar playmates, she might have come to care less what the executioner did with her mortal body. She might even have learned the mysteries of becoming stable enough out of the body to rise to a level of power at which she could watch, as if self-hypnotized, her body being burned without feeling the pain, as is said to have been the case with some of the Anglican martyrs burned by Bloody Mary, who, wise to their tormenters' folly, could smile and bless their claybound executioners.

Of the actual flesh-and-blood sabbats, rather than the purely "tripping" routines—though there were presumably astral features in both—the most convincing historical analysis is to be found in the two twentieth-century classics of Margaret Alice Murray, *The God of the Witches* and *The Witch Cult in Western Europe*. Discredited by her academic colleagues because she supported James Frazer's *Golden Bough* theories of the sacrificed king, and because she was an Egyptologist rather than strictly a historian of their limited disciplines, Murray nevertheless admirably develops the notion of the sabbat as a ceremony of the Old Religion of the horned God, worshiped for thousands of years, going back to the Egyptian Khoum. She describes how, for camouflage, on the way to the sabbat, the witches, male and female, wore the familiar black-hooded cloaks, so as not to have their features easily recognized.

The sabbat proper, in which any number of covens of witches might participate, was the main ceremony of the craft, celebrated eight times a year on the same days as the Druid festivals of Candlemas (or Walpurgisnacht), Lammas, Halloween, and, of course, the perennial astral stations of the solar orb, the solstices and equinoxes. A lesser festival, the Esbat—from the French to "frolic," or "leave one's worries at home"—was generally celebrated by no more than a single coven of thirteen witches, at the full moon, thirteen times a year.

For further security, the more intimate Esbat might take place in a spooky, lunar spot such as a graveyard, whereas the larger sabbats, more numerously attended, were likely to be held in remote and desolate spots such as Rolling Rock, with its megalithic remains. Many sites in England still carry the names of the former rituals performed at them, such as the Seven Sisters and Dancing Maidens.

Witches perform their rites in the nude within a circle prepared with a consecrated knife, or athane, by high priest or priestess of the coven. By the athane, means of the "astral light" and its denizens can be dispelled or dispersed, and by molding the "astral," or orgone, field within the circle, a protective and power-charged cone can be raised, visible and directable by the will of the coven. Within this circle usually stands an altar with the Tarot symbols of Pentacle for earth, Wand for air, Sword for fire, and Chalice for water. There are also candles, salt, a censer, a bell, and a scourge—the latter not less likely a means of mild control than—as discovered by Reich—a means for liberating sexual energy, so pent-up by enforced restriction that it can no longer find its natural genital outlet. Witches were initiated into three degrees of the craft, with rites similar to those of the Templars, requiring "the fivefold kiss" on feet, knees, groin, breast and lips.

The object of the initiations was spiritual and psychic development of each individual, teaching them how to reach other levels of consciousness and a heightened awareness of reality.

To keep away evil spirits, a circle was invariably drawn around the site of the ritual. W. G. Gray, in his *The Rollright Ritual,* claims he could distinctly sense a magnetic ring a mile in diameter as he approached the magical site. In smaller circles, the witches would raise by their magical powers a cone of energy, visible to the clairvoyant, almost palpable. It is this engendered power which is still used by the craft today for therapy, prophecy, and sexual magic. By concentrating the will on a wish at the moment of orgasm the witch believed her will would be done.

The rule was for all to go naked at the sabbat to allow the magnetic current to flow more freely. For wintery nights, the anointed unguents served the double purpose of insulating the skin and drugging against the cold. And then, there was always the bonfire, the ashes of which were later spread in the fields for fertility.

With their cast-off clothes, the covens were wont to cast off their worldly cares, the distinction of class being lost in the nude as all became one with each other and nature. It was this freedom and beauty, says Doreen Valiente, witch, and informed writer on the craft, which constituted an important ingredient of the religious ecstasy of the pagan ritual. One of the great appeals of the sabbat to women was the freedom it afforded, not only sexually, but as creatures in their own right, rather than the slaves to which they had been reduced by Judeo-Christianity, silenced in church, with few legal rights, unclean since Moses, because of their sex.

At first sight nothing but four lovely ladies, discreetly avoiding any frontal exposure, Dürer's witches actually convey a Hermetic message in that their various hairstyles betray the fact that women of totally different social strata could happily meet as equals during the sabbath.

At the sabbat, they could revert to the matriarchal roles of the pagan world, tending the fire, stewing the pot, collecting the herbs—healers, soothsayers, interpreters of dreams and casters of lots. Among the various rituals of the sabbat was scrying in crystals or in the smoke of the bonfire, to become aware of past lives, and to foretell the future.

Diana, queen of the night, bade her followers feast and drink, sing and dance, to show that they were truly free, both men and women, as naked in their rites as they were naked in their souls, as ecstatic in their loving intercourse as was their stunning goddess of fertility with her phallused mate, the Hornéd God. Hence the feasting, wining, dancing into Bacchic, Dionysian frenzy, chanting to the cosmic goddess to engender that mysterious *élan vital* or "astral light," awaken the secret serpent power that could raise the participants to that universal ecstasy of Bruno, or the Sufi saint Al Hallaj, or any of the other frenzied martyrs of the God of love.

That men and women, pairing off for a deliberately promiscuous intercourse as practiced by the early Gnostics, might have been indulging in an intentionally Christian act of sharing designed to cement the brotherhood of man, was overlooked by the Inquisition, as was the conceit that the ritual might be designed to destroy that most fiendish and bloodthirsty of human devils, the green-eyed jealousy engendered by a compulsion to possess, which—as Wilhelm Reich laid down his life to show—leads only to sadism, servitude, and senseless slaughter. What rational spirit would choose the torment and disaster of war and Inquisition over the ecstatic fertilizing ritual intercourse of the sabbat, in which the greatest pain and damage might be the tearing of a hymen.

Although the early accounts of these sexual orgies tell of their being of the most voluptuous and satisfying kind, enjoyed by women *maxima cum voluptate,* victims of the witch trials were brought to confess to the Inquisitors that the "devil's" member was always cold, hard, and often hurt them.

All of which, by the sexually deviant Inquisitor, was reduced from a symbolic *hierosgamos,* or marriage between heaven and earth, from the world of eros and agape, to an analytic if not pornographic probing for the dimension and consistency of the penis of the Devil.

Gradually, as the persecution intensified, and the covens were thinned out by execution, the craft was forced more and more underground, and security had to be increased to keep out inquisitive spies. Hence the obligation of members to spit or piss on the cross, the most effective measure for identifying a spy who, as a believing Christian, would cringe in fear of hell for urinating on an otherwise harmless symbol. As the repression continued, the craft became the repository of more inverted religious rites and symbols, so that the witches' commitment, as Kenneth Grant puts it succinctly, was not so much to an anti-Christian faith as to the ante-Christian one.

It is also not difficult to see how the image of the sexy, beautiful witch could become distorted into that of the wicked witch of Halloween. At the peak of the persecu-

The esbat, with its full moon, provided a monthly flood tide of astral and psychic power, affecting not only the menstrual flood of women, but the formation of sperm in men. And the witches' ceremonial imbibition of the seminal fluid has found its *raison d'être* in modern science, which has discovered that young virgins need the imbibition because the hormones in sperm set their cycles going.

tion, any old widow, without relief, forced to subsist in rags on the edge of a moor, might be inclined to use what magical powers she could muster against a pharisaiacal Church. Hence the stereotype witch of black magic: old, gaunt, loathsome, toothless, squatting in tombs, feeding on corpses, forcing the dead to reveal the future, "taking a recent corpse and pouring into its breast a mixture of warm menstrual blood, the guts of a lynx, a hyena's hump, the froth of a mad dog."

In France, between 1673 and 1680, at least fifty priests were executed on charges of using the mass and the sacraments for sorcery. In *The Renaissance and the Witch Mania* the author reports the fate of several priests who were brought before a secret court, meeting in a candlelit black-draped room where confessions were extracted by torture and from which there was no appeal. "Father Tournet was found guilty of saying mass on the body of a girl he had made pregnant, with the intention that she should miscarry: she died of fright. . . . Father Gérard was convicted of using a girl's body as his altar and copulating with her during mass. . . ." And so on.

And the black mass, according to the French expert on witchcraft Jules Michelet, came as a revolt against the false Christianity of harsh and narrow-minded Puritans, of the gross injustice and cruelty of Catholic Inquisitor with his butchering secular arm.

As Harrison points out, the extirpation of the Old Religion launched by Kraemer and Sprenger succeeded not only in almost totally destroying the simple fertility cult as it had survived into the fifteenth century, but of substituting for it the false sabbat, or black mass, with its Satan, a totally spurious and totally Christian affair which required that a Host be desecrated only by a consecrated Catholic priest inserting it into the vulva of a naked female which he then asperged with semen. Such a performance conducted with a small piece of bread could only be laughable to a non-Christian.

Yet nobles of the court of Louis XIV hired as many as fifty or sixty authentic Catholic priests to conduct special black masses on the belly of a nude girl stretched across an altar. Madame de Montespan herself lay naked on such an altar in the hope thereby of retaining the favor of the king.

Sade in *Justine* describes such a black mass, during which a young girl is stripped and made to lie belly-down on a large table, with a statue of Jesus between her legs so that the mass can be celebrated on her buttocks. Part of the host, says Sade, was pushed into her "obscene entrance" while the priest "ignominiously crushed it under the repeated lunges of his monstrous tool, shouting blasphemies and emitting foul surges of the torrent of his lubricity over the very body of his Saviour."

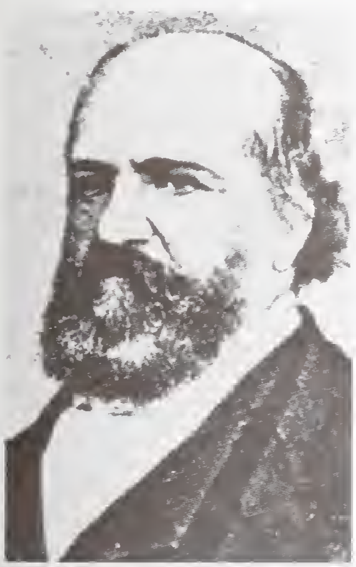
Hardly the spiritual ethics and aesthetics of Diana. And no wonder the witches ran from the horrors of the established society to the refuge of a Rollright circle to learn to master the magic of the astral world and the more spiritual realms stretching beyond, presumably *ad infinitum*.

The religions of the world

19. MAGICIANS OF THE GOLDEN DAWN

The nineteenth century's most renowned magician and expert on the "astral plane" began his career as a Catholic abbot, but soon found himself wondering whether the priests of his chosen religion in fact believed in God. In Paris, his religious schooling—"like a prison where one learns ignorance slowly and with difficulty"—convinced Alphonse-Louis Constant that from a scientific point of view the ancients had been libeled by "the infinite historical ignorance" of the professors of his day.

His fellow seminarians he found "stiff, oily-skinned, greasy-haired, with revolting *soutanes,* their natural mistrust and extreme reserve revealing a mortal coldness."



Lévi identified Mesmer's animal magnetism with "astral light," which he described as a universal medium analogous to the all-pervading ether, "a subtle matter of admirable virtue, for it attracts all that is near it." He called it a unity compounded of opposites which, like a magnet, had opposite poles, and said it responded to the human will, whose "astral body" was made of it. He also called it "the fluidic and living gold of alchemy," avowing that to control it was to master all things. At the same time Lévi warned that astral light "could be an instrument in subservience to fallen spirits," that it was "the terrestrial Mercury to whom sacrifices were ordained by diviners, the fluidic genius of the earth, fatal for those who arouse it without knowing how to direct it; for it is the focus of physical life and the magnetized receptacle of death."

For warmth—though he had already vowed perpetual chastity—the young subdeacon fell into the arms of a pretty Parisienne and never looked back on the priesthood. Yet it did not diminish his religious ideals or his zeal. As a radical writer, and a prolific one, Constant wished to regenerate and universalize religion by a synthesis and rational explanation of its symbols, constituting what he hoped would be "the true Catholic Church," a universal association of all men—and women. An early supporter of women's rights, Constant maintained that "honest" women, to avoid selling their bodies, should be admitted by law to any job they could do as well as a man.

Such notions from a religious progressive earned him frequent and unpleasant sojourns in jail. His writings on magic, which he produced under the pen name of Eliphas Lévi, were, on the other hand, better received, especially in England, where he was welcomed by Hargrave Jennings and Bulwer Lytton both as a friend and as an Hermetic brother who believed, as they did, that the material universe constituted only part of a greater reality whose planes of existence could be explored through other modes of consciousness.

Asked to demonstrate the expertise of his magic in an English country house, Lévi invoked the spirit of Apollonius of Tyre, whom he described as appearing wrapped from head to foot in a gray shroud, "lean, melancholy, and beardless."

Too frightened to pose the questions he had prepared,

Lévi swooned away. Nor could he explain the physical laws by which he claimed to have seen and touched such a phantom. Yet he insisted, "I did see and I did touch. I saw clearly and distinctly, apart from dreaming." And that, the French magus maintained, was sufficient to establish for him the real efficacy of magical ceremonies.

To explain apparitions, he posited, or fell back on, a universal agent called "astral light," a plastic medium upon which thoughts and images can be imprinted, serving as a matrix for all forms, a mirror for the imagination and dreams, a medium which can take up any form evoked by thought, causing it to become manifest even to touch. Through this astral light, Lévi concluded, healing could be accomplished, the weather affected, and such apparent miracles as the raising of Lazarus performed.

The basic function of magic, according to Lévi, is to enable the magician to direct his will more effectively, so as to be master of the "astral light," not affected by it.

Astral light, Lévi explained, consists of two opposing or complementary currents, masculine and feminine, which the magician must balance—a balance symbolized by the androgynous Baphomet of the Templars, with its woman's breasts and male phallus, or by the cabalists' Tree of Life, with its masculine and feminine currents around a mediating column.

Though ostensibly still a Catholic, Lévi became a Free Mason in 1861, initiated into a Parisian Lodge called the Rose of Perfect Silence. The same year he was visited by a young English occultist, Kenneth R. H. Mackenzie, a Master Mason, author of the *Cyclopedia of Masonry,* who claimed to have been initiated into a Continental Rosicrucian fraternity by an Austrian count named Apponyi.

In a detailed report on his visit, Mackenzie told his English brethren how Lévi had shown him the photographic copy of an inestimably rare book containing a prophecy by Paracelsus, illustrated with symbolic figures, predicting the French Revolution, the rise of Napoleon, the downfall of the papacy, the restoration of the Kingdom of Italy, the abrogation of the power of the pope, the downfall of the clergy, and, as a means of restoring general harmony in society, the ultimate ascendancy of the occult sciences. Lévi had also produced for his guest a "cabalistic plate" which he said he had bought on one of the quays along the Seine, and which was the source of a curious story. In a manuscript attributed to Cagliostro—then owned by a Count Braszynsky—the prediction was made that in the nineteenth century, a certain person by the name of Alphonse would clearly understand the meaning of the plate.

"I," said Lévi, "am that Alphonse." He then spent the rest of the interview filling in Mackenzie on the arcane mysteries of magic.

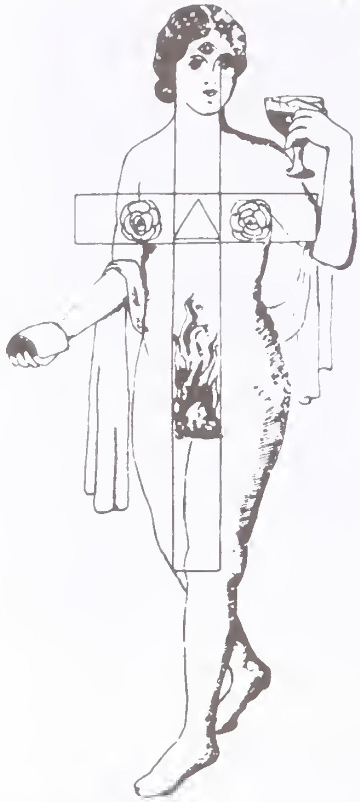
Back in London, Mackenzie shared with his fellow Freemason Hargrave Jennings all he had learned from the French magus. Jennings had meanwhile acquired from the estate of a deceased French occultist, J. B. Ragon, certain rare manuscripts which purported to give details of authentic Rosicrucian degrees and rituals. To perpetuate this wisdom, Jennings and Mackenzie got together with some other enthusiastic occultists such as Robert Wentworth Little to form the Societas Rosicruciana in Anglia, of which Eliphas Lévi was made a Master. Any other Mason with a master's degree interested in the "discovery of the secrets of nature through the symbolism of the art and literature of the past" was welcomed into the society, which began publication of its own organ, *The Rosicrucian,* naming as its Honorary Grand Patron the former British minister to Egypt, author of the Rosicrucian novel *Zanoni,* now Lord Lytton.

The man and woman reaching for each other across the inverted triangles of creative sexuality (appearing in the Rosicrucian *Anthology of Christian Rosenkreutz*) are less obscure in their meaning than the Hermetic Latin surrounding a medieval alchemist, and the captions from Proverbs: "The full soul loatheth the honeycomb; but to the hungry soul every bitter thing is sweet." And "A scorner seeketh wisdom and findeth it not: but knowledge is easy unto him that understandeth."

Among the first to join was Master Mason W. J. Hughan, and he and Jennings became pupils of an extraordinary character, said to be the greatest wizard in England since Merlin, George Pickinghill, who promised to show them how to master various elementals. It was one of their main endeavors to find the proof that the Masonic craft and the rites of the Rosicrucians were descendants of the old religion of the horned god of the Egyptians.

In a five-hundred-page opus, *The Rosicrucians, Their Rites and Mysteries,* Jennings hinted as strongly as he could that these rites and mysteries were of a fundamentally sexual nature, though to make his point in Victorian England he was obliged to resort to some involved and often poetically purple prose. Dancing around the theme of Tantric sex as the basis of the Rosicrucian philosophy, Jennings was almost specific when he pointed out that just as the Masonic seal of Solomon symbolizes the intertwined triangles of male and female, which in conjunction represent life, so the obelisk always indicates the male power derived from the sun, whereas "the pyramid indicates the female corresponding tumefactive or rising power—not submissive, but answeringly suggestive, synchronized in the anatomical clitoris (Greek from sunflower turning to the sun, that eccentric minute object, meaning everything in the Rosicrucian anatomy.)"

Ignored by his contemporaries and pilloried by later critics, Jennings nevertheless went on to produce *The Indian Religion, or Results of the Mysteries of Buddhism,*



William Wynn Wescott (1848–1925), Supreme Magus of the Societas Rosicruciana in Anglia and Worshipful Master of the Masonic research lodge Quator Coronati, translated Eliphas Lévi's work on the Tarot, and originated a groundbreaking work on the Isiac tablet of Cardinal Bembo. He died in South Africa.

in which, though maintaining as did the Theosophists that the human soul was a spark of fire taken from the eternal ocean of light, he argued that divine and supernatural illumination was the only means of arriving at the truth.

Jennings went on to explain that the Fire-Philosophers, the Rosicrucians, and the Illuminati all taught that knowable things both of soul and body were all evolved out of "fire" and finally resolve into it again, but that "this fire is not our vulgar, gross fire, but an occult, mysterious or inner supernatural fire."

The Rosicrucians, said Jennings, "claimed not to be bound by the limits of the present world, but to be able to pass into the next world (inaccessible only in appearance) and to be able to work in it, and to come back safe (and self-same) out of it, bringing their trophies with them. . . ." To this he added that they were merely following in the footsteps of the ancient Egyptians, who, "acquainted with the wonders of magnetism, built a bridge."

To achieve this passage, said Jennings, was the point and purpose of Egyptian, Rosicrucian, and Masonic initiation. Like Saint-Germain he believed that man had not originally been created susceptible to death. "The Rosicrucians contend that diseases are not necessarily incidental to the body . . ."

To drive home the point, Jennings translated from the Latin into English, Robert Fludd's opus on Rosicrucian philosophy, his *Apologia comendiaria fraternitatis de rosea cruce,* originally printed in Leyden in 1616. It hardly caused a ripple.

For several years the Societas Rosicruciana in Anglia progressed without undue notice until a member of its high council, William Wynn Westcott, decided to form an even more secret society. A supreme magus in the order, Westcott was also a London coroner, who, in the course of a lifetime may have conducted as many as ten thousand inquests, a calling which provokes the rumor that his penchant for autopsies involved a greater interest in corpses than in spirits.

Westcott had also acquired a mysterious manuscript, this one in cipher, to which he had managed to find the key—not too difficult a task, as it was the same cipher devised by the Abbot Trithenius and used by alchemists of the fifteenth century, which John Dee had spent ten solid days translating, and examples of which were at hand in the British Museum. The key made possible the transcription of five mystical rituals which Westcott claimed to be Masonic, drawn from the ancient Egyptian texts, but which later exegesists, from their inner content, believed to have


Samuel Liddell MacGregor Mathers in a rare photograph. The picture drawn of him by biographers is of a mother-fixated, sexually impotent male who avoided women and whose real passions were magic and the theory of war, and who was eventually converted to the Church of Rome. With no money, he sold inside information on the stock market to would-be investors. Kept alive by a lady adherent of the Golden Dawn, Anne Horriman, Mathers wrote and translated several important hermetic and occult works, including a lost book on Egyptian symbolism based on his exhaustive study of the Egyptian collection in the Louvre. Crowley accused him (in fiction) of sending his pretty wife out on the boulevards to make money, and of compelling her to undergo an abortion. He is credited by Ithel Colquhoun with being the mastermind behind the Golden Dawn before it was taken over by Crowley.

been concocted some time after Champollion had deciphered the glyphs, perhaps as late as 1870.

Westcott further claimed that the document opened the way to higher degrees of Rosicrucian initiation, to which had been given the high-sounding Latin titles of zelator, theoricus, praticus, and philosophus, used in the eighteenth century by the German rite of The Golden and Rosy Cross. Westcott also maintained that a letter found with the manuscript enabled him to get in touch, through an initiate in Germany, with the actual "Secret Chiefs" of the ancient order, originally introduced into Strict Observance Masonry by Baron von Hund, and that they had granted him permission to form a lodge in England, the Isis-Urania Temple of the Hermetic Order of the Golden Dawn.

This was considered an exciting breakthrough into the realms of higher magic; but as Westcott was no great magician, the real power in the new lodge fell into the eager hands of a character with the given name of Samuel Liddle Mathers, who, because of a Jacobite ancestor ennobled by Louis XV, was pleased to assume the title of McGreggor, comte de Glenstrae, and was not unwilling to have people believe him to be, in reality, James IV of Scotland, not killed at the Battle of Flodden, an adept who had learned, like the comte de Saint-Germain, to become immortal.

A Master Mason, then in his thirties, Mather had acquired a profound knowledge of Egyptology by reading every book he could find in the British Museum on magic, alchemy, symbolism, and the religious mores of ancient Egypt. To an acquaintance who spotted his gaunt, resolute figure in the reading room, he confided: "I have clothed myself with hieroglyphs as with a garment."

Further to explore the various astral planes, Mathers also taught the use of Dr. John Dee's Enochian magic. From the jumbled mass of Dee's papers and diaries, preserved in the British Museum and the Ashmolean Library at Oxford, Mathers managed with some effort to produce a coherent system of Enochian magic which seems to have helped initiates of the Golden Dawn explore the superphysical world of Dee's thirty "aethyrs."

Mathers also partially translated from the German Knorr von Rosenroth's seventeenth-century *Kabalah denudata,* which enabled him to equate the ten sephiroth of the Jewish cabalist's *Tree of Life* with the inner planes of the astral world, "reaching up to a limitless light beyond which nothing more can be known."

To secure his grasp on the Order, and to impose on it obedience, Mathers claimed to have forged a personal

Florence Farr (1866-1917)—Mrs. Edward Emery—mistress of the poet W. B. Yeats and of Bernard Shaw, was a leading member of the Golden Dawn, who specialized in "Scrying the Spirit-Visions." Left by Mathers in charge of the society, she wrote plays dealing with the Egyptian magical tradition. She also ran an avant-garde gallery where the paintings of D. H. Lawrence were seized as shocking.

Moina Mathers, lovely, delicate sister of Henri Bergson, was a clairvoyant who could bring to earth material from the "inner planes." But the sex act was reported to have "filled her with revulsion" and her marriage appeared to have been sexless, at least with her husband.

link with Westcott's "Secret Chiefs," about whom he could say nothing other than that they conveyed to him arcane knowledge, either clairvoyantly, on the astral plane, through automatic writing, or by means of a sort of ouija board, the use of which he said required great skill and attention to avoid interference by opposing "demonic" forces.

Mathers admitted he seldom had seen the "Chiefs" in the flesh, nor did he know their earthly names, but they appeared to him to be human with superhuman powers which were manifested as "transcendent health and vigor, as if they possessed the Elixir of Life." To be close to them, said Mathers, was like being close to a lightning flash during a violent storm.

The grades of initiation in the Golden Dawn were divided into three main levels, the first corresponding to the material world, the second to the astral, the third to the transcendental. Among the more prominent of the hundred-odd members some, like the wife of Oscar Wilde, were determined to practice magic. Others, such as Florence Farr, the actress, and mistress of G. B. Shaw, claimed to be controlled by "a certain Egyptian astral form first contacted through a piece of mummy case." W. B. Yeats, the Irish poet, more interested in inspiration, was introduced by Mathers to the world of symbolic "archetypes," where "images well up before the mind's eye from a deeper source than consciousness or subconscious memory." Yeats described visions which recalled "the planetary images of Ficino and Bruno," and, by concentrating, said he could even transfer symbols to someone else's mind.

In Paris, where he had moved for financial reasons, Mathers found in the Bibliothèque de l'Arsenal another magical system spelled out in a sixteenth-century manuscript, which he translated into English as *The Book of the Sacred Magic of Abra-Melin the Mage*. He claimed it enabled his fellows of the Golden Dawn to attain, through another ancient Egyptian ritual, "knowledge of, and conversation with, their own Holy Guardian Angel."

For some years Mathers continued to run the Golden Dawn from France with the financial help of one of its lady members, who, somewhat neurotic, accused Mathers and his wife, Moira Bergson, sister of the French philosopher, of dabbling in sexual magic. Both denied the charge of having made pacts with qliphotic or demonic forces, but their financial support was rescinded. Worse troubles, as lucidly described by Ellic Howe in his *The Magicians of the Golden Dawn,* were to follow. First Mathers failed to convince his fellow Golden Dawners of the actual existence of his "Hidden Chiefs"; then he admitted he had known all along that the original letters from Germany accrediting the Order had been forged, presumably by Westcott. Quarrels between members of the Golden Dawn accelerated its day toward a sunset. It only remained for the youngest and most energetic of its aspirant magi, Aleister Crowley, to ease Mathers into a personal *daemmerung,* by first taking his side, and then taking his place.

Edward Alexander Crowley in his twenties

Edward Alexander Crowley, better known by the first name of Aleister, was twenty-three and just down from Cambridge when he was initiated, in London's Mark Mason's Hall, into the Golden Dawn as Frater Perdurabo ("I will endure"). Two years later, he was a thirty-third-degree Mason. Within the minimal time he had worked his way up to the top of the complex order of Hermetic degrees concocted by Mathers. This he accomplished with the help of a senior magus, Allan Bennett (Frater Jehi Aour), who broke his oath to supply Crowley with the required secret data, later abandoning the Golden Dawn to become a Buddhist monk.

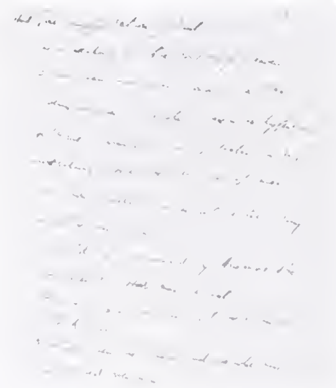
The next step, the contacting of his own guardian angel through the magic of Abramelin the Mage, Crowley could not speed up because it required a concentrated six-month effort which could only take place precisely between the vernal and autumnal equinoxes. To find the right atmosphere of privacy for this magical exercise, Crowley spent £2,000 of his father's inheritance to acquire a pink-washed, one-story lodge called Boleskine, overlooking the murky waters of Loch Ness between Foyers and the Enochian-sounding village of Inverfarigaig.

Exhausted by several months of apparently unsuccessful endeavors, Crowley suddenly reverted to his penchant for exploring exotic corners of the planet and set off for Mexico and the Far East, returning via Ceylon, India, Burma, Baltistan, and Egypt, having tackled and nearly mastered two of the highest unclimbed peaks in Asia. To Egypt he returned with a young bride, Rose Kelley, sister of Gerald Kelley, later Sir Gerald, president of the Royal Academy.

Rose Kelley Crowley

Masquerading through Cairo as a Persian prince called Chio Khan (Hebrew for "the beast"), dressed in flowing golden robes and a jewel-encrusted turban—so that runners would clear a path for him through the crowded streets—Crowley took his bride to honeymoon in the King's Chamber of the Great Pyramid, where he said he demonstrated to her his magical powers by causing the entire chamber to glow a pale lilac with "astral light."

Back in Cairo in an attempt to convince Rose of the



A page from Crowley's handwritten *Book of the Law.* The author, says Crowley, claimed to be a messenger—like Mohammed and others—of the Lord of the Universe, and therefore to speak with absolute authority. The book is said to be a statement of transcendental truth, and to have overcome the difficulty of expressing such truth in human language by what amounts to the invention of a new method of communicating thought. This Crowley describes as not merely a new language but a new type of language. "A literal and numerical cipher involving the Greek and Hebrew Cabbalas, the highest mathematics, etc." The book, says Crowley, ". . . claims to be the utterance of an illuminated mind coextensive with the ultimate ideas of which the universe is composed . . . an intelligence both alien and superior to myself, yet acquainted with my inmost secrets, a discarnate intelligence." Kenneth Grant says of the *Book of the Law* that anyone possessing any capacity for understanding the language of symbolism "will be staggered by the adequacy and accuracy of the summary of the spirit of the Aeon. . . ." It gives the basic law of the new aeon as: "There is no law beyond 'Do what thou wilt' and 'Thou hast no right but to do thy will.' " The theory being that every man and woman each has definite attributes whose tendency, considered in the relation to environment, indicate a proper course in each case. To pursue this course of action, says Grant, is to do one's true will. Hence: "The word of Sin is Restriction."

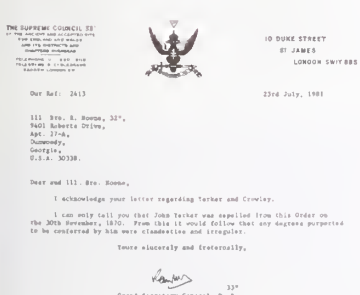
existence of elementals by invoking sylphs, or spirits of the air, Crowley merely managed to put his bride into a mild trance in which she informed him that the Egyptian god Horus awaited him with instructions to sit at his desk at noon on April 8, 1904, to receive a message.

At the appointed hour, Rose—whom Crowley now called by the pretty Arabic equivalent of Ouarda—suddenly spoke over his shoulder in a rich baritone in an English "uncannily perfect and free of ascertainable accent, native or foreign," which identified its owner as Aiwaz, Egyptian minister to the Lord of Silence, Hoor-Paar-Kraat.

On three consecutive days, the deep timbre of the voice "poured forth slowly, steadily, solemn, voluptuous, tender, fierce, in harmony with the message delivered," while Crowley with his Swan fountain pen scribbled and scribbled. Result: a twenty-one-page prose-poem known as the *Book of the Law,* which was to revolutionize Crowley's life, and would, he believed, greatly affect the future of mankind. It announced the advent of a new eon in which Crowley was to become the priest-prince of a new religion, the Age of Horus. He was to formulate a link between humanity and the "solar-spiritual force, during which the god Horus would preside for the next two thousand years over the evolution of consciousness on this planet." The technique used by Crowley to commune with Horus was "to seal the plasma of his astral body in the mentally formed image of a golden hawk—a vehicle of Horus—and in that form explore the subtle aethyrs of the universe, angelic or non-terrestrial dimensions of consciousness not usually experienced."

The message from Aiwaz, whom Crowley understood to be his own guardian angel, convinced him that his mission in life was to give the *coup de grace* to the Age of Osiris with its moribund appendage, the Christian faith, and build on the ruins a new religion based on the law of Thelema—Greek for "will." The theme of this new dispensation Crowley summed up in the dictum "Every man and woman is a star. Do as thou wilt shall be the whole of the law." To which he added the further and even more important proviso of "Love is the law, love under will." But love and affection under the law of Thelema was not to be confused with the possessive kind that breeds pain, jealousy, and hatred. It was to be a Charter of Universal Freedom for every man and woman in the world, each individual considered as the center of his own universe, his essential nature determining his relations with similar beings, and his proper course of action. Crowley's law of Thelema, as an ideal Freemasonry, saw each member of the

Crowley's diploma as a 33° Mason, issued in London, October 1910



THE SUPREME COUNCIL 33°

10 DUKE STREET
ST JAMES
LONDON SW1Y 6BS

Our Ref: 2413

23rd July, 1981

Ill. Bro. R. Boone, 32°,
9401 Roberts Drive,
Apt. 27-A,
Dunwoody,
Georgia,
U.S.A. 30338.

Dear and Ill. Bro. Boone,

I acknowledge your letter regarding Yarker and Crowley.

I can only tell you that John Yarker was expelled from this Order on the 30th November, 1870. From this it would follow that any degrees purported to be conferred by him were clandestine and irregular.

Yours sincerely and fraternally,

33°
Grand Secretary General, R. E.

The Grand Secretary General of the Supreme Council 33° in London declared Crowley and Yarker to have been expelled from the brotherhood of Masons.

human race as unique, sovereign, and responsible only to himself. "In this way," says Crowley, "it is the logical climax of the idea of demorcrary. Yet at the same time it is the climax of aristocracy by asserting each individual equally to be the center of the universe." The conclusion from these premises was that the sole and whole duty of each human being was to discover the purpose for which he or she is fitted and devote every energy to its accomplishment. The *Book of the Law,* said Crowley, opened a path of progress to mankind which would eventually enable the race to strike off the fetters of mortality and transcend the limitations of its entanglement with earth. He also called it "a veritable Golden Bough," an absolute passport through the Amenta of the Egyptians.

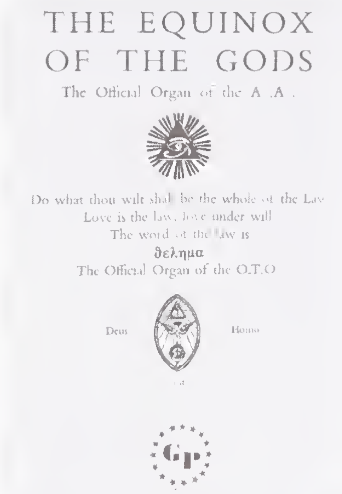
By his adepts, the *Book of the Law* was described as containing occult formulae of cosmic scope, "some openly expressed, some veiled in the most complex web of qabalistic ciphers ever woven into a single text." Nor was it just a piece of "automatic writing," said Crowley, but a clearcut message from an intelligence of superhuman power and knowledge, some extraterrestrial transcendental source, "one of the real hidden masters who would thereafter manifest to him."

Crowley describes Aiwaz as appearing to him later in the form of a tall, dark man in his thirties, "well-knit, active and strong, with the face of a savage king, and the eyes veiled lest their gaze should destroy what they saw." The apparition's dress, says Crowley, was not Arab, but suggested Assyrian or Persian, only very vaguely, because "at first I took little note of him as he was like an angel, such as I had often seen in visions, a being purely astral."

Later still Crowley was inclined to believe that Aiwaz was not only "the God or Devil once held holy in Sumer, and mine own Holy Guardian Angel, but also a man as I am, insofar as he uses a human body to make his magical link with mankind, whom he loves, and that he is thus an Ipsissimus, the highest spiritual achievement possible to man, literally his own very self, the head of the Great White Brotherhood."

By this Crowley did not necessarily mean that Aiwaz was a member of the human race, but that he could apparently form for himself a human body, as circumstances indicated, from the appropriate elements and then dissolve it. "I saw him again often in different human guises all equally material."

Acting upon the authority of Aiwaz, Crowley was happy to supplant Mathers and his Golden Dawn by forming a


THE EQUINOX
OF THE GODS
The Official Organ of the A∴A∴

Do what thou wilt shall be the whole of the Law
Love is the law, love under will
The word of the law is
θελημα
The Official Organ of the O.T.O

Deus Homo


The poet Victor Neuburg

By some experts, Dee's Enochian language is suspected of being Ur-Semitic, the source of later Semitic tongues. To others it is "the language that lies behind Sanskrit," or even the language of the Atlanteans. It was, in any case, a hieratic tongue to be used in ritual, its vocabulary related to a transcendental world, a sacred alphabet of letters and numbers, in which the letters were also sigils, or glyphs.

new order called Astrum Argentum, or Silver Star, named after Set, or Sirius, of which he claimed our sun was but a reflection, or son. The order, which Crowley considered the truly occult representative of the Great White Brotherhood, was designed to bring out into the open the secret knowledge so painstakingly preserved by initiates. The rituals of the A: A:, as it was glyphed, were to be simpler, including yogic practices Crowley had learned in the East. Their purpose: to prepare humanity for the next stage of its progress—initiation into the solar consciousness of Horus. At first there were few recruits to the A: A:, other than a sycophantic young admirer down from Oxford, the poet Victor Neuburg; but Crowley pressed on. With what was left of the money inherited from his father, he decided to launch a twice-yearly publication, *The Equinox*. The first issue, beautifully bound in white and gold, appeared in March 1909. Crowley described it as the first serious attempt to put before the public the facts of occult science "since Blavatsky's unscholarly hotch-potch of fact and fable, *Isis Unveiled.*" He considered his to be the first attempt in history to treat the subject with scholarship and from the standpoint of science. It contained the technique for assuming a god-form, of ritually evoking and banishing astral, elemental, and planetary entities. In the second issue, in October, true to his promise to reveal the initiatory secrets, Crowley published the neophyte ritual of the Golden Dawn with fifty-four diagrams to illustrate the mysteries. The cat was out; and once he and Neuburg had seen that it was well received, they took off for the North African desert of Algeria to embark on a more ambitious experiment in magic: further exploration of Dee's astral levels with the use of a large topaz as a shew-stone which Crowley would scry while Neuburg scribed.

Crowley says that eventually he learned not to travel in his astral body because he realized that space was not a thing in itself, but merely a convenience enabling one to distinguish objects from each other. When in one of Dee's Aethers or Aires he says he found himself simply in a state characteristic of its nature, his senses receiving its subtle impressions. Thus he claims to have become as cognizant of the phenomena of Dee's worlds as ordinary man is of his. But unable to break into the fourteenth Aire, Crowley had the sudden impulse to use sex to advance his magic. "We accordingly took loose rocks," says Crowley, "and built a great circle, inscribed with the words of power; and in the midst we erected an altar and there I sacrificed myself."

Crowley claimed he was obliged to write his more

According to Kenneth Grant, the barbarous names of evocation and invocation, whether Enochian, Goetic, Gnostic, or Tantric, are peculiarly adapted to unsealing the subconscious, their potency lying chiefly in their being unintelligible to the conscious mind. Crowley says: "The long strings of formidable words which roar and moan through so many conjurations have a real effect in exalting the consciousness of the magician to the proper pitch." He quotes Dee as voicing: "ZODACARE, ECA, OD ZODOMERANU! ODO KIKALE QAA! ZODOREJE, LAPE ZODIREPO NOCO MADA, HOATHATE IAIDA"; or: "Move, therefore, and show yourselves! Open the mysteries of your creation! Be friendly unto me, for I am the servant of the same your God: the true worshipper of the Highest!"

specific explanation in hieroglyphs because it had to do with matters "of which it is unlawful to speak openly under penalty of the most dreadful punishment: but I may say that the essence of the matter was that I had hitherto clung to certain conceptions of conduct which, while perfectly proper from the standpoint of my human nature, were impertinent to initiation. I could not cross the Abyss till I had torn them out of my heart."

Crowley the magician

Francis King, in *The Magical World of Aleister Crowley,* is more specific when he writes that the magus "sacrificed himself in a way which consumed every particle of his ego . . . he deliberately humiliated himself by being Neuburg's passive partner in an act of buggery."

The result, at the moment of joint orgasm, appears to have been a stunning entry into Dee's fourteenth Aire, where Crowley learned "to allow my ego to be totally destroyed so as to unite my spirit with the ocean of infinity."

From then on, said Crowley, sexual acts, which he had indulged in "with casual abandon," became for him a sacrament, a rite to be performed deliberately for the glory of the gods. Buggery, Crowley avowed, other than for religious purposes, was abominable; and to differentiate his magick from the nonsexual variety, he added to the word a *k,* symbol for kteis, Greek for the female genitals.

One of the demons conjured up by man from his own created storehouse

Crowley used *key* and *aethyr* for Dee's *call* and *aire*. A gramophone record of Crowley exists in which he recites the first forty-eight Enochian "calls." It was a language, says Ithell Colquhoun, that had to be vibrated like a mantra, and she suggests that Enochian magic is a Western equivalent to Hindu mantra yoga, and that vocalizing the sound gave access to an Atlantean world, "a superstructure unimaginably attentuated and jewel-clear, which the Egyptian *Book of the Dead* symbolizes as 'the lily of green felspar.' " She believes the Enochian Tables conceal a musical system, a record of frequencies on which the calls should be sent out, and "may even suggest the construction of an instrument." Crowley called the language "very much more sonorous, stately and impressive than Greek or Sanskrit, and the English translations, though in places difficult to understand, contain passages of a sustained sublimity that Shakespeare, Milton and the Bible do not surpass."

Reaching the tenth Aire—which had to be approached backwards, since it had been taken down by Dee for fear of unleashing demonic forces—Crowley realized he must consciously cross what he called the "Abyss," or great psychological barrier separating ordinary men from the "Secret Chiefs," a barrier guarded by the mightiest devil of all, the demon of spiritual chaos, the same Chorozon encountered by Dee. It now became clear to Crowley "that one must look inward and face one's own demons, for they may be the same as those one evokes."

There was a flash of lightning followed by a rumble of thunder, and a voice intoned: "I am the master of Form and from me all forms proceed."

Chorozon, Crowley later explained, represented all the suppressed fears and hostilities which had flourished in his subconscious. By materializing them, and by integrating them openly into his psyche, he says he disposed of their power; as a result of which ordeal he claimed to have earned a higher occult degree than Mathers, becoming a Magister Templi.

Mathers, in London, afraid that all his powers would now be lost by publication in *The Equinox* of the most secret rituals of the Golden Dawn, filed a restraining order against the third issue; and though at first he succeeded with the help of a judge renowned as a Freemason, the judgment was reversed on appeal and the second issue of *The Equinox* appeared intact.

Mathers, who admitted at the trial, under oath, "to raising devils, making himself invisible, transforming men into animals, making gold, making rain, and all the other fabled arts of sorcery," managed to further annoy several occultists by claiming to be *the* chief of the Rosicrucian order. Another such chief, a German, Theodor Reuss, reputed agent of the German secret service, employed to spy on British Marxists, was equally annoyed. As head of the Ordo Templi Orientis, Reuss considered his occult order to be the successor to the Knights Templar, and to be the true successor of the Rosicrucian fraternity, just as his earlier order, the Grand Lodge of Memphis and Misraim, had been the successor to both Cagliostro's Egyptian rite, and to Adam Weishaupt's Order of the Illuminati (OTO).

Reuss had inherited leadership of the OTO a few years earlier from a wealthy Austrian iron founder and high Mason, Karl Kellner, who had died in mysterious circumstances after changing the order's name from the Hermetic Brotherhood of Light to the Order of the Temple of the East, on the grounds that the East was the locus and source

The Hermetic Philosophy.

First Matter of Hermetic Philosophy, or the Font of Miracles. The text that goes with this illustration from the Rudolph Steiner Christian Rosenkreutz Anthology reads: "I am the mixture which preserves everything in nature and makes it alive. I pass from the upper to the lower planes. I am the heavenly dew and the fat of the land. I am the fiery water and the watery fire. Nothing may live without me in time. I am close to all things; in and through all things; nevertheless, unknown." The caption alongside the hermetic drawing reads: "This moisture must be caught, lest it should change into vapor or fume. The two vapors or fumes are the roots of the art."

of the illumination symbolized by the solar-phallic energy.

Reuss called on Crowley in London to accuse him of having revealed the innermost secrets of the ninth degree of the Ordo Templi Orientis. Surprised, Crowley replied he could hardly have done so as he had not been admitted to that degree and could therefore not know its secrets.

Reuss reached for a copy of Crowley's *Book of Lies* and pointed on page forty-six to the Ritual of the Star Sapphire. Crowley was thunderstruck. In his own work—in which he claimed to have surprised the supreme secret of all practical magick by pure chance while lying with a whore—he recognized a reference to sexual magic disguised beneath the symbols of the "rood" for phallus and the "mystic rose" for vagina. The scales fell from his eyes. At last, said he, his suspicion was confirmed that "behind the frivolities and convivialities of Freemasonry lay in truth a secret ineffable and miraculous, potent to control the forces of nature, and not only to make men brethren, but to make them divine."

Reuss was quite categoric: the OTO was a body of initiates in whose hands was concentrated the secret knowledge of *all* oriental orders and of all existing Masonic degrees. Its chiefs were initiates of the highest rank, but not in conflict with the grand lodge of England. It was all clearly stated, said Reuss, in the organ of his Grand Lodge of Memphis and Misraim, a magazine called *Oriflamme,* which spelled out that the order had "rediscovered the great secret of the Knights Templar, the magic of sex, not only the key to the ancient Egyptian and hermetic tradition, but to all the secrets of nature, all the symbolism of Freemasonry, and all systems of religion."

In the secret code of the order, Crowley found *Athanor* to be the name for penis; *blood of the red lion* for semen; *curcubite* or *retort* for vagina. Vaginal liquids were known as the *menstruum of the gluten,* and when mixed with semen, they became *first matter;* further impregnated with magic, they equaled the *Elixir of Life.*

Karl Kellner, the OTO's founder, said Reuss, claimed to have rediscovered the "secret doctrine" during his travels in India, where he had been initiated into Tantrism and the use of the sexual current by a notorious Arab magician, Soliman Ben Aifa, practitioner of an unorthodox form of Sufism, and by two Indian Tantrics, Bhima Sen Pratap and Shri Mahatma Agamya Paramahamsa, initiates of the *vama marg,* or left-hand path, the magical use of sexual energies accomplished with the help of a female companion, or *shakti.*

The OTO, said Reuss, had been founded in the 1890s

by an amalgamation of the original order of Bavarian Illuminati and the Hermetic Brotherhood of Light, an order formed by the American Paschal Beverly Randolph, natural son of a rich Virginian and a mulatto woman said to be of royal Malagasy blood. As a friend of Lincoln's, he is said to have encouraged the president in his aid to Negroes. According to Serge Hutin, Randolph became involved with Freemasonry and the Fraternitas Rosae Crucis, and thanks to his extensive travels in the East had met Tantric initiates who enabled him to produce his main work, *Magia sexualis*.

So the chain linked Reuss and Kellner and Paschal Beverly Randolph back to Hargrave Jennings and the early members of Rosa Crucis in Anglia who had been obliged to keep so secret the fact that they too practiced the secret rituals of Tantric sex which Edward Sellon had described in his book. Suddenly all of Jennings's Hermetic phrases, teetering on the verge of revelation, became easier to comprehend.

Furthermore, says Manley Hall, it is possible that Jean Marie Ragon and Alexandre Lenoir could have been pupils of Saint-Germain when he practiced masonic and rosicrucian rituals in the palace of Prince Karl of Hesse at Eckernforde in 1780-85.

Delighted by Crowley's grasp of Tantric yoga, Reuss offered to initiate him into the highest degree of the OTO, suggesting that his new adept head a British section to be known as Mysteria Mystica Maxima, wherein initiates could be given hints in the lower grades of the whole truth of the power of sexual magic, which would be revealed during the higher degrees.

The first six degrees of the OTO Crowley found to be simply Masonic. In the seventh the initiate was given a

Crowley became convinced that his job was to cure the whole world of sexual repression, a plague that was paralyzing spiritual progress. He wanted sexual expression to be not a legal or a financial or an endured performance but a "magnetic phenomenon"; he wanted love to be a gift to be treasured without shame or hypocrisy. And he saw his mission not merely to illuminate the few, but "to set in motion occult forces which would result in the illumination of all by 2000 A.D." To achieve his goal he determined to study every detail of sexual behavior and bring every sexual impulse up to the region of rational consciousness. To this end he experimented with altered states of consciousness, including hashish, cocaine, and opium. To push his consciousness to its limits, to reach a transcendent state, he used orgiastic practices, believing that in a deathlike trance of the body, the spirit was free to unite with an invoked "god." But he warned: "Sex is, directly or indirectly, the most powerful weapon in the armory of the magician, and precisely because there is no moral guide, it is indescribably dangerous. I have given a great many hints, especially in *Magick* and the *Book of Toth*—some of the cards are almost blatantly revealing; so I have been slapped rather severely over the knuckles for giving children matches for playthings. My excuse has been that they have already got the matches, that my explanations have been directed to add conscious precautions to the existing automatic safeguards."

In *Liber agape* sexual intercourse is referred to as "the sacrifice of the mass": entering the privy chapel is to enter the woman's vagina; to bestow at least one hour in adoration at the altar is sexual play; extolling God in strophe and antistrophe and performing the sacrifice is to achieve orgasm; "the elixir being prepared solemnly and in silence do thou consume it utterly," is to swallow the mingled male and female secretions, described as "the most powerful, the most radiant thing that existed in the whole universe."

glimpse of sexual magic. In the eighth he or she was taught to practice autosexual magic through masturbation. According to Henri Bertreux in *Aux pays du Dragon*, astral energy can be released by a form of massage, or magical masturbation, which stabilizes the astral field of a person, making his or her magnetic force more harmonious. It can then be used as a form of protection against sexual vampirism performed by sexual entities operating in another dimension. "A wall of light," said Crowley, "can be made to encircle the magician charged with solar-phallic power drawn from the sun. . . . Sexual vampires seeing the radiant wall of light are drawn precipitately towards it and dashed to pieces, electrocuted on impact."

In the ninth degree of OTO heterosexual magic was performed involving sexual congress, the essential goal of which was the same as in witchcraft: concentration of the will at the moment of orgasm in order to obtain a wish. As with the witches, Crowley said he performed this magic on the astral plane in his so-called body of light. His imagination, powered by sexual energy, was set to function on an astral level, and, according to Crowley, at the moment of orgasm the sexual organ actually "shines" astrally. The ability to function on the inner, or astral, planes, to travel freely in the realms of light, or inner space, are derived, as Crowley explained it, from a purification and condensation of "vital force," which he described in its densest form as being identical with sexual energy. "The emanations of the 'Body of Desire' of the material being whom one visits," he said, "are, if the visit be agreeable, so potent that one spontaneously gains substance in the embrace."

He explained that in order to transform sexual energy into magical energy, the dormant fire-snake at the base of the spine is awakened. And the function of semen in the ritual is to build up the body of light, or astral body. "As the vital fluid accumulates in the testicles it is consumed by the heat of the roused Fire Snake radiating waves of astral energy whose subtle fumes go to strengthen the inner body."

Curious to discover whether a magician could produce the phenomenon at will through *any* practice of sexual magick, Crowley went with Victor Neuberg to Paris, where they enlisted the help of the correspondent of the *New York Times*, Walter Duranty. Beginning in January 1914 they performed twenty-four rituals of sexual magick in forty-three days, designed to invoke several disembodied entities ranging from Hermes to Jupiter. Crowley kept a diary describing these events, which he wrote up as *Rex*

According to Horapollo, the Egyptians used the falcon as a symbol of the god Horus because of its long life, its piercing sight, its ability to climb straight up and to drink the blood of a victim while flying upside down; also because the female was said to accept the male thirty times a day.

Crowley describes his method for assuming a god form. "By concentrated imagination of oneself in the symbolic shape of any god, one should be able to identify oneself with the idea which he represents." Crowley describes invoking a god form with Neuburg in a locked temple: "On one occasion, the god came to us in human form and remained with us, perfectly perceptible to all our senses, for the best part of an hour, only vanishing when we were physically exhausted by the ecstasy of intimate contact with his divine person, and sank into a sublime stupor; when we came to ourselves he was gone." At other times, Crowley continued the evocation of elemental forces "to visible appearance," and to make various talismans charged with spiritual energy, by means of meditation. He also continued to build up "my (so-called) astral body until it was sufficiently material to be perceptible to the ordinary physical senses of people I should visit in this shape."

de arte regia, listing every sexual act of any form in any possible combination, with the goal to be achieved at the moment of orgasm. Occasionally Duranty would substitute for Neuburg as a partner and "magician joined to magician," they would make the invocation: "Hermes, King of the Rod, appear, bringing the ineffable word!"

To impersonate an Egyptian god-form, mental concentration on the form of the god was required throughout intercourse; one had to imagine the god to have a life of its own. At the moment of climax, a transference of consciousness to that of the image was necessary, "blending the personality of the initiate with that of the god." Crowley still insisted that the practice of buggery was "an abomination" except in magick, and Serge Hutin says Crowley could not have been a homosexual or he would not have been admitted by the Hindu Tantric masters to their secret rites of the "left hand" because homosexuals are excluded—not for moral reasons—but because the normal polarity is reversed, and the magic will not function. Not satisfied with these extraordinary results, Crowley was to develop two more grades of sexual magick for the OTO, based on homosexual ritual.

It was clear to Crowley that the accusations against the original Templars of practicing sodomy and orgies with women had been grounded, but not as understood by their detractors. The Templars were evidently practicing rites they had picked up in the East. G. Legman, in *The Guilt of the Templars,* a composite work by five distinguished English academicians, says the Templars did not practice homosexuality *faute de mieux* but as a formal dedication, betrayed by the ritual nudity required at their secret initiation, and by the scatalogical kisses on mouth, penis and arse, which "clearly could or did end with the fellation or pedication of the recruit by the Templar receiving him." Legman suggests that the whole secret ritual implied or symbolized "a complete erotic itinerary of the recruit's bare body under the guise of ritual kisses." This was followed by the admonition that if at any time he felt the "stirrings of the flesh" (which Legman says could certainly be observed if it occurred while he was kissing the recruit's penis) it was permissible to "unite himself carnally with any of the brethren, and that he was to submit himself passively to them if asked." The neophyte was also told that it was better to satisfy each other than give a bad name to the order by going after the women pilgrims they were charged with protecting. Though it appears, says Legman, that the rich and powerful Templars had all the women they wanted "very handsome and elegant."

That there was more to the Templar ritual than a banal satisfaction of the senses is indicated by the nature of its kiss on the mouth—a hermetic means of transmitting a subtler spiritual breath from initiate to novice.

The Templars appear to have realized long before Wilhelm Reich that society could not be reformed into a peaceful brotherhood so long as repressed sexuality could be distorted into neurosis and aggression, and that any sexual discharge of pent-up vital energy was better than having it turn noxious, as with the torturers and warmongers.

What actual Tantric practices the Templars may have indulged in, whether masturbatory, homosexual, or heterosexual, is not easy to determine; for the brothers were understandably reticent in exposing the fabulous secret of their Order.

Crowley, in his *The Secret Garden,* adds a curious footnote to the Western Christian laws against homosexuality illustrative of the folly of man's misconception in matters of religion: "When the power of the Crescent menaced that of the Cross, sodomy was put down with Draconian rigour because the Turks believed that the Messiah (a reincarnation of Jesus) would be born of the love between two men. Sodomy was thus a religious duty with the Turk; at any moment his passion might be used to bring about the Millenium; so with the Christian it became heresy, and was punished as such!"

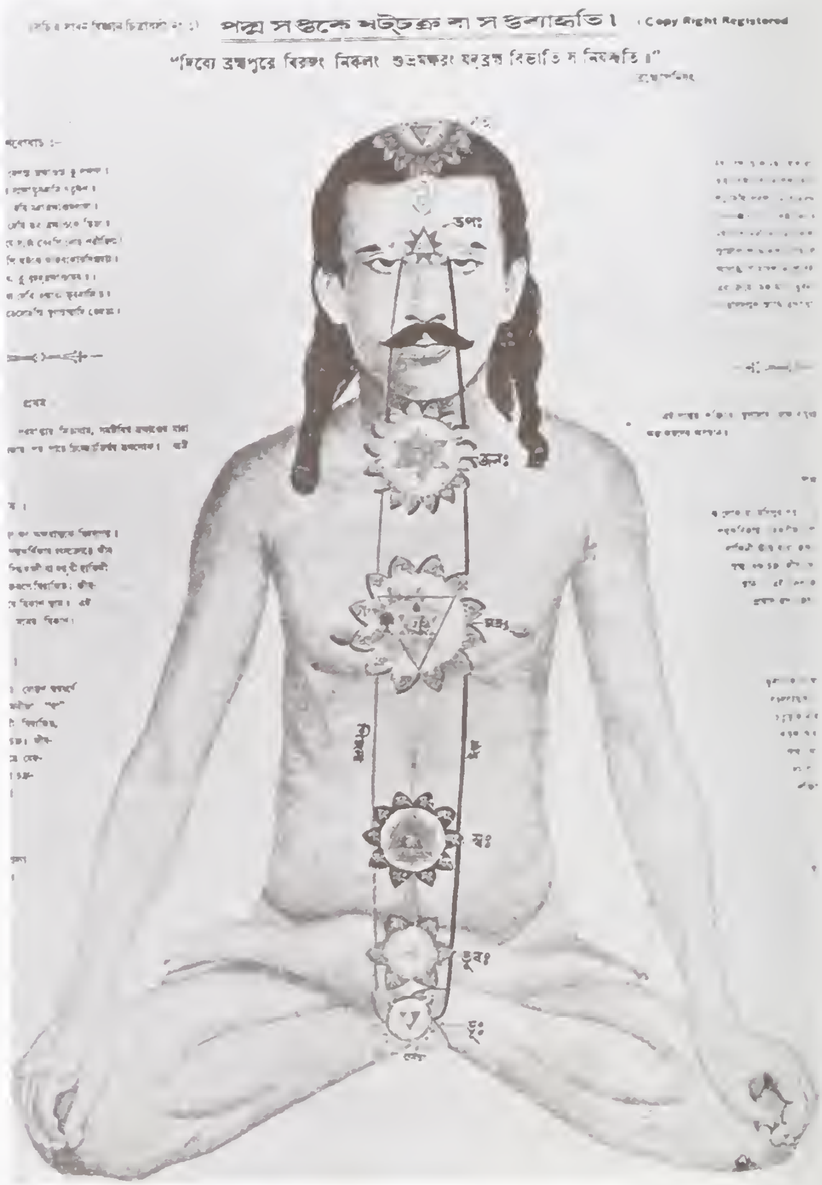
Crowley synthesized his message: "I say to each man and woman: You are unique and sovereign, the center of the universe. However right I may be in thinking as I do, you may be equally right in thinking otherwise. You can only accomplish your object in life by complete disregard for the opinions of other people. . . . My mission is, in short, to bring everyone to the realization and enjoyment of his own kingship, and my apparent interference with him amounts to no more than advice to him not to suffer interference." This, said Crowley, in no way diminishes the advantages of "joint action directed to the attainment of a common purpose."

The Tantrism of the left-hand path, revived in the West by Kellner, was based on the Hindu mystic concept of a mindless universal energy, personified by the goddess Shakti, locked in embrace with the god Shiva, from whose eternal orgasm every factor in the universe is derived.

Practiced by individuals, heterosexually, it is similar to Pico, Ficino, and Bruno's means of slipping through the mesh of sensitive illusion, a sort of magical ascent beyond the world of appearances, during which the participants, in a paroxysm of orgiastic ecstasy, burst forth from the limits of the body to explore the more rarefied regions of the cosmos, to experience directly, as two gods embraced, the consciousness of Shakti and Shiva—at One.

That these secret Tantric practices had flourished in widely scattered cultures from China to Africa, from India to the Middle East, and that they may have come to America and Africa from lost Atlantis was claimed by Gerald Massey; and it was through him that Crowley was able to track sexual magick back to its Egyptian prime, developed from an African source—the same source which took it to Haiti as voodoo.

The essence of Tantric lovemaking is to postpone orgasm by various postures, meditations, incantations, and prayers so as to raise the kundalini.



The liquid known as amrit (ambrosia of the gods), or the elixir of life, is said to flow from the genital outlet of the priestess chosen to represent the goddess. In man the fluid is said to be charged only when the Fire Snake—controlled by a form of yoga involving the anal sphincter—flashes back and forth between the prostate region and the brain. Once the kundalini was raised the human organism was to be used as a condenser to draw in stellar or transmundane energy by tapping the appropriate chakra once it was animated and magnetized. The OTO aimed at using the subtle energies of the Fire Snake for establishing a door into space through which extraterrestrial cosmic rays might enter and manifest on earth, enabling humans to have intercourse with extraterrestrials more evolved than man.

In all Tantric magic, the essential requirement—whether in the ecstasy of couples or the solo rituals of a priestess—involved the raising of the energy known as the serpent of fire, or kundalini. This mysterious energy, described as lying dormant in the lowest of the seven chakras, can be aroused by two distinct methods, called, traditionally, the right- and the left-hand path. The right hand allots supremacy to the male principle, the left to the feminine. As the serpent power is aroused, according to clairvoyants, it climbs up the backbone of the adept, energizing each chakra, till it emerges from the skull—symbolically as a snake's head like those so clearly depicted in Egyptian statuary. The excited chakras are seen clairvoyantly as whirls of multicolored lights, glowing and pulsing along the spinal column, with lesser lights "pulsating like stars throughout the ganglionic network of nerves which constitute the subtle anatomy of man." The aroused chakras are described as petaled lotuses, tuned as receivers of powerful cosmic rays to link the microscopic body to the macroscopic universe.

As adepts describe the rising serpent, it unites with the "many-petalled lotus of the cerebral region" to bring about illumination—or the highest form of initiation—as the current "climbs back from duality to unity by reversing the path it originally took down the chakras to procreate humanity."

Details of the OTO's initiation into Hindu and Tibetan Tantra, including ceremonies involving the use of "exudations" from specially trained priestesses, were brought to a wider public by Crowley's follower Kenneth Grant. Sacred courtesans, experts in ritual eroticism, known in India as *nautch* girls, *manjaris, suvasinis,* or *devadasis,* were exceptionally honored, says Grant, and given advanced education in music, dance, painting, literature, and philosophy. Their magic exudations, known as kalas, from the goddess Kali, have, for centuries if not millennia, been taken by adepts of Tantra as a medicinal elixir, quite possibly the "elixir of life."

David Farren, an ex-Jesuit professor of philosophy who married a witch, says in *Sex and Magic,* it was the Chinese Taoists who dared to use human sexuality in an effort to produce a substance that would provide physical immortality. According to the Taoists, if a man could provoke a woman into producing vaginal secretions while he kept himself from ejaculating, he could then assimilate her own life-force, or yin, while not losing any of his yang. A man who could take ten women in a night was considered well on his way to being one of the legendary immortals.

Adepts of the left-hand path use the kalas, or vaginal essences, by invoking the goddess at the Muladhara chakra, by the female genital outlet. Grant says the Elixir of Eternal Life manifests in the high priestess at the climax of the sacred rite. "The invisible seed (bindu) at the heart of the central yoni represents the 16th Kala." Grant calls the kalas essences, or "rays of time," and suggests that as the earth's aura continues to be impregnated by rays from the stars, new and subtle kalas penetrate human consciousness. The stars, he says, represent, magically speaking, astral consciousness concentrated in the subtle essences of the kalas, or vaginal vibrations. The sixteenth kala, or ray of the moon, which he calls the most secret of all, is "the essence where time stands still, where time is NOT, i.e. NUIT."

To arouse sexuality in the priestess, and to build up her libido, various methods were employed in different cultures. Whereas the Chinese Tantric Taoists are reported to have used infraliminal vibrations from large gongs reverberating just beneath the threshold of normal audile receptivity, the Egyptians, from extant depictions, used what are described as "manipulative techniques of sexo-somniferous magnetization." And whereas the Atlanteans, to arouse the fire-snake, are believed to have applied magnetized metal instruments to the chakras of a priestess, one of Crowley's more eccentric fellows, a Royal Navy commander G. M. Marston, experimenting with the rhythm of tomtoms, was able to lead demure English women to "shameless masturbation and indecent advances."

The goddess Kali was, in any case, invoked at the region of the Muladhara chakra, seat of the kundalini, the zone whose gate is the female genital organ. As the kundalini rises in the temple priestess, Crowleyans describe it vitalizing not only the chakras but a series of secret erogenous zones known as marmas, imbuing them, in the poetic language of Tantra, with nectar, or vibrant energy, causing each sacred lotus to generate subtle effluvia, or kalas, of great potency, considered by Crowley the "Magick Light," the Hadit, or Set of the *Book of the Law,* the Aub or Ob of the voodoo.

The science of the marmas, says Kenneth Grant, is highly complex, and only communicated under cover of secrecy during an initiation. According to Havelock Ellis, only fourteen of the seventeen bodily secretions known to Tantrics have been recognized by Western science. The fifteenth and sixteenth, which are known to orientals, only manifest, says Grant, in the vaginal emanations of the fully trained and developed suvasini. Crowley and his fellow adepts found that the kalas differ in chemical composition according to the phases of the feminine cycle, the age and condition of the woman, the phases of the moon, the relative location of the stars—which, if nothing else, indicates that the Paracelsian notions of the effect of planets and stars on humans contained greater wisdom than his contemporaries were able to accept, a notion more fully developed by the clairvoyant scientist Rudolf Steiner.

In the world of Tantra, the sixteenth kala is represented by the invisible seed, or "bindu," the catalyst that makes the "virgin" glow and emanate the nectar, or amrit, which contains in its fragrance the ultimate essence—the elixir of life. Bindu, or semen, is represented by a point or dot at

Crowley said the ancients did not obtain their ductless-gland extracts from brainless dead cats, dogs, or pigs, but from living humans, where the substance was of greater value. "The urine of a healthy young female which contains the internal secretions from various organs of therapeutic value and health-giving importance is used as the medium for the imbibition of tonics.

the heart of a triangle, or yoni. Shades of the Davenport stele!

An essential part of the Tantric ritual is the vibration of mantras, or magical sounds. Whereas the creative mantra of the fire-snake is the familiar Masonic and voodooistic Om or Aum, the mantra that effects the gradual release of the sixteenth kala, as described by Grant, is one of the most guarded secrets of the left-hand path, consisting of sixteen syllables each vibrated for one kala.

In the *vama marg* ritual the resulting elixir, or "secret seed of the stars," is caught on a leaf and is absorbed orally by the magician without contact with the priestess, whose supersensitivity aroused by sexuality could be short-circuited by a touch.

Imbibition of the kalas, charged with the upward-directed kundalini current, is said by Crowleyans to transform human consciousness and make possible communication with transcendental entities: the sport of Apollonius, de Molay, Ficino, Pico, Dee, Cagliostro, Lévi, and their followers.

Conversely, Grant warns, the intake of the downward-directed venom brings man into contact with the demonic world of the lower elementals, where only a powerful adept may venture with impunity. The sixteenth kala is also said to bisexualize those who absorb it in the prescribed manner; hence the representation of Shakti gods as androgynous, like the Baphomet of the Templars.

Thus the source of the vital elixir sought by the alchemist and adept of yore was exuded from a human female flower. Crowley adds that the secretions of the endocrine, or ductless, glands from a healthy young female are much finer and much better for human imbibi-

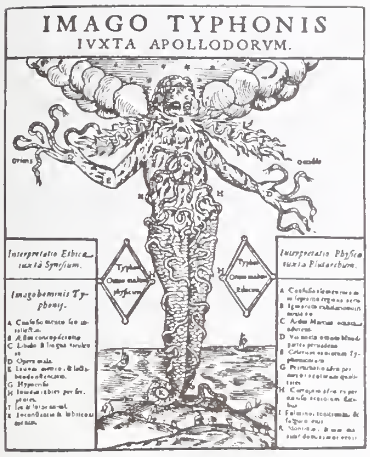
Budge describes Tuart as the wife of Set, or Typhon, also known as Apt. Her common title was "mistress of the gods" and "bearer of the gods." One of her forefeet rests upon the symbol of magical power, which, says Budge, probably represents a part of her organs of generation. To de Lubicz, she is the womb, considered as volume, one that embodies and materializes substance. She is the sky when considered as three-dimensional space that engenders all volumes. She is a *mammal* because she symbolizes the function of nourishing or quantitative multiplication brought about by selective affinity.

tion than those used by modern medics and extracted from the dead glands of animals which lack the essences of humans.

Understanding the ritual of the *vama marg,* says Grant, gives meaning to the Hermetic opening of Crowley's *Book of the Law,* where in the first stanzas, it proclaims, "Behold! it is revealed by Aiwass [spelled differently at different times by Crowley for numerological reasons] the minister of Hoor-paar-kraat. The Khabs is in the Khu, not the Khu in the Khabs." Incomprehensible, until it is realized that *khabs* in Egyptian means "star," and *khu* is the female essence, or magical power. Interpreted thus, it is the starlight which resides in the magical power of the female generative essence. Stars, rays, flowers, essences, perfumes, oils, unguents, times, cycles, emanations—all, as Grant points out, are concentrated in the black goddess Kali, the flower, the living symbol of time.

In his *The Magical Revival,* Grant goes on to show how Crowley's use of sex as a means of gaining access to the invisible worlds, and other planes of dimension, was a return to the rituals of predynastic times in Egypt, where the great mother goddess Tuart was worshiped through sexual rites which were then exported to India and the East, and later perpetuated in a more or less decadent form in the *orgia* of the Greco-Roman mysteries. The Egyptian predynastic tradition, known as Draconian, or Typhonian, is traced by Grant from an earlier African mystery system, similar to voodoo, possibly derived from Atlantis. According to his analysis of the Crowleyan data, the Draconian cult in Egypt was the cult of the fire-snake, based on "magnetism, intercourse with spirits, and elemental manifestations seen clairvoyantly. The astral body was an observed fact, and indicated spiritual survival after death."

The contention is clearly that the "mysteries" moved from ancient Egypt to Sumer, India, Tibet, and China, where they flowered into the Taoist Tantras. That the oriental systems were based upon the Draconian-Typhonian cults of ancient Egypt is deduced by Grant from the many Egyptian terms in the texts of the Tantras, particularly those of India. Shakti, or power, the central concept of the Tantras, he equates with the Egyptian Sekht, or Sekmet, consort of the gods, typified by the heat of the southern sun, or the sexual heat of the lioness. Khart in Egypt is Horus, child of the god; in India the son of the sun god is Kartikeia. The Egyptian sun god On is the Vedic Ong or Om. Sesheta, which typifies the female period, is Sesha in Hindi.



Kircher's rendition of Typhon, whom the Greeks identified with Set, son of the earth (Geb) and of the sky (Nut), reputed to have torn himself violently from his mother's womb. Originally a beneficent god of Upper Egypt, Set was arbitrarily declared by the priests of Horus to be "unclean," though his worship was one of the oldest cults in the country. Representing the cosmic opposition of darkness to light, Set and Horus were understood to be facets of a single source. In the murky mythology, Set murders and dismembers the body of his brother Osiris, and persecutes the widow Isis and her son Horus until the latter revenges his father.

The predynastic Egyptians worshiped the feminine principle, the great mother goddess represented by the seven stars of Ursa Major and her child Sirius the dog star, or Set. Sirius was also represented by the same symbol as his mother, whom he is supposed to have fecundated. Those Draconians or Typhonians, says Grant, oblivious of the role of the male in the biological mysteries of creation, worshiped the "whore and her bastard," later typified as Virgin and Child. And so, back to the mother goddess of the witches and the old religion.

To the ancient Egyptians, Ursa Major was Ta-Urt, goddess of the mysteries of time and cycles, from whose name Crowley derived the Tarot's use for divining past and future. Ta-Urt was also known as Serk, to whom the dog-star Sirius, or Set, was sacred. During the Draconian migration from Egypt to Sumer, says Grant, Set became Shaitan, and then Aiwaz in Babylonian Akkad.

One of the names for Set was an upright stone or pillar, and Grant points out that the gemantic number for IHVH, the name that cannot be uttered by Jews, was twenty-six, which he equates with the middle pillar, or phallus, twenty-six being also the gemantic formula for the phallus in function, or extended in action.

The Sabean form of Set, which was Sevekh, later became Sebek-Ab-Ra, meaning "lamb of Ra," or "lamb of the sun." This Grant equates with the solar-phallic energy perpetuated by the gnostics as Abrahadabra, Had being Chaldean for Set.

The Sabean cult of the stars was followed first by a cult of the moon with the moon god Thoth, lord of the double light, who replaced Set; though Grant points out that Thoth's symbol, the dog-headed cynocephalous ape, is a continuation of the dog symbol of Set. The moon cult was in turn superseded by the solar cult of the Osirian, or Ammonite, supporters of male supremacy, with its deleterious effects down to the present.

Conflict between the Draconian-Typhonian worship of the feminine principle and the solar masculine cult, says Grant, split Egypt for centuries, yet the Draconian tradition "lingered on into the dark dynasties whose monuments were gradually laid waste by the solar cultists who abhorred all reminders of the Sabean origins of their theology." It was a conflict, says Grant, which lasted from the predynastic eras to the final fall of the Draconian cult, around the time of the Seventeenth Dynasty (variously estimated by Egyptologists as between 1650 and 1570 B.C.).

An effort to revive the Draconian cult of Sabek-Ra, or

In *Across the Gulf,* volume six of the *Equinox,* Crowley described in opalescent language his reconstruction of what he called his own life as a priest in the Twenty-sixth Dynasty, "when I was ANKH-F-N-KHONSU and brought about the Aeon of Osiris to replace that of Isis." The name, he said, means "his life in Khonsu"—Khonsu being the moon god of Thebes. Crowley regarded the recovery of "past lives" through overcoming the obstacle of past deaths as essential to "understanding the general object of existence." Grant adds that the Ankh, or sandal strap, the glyph of Venus, symbolizes the ultimate transcendence of individual consciousness.

Those who do not read Crowley's work with care, says Grant, miss the deeper implications; yet, properly understood, it presents the most precise and austere code of conduct ever enunciated. But because it implies the total freeing of sex from the shackles of the convential, "it creates an immediate resistance in the mind unprepared for New Aeon attitudes." Spiritual attainment, said Crowley, was "incompatible with bourgeois morality," and he opined that the social and moral inhibitions and restrictions of his day were a crime against nature for which a severe toll would be exacted. The

Set, was made by a Theban priest of the Twenty-sixth Dynasty, Ankh-af-na-Khonsu, in the seventh century B.C. And the effort of this Theban priest of the Saite Period throws light on Crowley's hypnotic involvement with Set and Aiwaz. Crowley maintains that *he* was that Theban priest. "Tradition asserts that we forget our previous incarnations, because the shock of death erects a barrier; wihout assenting to this theory, I will say that having trained myself to face the fact of Death without mental disturbance, I found myself able to recall my last death."

Crowley recalled not one, but many past lives; very few of which, says Grant, "were outstanding in a worldly sense." Some, as described by Crowley, were "of almost uncompensated wretchedness, anguish and humiliation," voluntarily undertaken, he says, so he might resume his work "unhampered by spiritual creditors."

Crowley says he found it difficult to remember his "magical mistakes," and was "barred from remembering details of a tremendous magical catastrophy in the remote past." Its effect he describes as being hurled from a series of incarnations in which he was a high initiate, "to climb painfully once more to my present state." There was thus a large gap in his magical memory, "a shape of shame and horror which I have not yet found courage to unveil." In volume one, part ten of the *Equinox,* Crowley gives details of the life of Ankh-af-na-Khonsu, and of his failure to reinstate the worship of Set.

As a result of this failure, says Grant, the faint echoes of the ancient cult died down, and in their stead came "the flood of grotesque occult lore and debased sorcery that was to wash away the last vestiges of Egypt's glory." The remaining few dynasties saw merely an acceleration of this process of degeneration. "It was not till many centuries had elapsed that the Draconian Current reawakened, not in Africa but in Asia in the guise of the Tantras of the Left Hand Path."

Crowley's memories of a life as a Roman named Marius Aquila and those of a Cretan priestess called Aia are relatively banal, but those of a disciple of Lao-Tse, and author of the *King Khang King,* give meaning to the art of clearing the blocks which veil man's memory of the past.

John Blofeld, in his *The Wheel of Life,* refers to adepts of Taoist Tantra in China who, controlling their consciousness, were able to achieve what he calls "a relative immortality," with no need to preserve a physical body in order not to "die" in one body and be reborn without losing the train of their identity; although, says Blofeld, the alternate aim was "total absorption in the Goddess, mere mention of sex, he said, "draws man into a blind spasm of lust, either exploding into priapism or camouflaged into shocked indignation." Only when people can contemplate any given sexual idea without emotion of any kind will they be on their way to freedom. Crowley saw as his object to release their minds from bondage—or, better, themselves from the bondage of their minds. In the end, says Grant, Crowley left a loose-knit network of occult groups using the Ophidian current (kundalini) to prepare human consciousness for intercourse with the denizens of other dimensions.

accomplished through Tantric sexual union with the priestess who embodies her." To the Taoist, the purpose of raising the kundalini appears to have been the creation of an astral body that would survive both death and the dissolution of consciousness.

In his *Confessions*, Crowley gives a brief view of a life shortly before Mohammed when his goal was "to bring Oriental wisdom to Europe and restore paganism in a purer form." He describes being present at a "council of Masters" in which various illumined ones were appointed to undertake different adventures. "Mohammed, Luther, Adam Weishaupt, the man we knew as Christian Rosenkreutz, and many servants of science were chosen. Some of the movements have succeeded more or less, some have failed entirely. . . ." Crowley, adds Grant, would not have referred to Weishaupt as a master unless he knew him to be far advanced upon the path in a magical or mystical sense.

In *Heart of the Matter,* which Crowley wrote under the pseudonym of Khaled Khan, or "Sword of God," he claimed to have been a reincarnation of the warrior who delivered the Arabs from the stranglehold of Christianity at the Battle of Damascus—in 1126. Crowley's next encounter with Tantra may have been in an incarnation in which he switched sides—a game often played by disembodied spirits. "I was involved," he said, "in the catastrophe which overtook the Order of the Temple."

This was followed by a less noble life as Pope Alexander VI, the Borgia menace, of which Crowley, in a masterpiece of understatement, reflected that "I failed in my task of crowning the Renaissance through not being wholly purified in my personal character," adding by way of exculpation: "An appropriate trivial spiritual error may externalize as the most appalling crimes."

Crowley's next three lives, in terms of the magic of obelisks, are more to the point. As Sir Edward Kelley, the Tantric adept and scryer friend of Dr. John Dee, Crowley maintained he misunderstood certain messages that referred to the New Aeon of Horus announced by Aiwaz. But as to the genuineness of the Keys Crowley submits that the best guarantee is "the fact that anyone with the smallest capacity for Magick finds that they work."

Grant suggests that Crowley, using Dee and Kelley's system of scrying with Enochian language, was able to go far beyond what they had managed to acquire at the beginning of the seventeenth century, and that by systematically exploring Dee's Aethyrs, he was able to "penetrate unknown dimensions of consciousness outside space

If it is of any consolation to those who believe that Crowley the heretic deserved the same flames that devoured Bruno, or the same jail that asphyxiated Cagliostro and Reich, he or she may rest assured that armored society did its very damnedest, decade after decade, to vilify Crowley in every possible way, publicly calling for the execution of "the wickedest man in the world" or longing to put him in jail forever; and had it not been that throughout his life he never committed the smallest infraction of the law, they might have succeeded. The press in Britain launched a campaign of libel comparable to if not worse than that provided by Morande, achieving for London the honor of producing the very worst as well as the very best of periodic pressings. Stevenson has provided a limpid analysis of how grossly and deadly unjust a press attack such as Beaverbrook's can be against a man unsupported by the vast sums it takes to bring suit. And once in a newspaper's morgue a libel lives forever. Whatever else Crowley may have achieved in his life, historian Robert Amadon says of him "This man is the greatest, and perhaps the only magician of the twentieth century in the West." Approaching death, Crowley asked fellow Mason Gerald Yorke to have him embalmed in the Egyptian manner; then he reconsidered, saying: "Since I already look like a mummy, I want to be cremated." Yorke admitted he was beginning to believe that AIWAZ could more

and time," and thus obtain solutions to many cosmic problems.

But the surprising chain is by no means over. Next, Crowley says he was born into the body of none other than Count Alessandro Cagliostro. This time his remembrances of events differ somewhat from those given by most Cagliostro biographers, though they make as much sense, and may be every bit as "historical." As Cagliostro, said Crowley, "I was born in a brothel, kept by my mother's mother. My mother was half Arab, my father presumably some rich traveller." There was, Crowley added, "a profound horror and gloom antecedent to this birth."

The mystery of Cagliostro's marvelous pomade, so good for ladies' skin, may at last have been revealed by Crowley in his most recent incarnation. Like the so-called Sicilian Magus, Crowley kept himself in revenue for a while in London by selling, for 2 guineas a jar, an effective pomade for ladies' complexions, whose prime ingredient was his own semen.

And the elixir of life promoted by Cagliostro may well have been Tantric kalas obtained from Serafina. Serge Hutin, the French professor who has written on every known occult subject, and especially on both Tantra and Cagliostro, suggests that the magus and Serafina may well have been a natural Tantric couple, and that the highest level of the Egyptian rite corresponded to an act of ritual sacred marriage, or *hierosgamos*.

Hutin further suggests that Mozart, privy to this secret, deliberately cast Papageno and his simple bride Papagena as symbols of common marriage, whereas in Tamino and Pamina, he represented a couple initiated into the world of Tantric love by none other than the Egyptian magus Sarastro-Cagliostro.

To cap this train of quite fantastic coincidences, Crowley next described his most recent death: "I found myself able to recall my last death and so pick up many memories of my previous life as Eliphas Lévi."

In his *Magick in Theory and Practice,* Crowley pointed out that Lévi's death occurred about six months before his own birth in 1875. Crowley thus found the explanation for his immediate pleasure and incomprehensible familiarity with a certain district in Paris's fifth arrondissement, by the rue de l'Ancienne Comédie. Lévi had lived in that neighborhood for several happy years.

Taken in series, these lives form a linkage. In Crowley's incarnation as Crowley he "expressly and unequivocally describes his work as the rediscovery of the Sumerian accurately be named Eyewash, and that Crowley was a pseudo-messiah, not a prophet, yet he did not doubt "that this extraordinary man was a genius and a gifted teacher of the highest mystical illumination." In the end Crowley admitted that he might have "failed at everything" but that he nonetheless stood by his life's work and message: "I have not failed at love for the only abiding love affair of my life is the one I have with God! Oh my beautiful God! I swim in thy heart like a trout in the mountain torrent. I leap from pool to pool in my joy. . . ." Whether Crowley's was the God of all, or only of Crowley, at his funeral Louis Wilkinson read aloud the magus's "Hymn to Pan": "Thrill with lissome host of the light./O man My man!/Come careening out of the night/Of Pan! Io Pan,/And I rave; and I rape and I rip and I rend/Everlasting, world without end,/Manikin, maiden, maenad, man/In the might of Pan./Io Pan! Io Pan Pan! Pan! Io Pan." Crowley's god, whose manifestation occurs at high noon, *en marquant midi,* he equated with Hadit and conceived that at the precise moment that man becomes Pan his point of view is dissolved into Nuit—pure nothingness: "for all is naught." To paraphrase Crowley, when a man, growing in consciousness by repeated acts of love under will, expands his consciousness to embrace all other consciousness, he becomes Pan: i.e., one with all. Omne, Aum, Amen, Amoun.

Tradition of Set"—precisely what he was supposed to have been doing as Ankh-af-na-Khonsu in the Twenty-sixth Dynasty. In the past, says Grant, several adepts attempted the rehabilitation of the worship of Set, among them Adam Weishaupt, Cagliostro, Eliphas Lévi, and Helena Blavatsky; but all failed. Only Crowley, he notes, succeeded, "because he had received initiation of a higher order." Using the hermetic numeration of the Golden Dawn degrees, Grant classes Cagliostro and Mathers as $7^\circ=4^\square$, Blavatsky and Levi as $8^\circ=3^\square$, and Weishaupt as possibly $9^\circ=2^\square$. Whereas Crowley, according to his own verdict, reached the highest grade of $10^\circ=1^\square$ or Ipsissimus.

In this rarefied air Crowley found himself "free from all limitations whatsoever, including good and evil." Across the abyss, says Crowley, the words of the Enochian Key "thrilled me with a meaning I had never suspected, each curse concealing a blessing . . . I understood that sorrow had no substance; that only my ignorance and lack of intelligence had made me imagine the existence of evil."

Grant considers that Crowley's crossing of the abyss, thanks to the power of the *Book of the Law,* which he calls "the utterance of an illumined mind co-extensive with the ultimate ideas of which the universe is composed," enabled him to "unite his consciousness with the universal cause, shift the center of gravity from himself to God," and so "proclaim his word (Thelema) as Allah and Buddha proclaimed theirs." But Grant's co-editor of *The Confessions of Aleister Crowley,* John Simonds, less partial to the self-proclaimed Ipsissimus, says that this is where Crowley made a false step, suggesting that "he illegally assumed this most exalted grade, and that it choked him." Prophets being seldom honored in their own country, the truth, as Bacon declared on the cover of his New Atlantis, remains to be known: *Tempora patet occulta veritas.*

But whereas Crowleyans claim it to be the imperative duty of the theurgist to thoroughly investigate in his "Iridescent Body of Light" the upper levels of Astral Light before transcending to a higher plain, Gopi Krishna, author of several works on Kundalini yoga, wisely says that almost all great spiritual teachers have pointed out the danger of succumbing to the lure of psychic power or visionary experiences on the Astral or mental plain, "For these constitute entanglements for the soul as confusing and as hard to shake off as the entanglements of earth." To perform surprising feats with invisible psychic or other cosmic forces, says Gopi Krishna, is descending again to the plain of earth.

Cippus representing Horus on the Crocodiles, with the head of Bes.

1. Horus. 2. Thoth and Har-shef. 3. Hek and Neith. 4. Khnum. 5. Ast.t. 6. Ptah. 7. Sem, or Selk. 8. Nekhebtop. 9. Commencement of long inscription continued on back. 10. Urhek. 11. "Great god in Kat, and snake User." 12. Isis. 13. Sebek. 14. Horus. 15. Golden hawk, Isis, Selk. 16. Horus. 17. Buto, Hu, and Sa.

20. RETURN OF THE PHOENIX

A Journal of Scientific Illuminism was the subtitle given by Crowley to *The Equinox,* and Kenneth Grant has no doubt that Crowley took the term *illuminism* from Weishaupt, adopting with it his glyph of the point in the circle as a secret cipher for the order, a glyph which is preternaturally sexual and Tantric. It represents, says Grant, the yin and the yang of China, the Chockmah and Binah of the Cabala, the Odnada and Obatala of Africa, the Kamakala and Tribindu of India, the caduceus of Mercury, the Nuit and Hadit of Egypt. In Hadit, Crowley saw the emblem of consciousness: a ray of light projected in the dark of night. Nuit, in Crowley's cosmology, was nothing that can be thought of or in any way formulated by the mind of man, "the infinite and eternal void or inner space, the undying darkness, symbolized by the yoni." Yet Crowley saw it as the hidden source of light, for Nuit can be stirred into being by Hadit, symbolized by the point, the male coefficient, typified by the phallus. In Crowley's words, "the infinitely great Nuit and the infinitely small Hadit unite in explosive rapture and the ensuing holocaust generates the event." In union the poles of Nuit and Hadit produce the objective universe.

In the macrocosm the immortal principle is represented by the sun, in the microcosm by the phallus. As the sun drenches the earth with its creative rays, the phallus drenches the womb with its seed. Yet the symbolism, note Crowley and Grant, is imperfect, for neither the sun nor the phallus in itself has power beyond that which flows through it from another source. In the case of the sun, they say, this power is refracted through Sirius, the star of Set. Set to them represents the light of initiation, "the opener of man's consciousness to the rays of the Undying God who is typified by Sirius, the Sun in the South."

To Crowleyans, in the new Aeon of Horus, Isis will rediscover the immortal principle in Osiris, and man, consciously using the formula of Love Under Will, will advance his spiritual development.

The old Aeon of Isis, according to Crowley, glorified matter, the mother, the body. The old Aeon of Osiris, denying the body, glorified the spirit in the afterlife; with its appendage, the Christian Era, it was characterized by

Horus the younger dominating the reptilian symbols of attachment to earth. Crowley maintained that hidden within the young Horus were two poles of energy, which he called HOOR-PAAR-KRAAT (or Harpocrates, the Greek god of silence or withdrawal) and RA-HOOR-KHUIT (KRUMACHIS or HERAHATY), Lord of the Balance, or Double Horizon—i.e. of the two equinoxes. This left for Set the two solstices, with the sun at zenith and nadir. Two birthdays were assigned to Jesus by the Christian Fathers, one at the winter solstice, the other at the vernal equinox. This system, says Massey, was based on the birthdays of the double Horus, the dual form of the solar god in Egypt, child first, adult at the vernal equinox. In Egypt, Massey points out, the year began with the summer solstice, when the sun descended from its midsummer height, lost its force, and lessened in size. This represented Osiris born of the Virgin Mother as the child Horus, the diminished infantile sun of autumn, who descended into hades, where he was transformed into the virile Horus and rose again at Easter, the sun of the resurrection, Horus of the two horizons. To the Egyptians, Osiris, as the child Horus, comes to earth to enter matter and becomes mortal. His father is Seb, the earth, whose consort is Nu, the bearer, one of whose names is MERI, the Lady of Heaven.

blood and agony, Osiris, the god of the Dead, exemplifying the Christian cult with its emphasis on death, suffering, and sorrow. Yet Isis, copulating with the dead Osiris, brought forth the child Horus, or unified cosmic consciousness, to produce, as Grant expresses it, the balance of these extremes in the realization of the identity of matter and spirit of male and female—a realization that comes through the union of opposites.

In Crowley's new aeon, man is no longer "to die to his body" in order to experience everlasting life; he will know, says Grant, that he never was a body, and realizing that he was never born, and therefore never died, that the body is a mere play of spirit undergoing ceaseless transformations, he will know that the spirit endures forever, triumphant, changeless, yet ever new. "Subject and object will be realized as one. Death, as understood, or rather misunderstood, by earlier cults will be finally and experientally transcended, abolished, nullified."

Grant further elaborates on Crowley by explaining that in the Aeon of Horus the dualistic approach to religion will be transcended through the abolition of the present notion of a God external to oneself. The two will be united. "Man will no longer worship God as an external factor, as in Paganism, or as an internal state of consciousness, as in Christianity, but will realize his identity with god." The new Aeon of Horus, based on the union of male and female polarities, will involve the magical use of semen and ecstasy, culminating in an apotheosis of matter—"in the realization that the old Gnostic notion that matter is not dual but one with the Spirit"—symbolized by the androgynous Baphomet of the Templars and the Illuminati.

Robert Anton Wilson, in his *Cosmic Trigger: The Final Secret of the Illuminati,* a more factual sequel to his fictional *The Illuminatus Trilogy,* came to the striking conclusion that at last he understood the secret of the Illuminati to be sexual. "They are not the fantasy of right-wing paranoids. The Illuminati was one of the names of an underground mystical movement using sexual yoga in the Western World." Wilson explains that "the veils of obscurity and mystery around such figures as Giordano Bruno, John Dee, Cagliostro, the original Rosicrucians, and Crowley himself, as well as various other key figures in the conspiracy, had nothing to do with politics or plots to take over the world. It was a screen to protect them from persecution by the Holy Inquisition in earlier centuries and from puritanical policemen in our time."

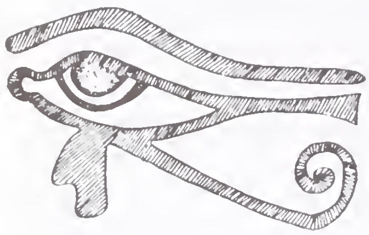
Wilson says that when he remarked to Timothy Leary—then in Vacarilla Prison for having experimented with hallucinogenics—that Giordano Bruno, "the first philosopher in history to suggest that there were Higher Intelligences in this galaxy," used Tantric sex, Leary replied: "It was obvious from Bruno's own writings. Sex-magic is *always* the first of the secrets."

Dr. Walter Huston Clark, in his *Chemical Ecstasy,* claims that most human beings normally only perceive less than .5 percent of known pulsations in the universe, but that people who take the metaprogramming substances soon assert contact with higher intelligences.

Wilson postulates that the "angels" who spoke to John Dee were extraterrestrials, but that Dee, unable to comprehend them in those terms, considered them, as have other shamans and mystics, to be "messengers from God." Wilson further adduces Gurdjieff's allegory in support of the notion that a group of interstellar intelligences already evolved to stages less mammalian than ours, are watching us all the time, and, occasionally, intervening to accelerate our evolution toward their level. He then quotes Leary and Dr. Jack Sarfatti to the effect that the mysterious entities—whether angels or extraterrestrials—reported by visionaries, rather than being members of races already evolved to this level, "may be ourselves in the future!"

Hassan-Ibn-Sabbah, mystic philosopher initiated into the sect of Ismaili and known as the Old Man of the Mountain, formed his own sect to practice the ecstasy of the Sufis. Surrounded by a vast library in his Castle of Alamut, the biggest outside of Baghdad, he found a way of mixing hashish with henbane so that a man could gain inflexible determination. Magre says that Persians, Indians, and Chinese all used hashish and opium and other plants to promote the emergence of the astral "double" and attain early degrees of ecstasy.

In *The Sirius Mystery,* Robert K. Temple devotes much space to demonstrating that to the ancient initiates Isis was a symbol of Sirius, and Osiris a symbol of the dark companion of Sirius. But, as Wilson points out, Temple was unaware of Crowley and Eliphas Lévi's insistence that the traditional secret revealed in the Eleusinian mysteries was that "Osiris was a black God." As Wilson reports,



Horus, said Isha Schwaller de Lubicz, is the key to Egyptian theology. "In the beginning and throughout time the universal Horus is the axis of the animating soul of the world. . . . He is the animator of preternatural Adamic Man before his fall into dualization. . . . The fall into matter creates his antagonist Seth, who through his constant opposition manifests the latent powers of Horus in nature." Seth is everything that tends to contrast and fix spirit in matter, a situation he seeks to perpetuate. Horus strives for the triumph of spirit in matter, light in darkness. His struggle with Seth makes history. In the eschatology, Horus the victorious becomes in the human being the supernatural Horus who reunites the divided complements and resolves all opposition. The Christian revelation introduces the god-man, Christ-Horus, incarnate in the human being. But after victory Horus returns to the black whence he came to start a new battle. He never rests.
Massey points out that the Gnostic Jesus is the Egyptian Horus, and in the gnostic iconography of the Roman catacombs, child Horus reappears as the mummy-babe who wears the solar disc. "Royal Horus is represented in the cloak of royalty, and the phallic emblem found there witnesses to Jesus being Horus of the resurrection." Massey lists among the numerous types of Horus repeated in Rome as symbols of an alleged historic Jesus. Horus as Ichtus, the fish; Horus as the bennu, or phoenix; Horus as the dove; Horus as the *bambino;* and Horus as the reversed triangle.

George H. Williamson, in *Other Tongues, Other Flesh,* claims that a secret order on earth has been in contact with Sirius for thousands of years and that its emblem is the Eye of Horus. Williamson, an early "contactee" of the 1950s, also claims to have met flying saucerites from Sirius and prints huge chunks of their language. Among these, Wilson found a few of the words that were almost identical with the "angelic language used by Dr. John Dee, Aleister Crowley and other magi of the Illuminati tradition."

As Grant describes the new aeon, a race will be propagated of magically generated beings able to probe extraterrestrial dimension. And the next stage in the advancement of evolution on the planet "will be achieved by a willed congress with extra-terrestrial entities of which, in a sense, Aiwaz is the immediate messenger to humanity."

When Theodor Reuss died in 1922 he nominated Crowley as his successor, and the German OTO lodges accepted him as chief. Reuss had also granted other charters outside Germany, and Gerald Encausse, the great French occultist, known as Papus, was chief of the OTO in France as well as of the French rite of Memphis and Misraim. In Berlin, Rudolph Steiner, who had broken away from the Theosophical Society to found the Anthroposophical Society, better to fulfill his Rosicrucian ideals, formed, as deputy Grand Master of the OTO, a chapter of its grand council known as Mysteria Mystica Aeterna.

Since childhood Steiner had been aware of spirit beings and their workings, and had found a whole universe permeated through and through by spirit activity. To Steiner, matter was spirit manifesting in material form: both man and the physical world were of a spiritual origin, and both had a spiritual destiny. The real ego, said Steiner, is spirit, and lives in a world of spirits. To Steiner this supersensible reality behind physical reality was directly perceptible, and he claimed that the knack, once a normal human faculty, could be reacquired, universally. Through his own clairvoyance Steiner was already able to give contemporary scientists answers to puzzling problems in physics.

To his own science, based on his understanding of the supersensible world and its relation to ordinarily perceived phenomena, Steiner gave the name Anthroposophy, *sophia* being "wisdom" and *anthropos* "man," the latter, with the former, capable of understanding the secrets of the universe by attaining ever higher levels of consciousness. And Steiner described in detail how man can shift

Ba, depicted as a bird with a human head, represents the human soul that goes back and forth between heaven and earth. It can be seen ranging about a tomb hoping the shade will emerge free from its bonds to the earth. Ba is the life-giving power in nature, the breath whose departure causes death. Pure, formless spirit, immeasurable, indivisible, unfractionable, free, and mobile, it needs an objective means if it is to manifest but it cannot be confined in a body. From Ba derives everything that constitutes the world and its final perfection. Ba, in its divine nature, is man's kinship with the creator, realizable through consciousness.
Ka assimilates Ba and generates a new being. Ka individualizes and binds the spirit. Ka is the attractive force that causes and fixes Ptah's incarnation in matter. Ka is the carrier of all powers of manifestation and the activator of cosmic functions. The original Ka is the creator of all Kas of nature: mineral, vegetable, animal. Man's individual Ka comprises his inherited and his personal character and defines his destiny. But Ka is not the slave of fate, because it is not part of nature. The soul is not subject to the stars: it is free and can alter its course. Man's higher Ka, the highest part of his spiritual being, the consciousness of the heart, is in touch with his lower Ka, or the aspects of Ptah imprisoned, which the consciousness of spiritual Ka alone can liberate, with the help of Ba.

his consciousness, as if tuning a radio, to different points of view from which he is aware of operating subtler bodies than the physical, etheric, astral, spiritual; and that man's life, on its various levels, is related to the universe of stars, sun, planets; that out of the physical body, or between death and birth, man lives in the spirit world of the stars in endless relationship with the divine spiritual beings of the star world.

All of which was evidently perfectly understood by the ancient Egyptians, who gave different names, such as Ka, Ba, Khaibit, Shout, Khu, and Sekhem to the various bodies, all equally real, but operating in different dimensions. To the Egyptian there were three basic worlds: the most immediate being this earthly one of everyday consciousness. Then came Amenta, the realm of the mummified Osiris, a sort of purgatory in which spirits of the dead made up for their earthly errors. Then came Tuat, or heaven.

Crowley's personal secretary and follower, Israel Regardie, who became a Reichian psychologist, describes Amenta and Tuat as two aspects, inferior and superior, of the astral plane of the occultist, every yard of which had been mapped out for the Egyptian theurgist, and its qualities noted, together with the names of the guardian watchers of the pylons through which the defunct soul had to pass in order to gain admission to some other of the halls of the kingdom of Osiris. Only on what it already understood of the strange "astral" world into which, reawakening from the defunct body, it suddenly found itself in the shape of an astral body, could the spirit get through Amenta to Tuat. If previously initiated into the mysteries of this strange world, while still alive, it could better cope, says Regardie, progressing on its mastery of the magic words contained in the *Book of the Dead,* described as "the most ancient yet detailed grimoire for those who will come forth in the light of full consciousness." As Gerald Massey puts it: "The object of the words of power, the magical invocations, the funeral ceremonies, the purgatorial trials, is the resurrection of the spirit to life everlasting." And he sums up the ordeal: "Learn the *Book of the Dead* in life and it becomes the Book of Life in death."

The spirit in Amenta pleads that his "mouth be opened," that his memory return so that he may utter the words of power required to handle the shifting world of astral forms. And memory, Massey explains, is restored to the deceased through the words of power stored up in life, to be remembered in death. Practice for this occasion

According to occultist Gerard Encausse, the Cabala constitutes the most complete teaching of the mysteries of Egypt to have survived, as elaborated by medieval Jewish authors on the basis of gnostic and Neoplatonist speculations. He says that all the secret religious societies—Gnostics, Templars, Rosicrucians, Martinists, and Freemasons—used the teachings of the Cabala, which aimed at giving man knowledge of his relationship to God and the universe, which may be regarded as an elaboration of the numbers 1 to 10 arranged in a geometric design connected by twenty-two paths. This Tree of Life represents the manner in which God's essence emanates from the nothingness beyond creation through ten stages into the visible world. The Sefiroth arranged to the right of the tree are male qualities, to the left, female. The lower levels represent love and nature. At the bottom stands the kingdom of Malkuth, the subconscious. As man rises in consciousness, he realizes his sacred origin, and can invoke the angels and archangels, until he reaches the level where he realizes that All is in One and One is in All.

The whole process of creation, said de Lubicz, occurs between the numbers 1 and 2; duality is

could be achieved in life during trance, when the spirit, leaving the body, could assume any form, at will, traveling anywhere under any guise.

In Amenta, the object is to avoid what is known as "the second death," which awaited those beyond purgation who once more lost consciousness; all of which makes of the gamut of earth, heaven and hades, but various states of consciousness, from the most illumined to the blacked-out, of which, in the end, the conscience of man is the only true judge, being both the knower and the known.

How is it that all this wisdom, sensed by gnostic, Templar, Rosicrucian, and Mason, was lost and only surfaced intelligibly with modern clairvoyants such as Crowley and Steiner? Michel Vladimirovitch Skariatine, an émigré Russian, who spent his life studying the ancient wisdom and wrote about it under the pen name of Enel, recognized in the Hebrew Cabala a mixture of Egyptian and Chaldean teachings, but found them often improperly put together, full of obscurities and even contradictions. So he went to the source: the sacred glyphs of the Egyptians. Puzzled by a language with so many homonyms and homophones, often with meanings diametrically opposed, Enel concluded that Champollion's phonetic decipherment, though it made possible pronunciation of the glyphs, concealed a further symbolic meaning, sensed by Champollion, but almost unanimously denied by succeeding Egyptologists until the Second World War.

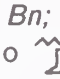
The brilliance of the Egyptian form of writing, says Enel in his *La langue sacré,* is the fact that it can contain more than one meaning, conveying an overt, and often banal phonetic significance, available to anyone, plus a Hermetic meaning available only to the initiate. The texts containing the overt credo of the Egyptian people, the funerary prayers, and the representations of life beyond the tomb, which needed to be available to all, were written phonetically. Yet they also contained the esoteric teaching of the initiates, designed only for adepts. The structure of the hieroglyphs made it possible to form a word with one direct meaning, read phonetically, and a recondite, mysterious meaning, symbolically.

The purely magical texts, written solely for the adept, says Enel, were not even given a phonetic sense, and were therefore untranslatable by Egyptologists, who concentrated solely on the phonetic approach, without pursuing the symbolic sense, the only one which could reveal the religious and philosophic doctrines of ancient Egypt. As Enel puts it: "Able to describe the body of Egyptian glyphs they ignored the soul which gave it life."

the fundamental character of the created universe. "This duality is the principle of sexuality. At the same time, duality implies a comparison within a succession of phenomena which produces the cerebral consciousness." Spirit, or formless substance, is passive, the feminine principle in the cosmos, but becomes generative when acted upon by the "verb." And all, de Lubicz felt, is manifest by its opposite. There would be no dark without light; nor any way to know light except by shadow. And just as a corporeal obstacle creates touch, so a liquid environment creates taste, and terrestrial or corporeal emanations create odor. In the course of "evolution" the energies within the different states of matter have developed the senses. As the river creates its bed, so light creates the eye, and sound creates the ear. The causal energy becomes mineral, the mineral becomes plant, the plant becomes animal, the animal becomes man, and man becomes Cosmic Man, the Saint, Buddha, Jesus (Jehoshuah). But Nature, said de Lubicz, only shows us the closed, Osirian cycle, which renews itself spirally in its progression towards the liberation of consciousness. Here the essential theme is reincarnation, with its karmic consequences, which forms a "wheel of elimination" moving toward liberation. It is the law *for all*. Punishment is reincarnation; but reincarnation is also a divine mercy that allows one to be redeemed. This is true justice, without cruelty, without threat, a justice everyone can accept. But it was only for the masses that ancient Egypt maintained the Osirian cult of renewal and reincarnation. To the temple elite it taught the Horian principle: Horus the Redeemer. The redeemer—the Unction of the Divine Verb—was the Christ within, but only for the man who realized it within himself. Throughout historical Egypt, said de Lubicz, the common people lived in the Osirian faith, which is a teaching of renewal, evolution through reincarnation of the living soul. Man lived then under the sky, under the ordinances of the heavens.

Neither through Coptic, nor through Greek, according to Enel, is it possible to understand the symbolic meaning of the hieroglyphs: the only route is via the Hebrew Cabala, offspring of the ancient Egyptian tradition. The object of the hidden symbols, he realized, was also to conserve for eternity the ancient knowledge of the mechanics of the solar system and the measurements of time and space accessible to human comprehension—a fact amply demonstrated by the extraordinary data encoded into the Great Pyramid of Cheops.

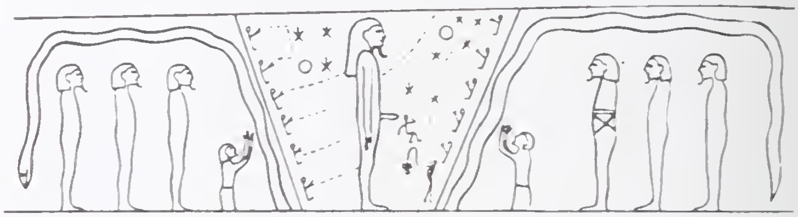
Enel believes the conquerors who brought this wisdom to Egypt were refugess from Atlantis, who came to found a colonial reflection of their powerful civilization with its sophisticated religion. Certainly the wisdom and science of ancient Egypt appears along the banks of the Nile already in flower, developed in some previous location, presumably the equinoctial land of the Golden Age of Saturn.

The twenty-six phonetic signs of the Egyptian alphabet, says Enel, also serve to describe the principles of creation, spelling it out in bold strokes as the ancients envisaged it. The glyph  , *B* symbolizes a perpendicular raised on a plain, such as the raising of an obelisk. As Enel deciphers its cosmic meaning, cosmic forces agitating inert matter attack the surface with the involutive spiraling force of  , *Bn;* and by means of an evolutive spiraling force raise it to  , *Nb*.

The action of these forces creates combinations of the four elements—fire, water, air, and earth—all of which derive from the same *MW,*  , the basic mother, or *mater*. Unformed mass  , which is *q,* is transformed into organized matter  , *p*. The glyph for the current which descends and ascends through twisted interlacings to manifest spirit on the material plane is  .  is to envelope in matter. And  is eternity, or the body of Ra which was and which will be. The creative verb  , Ra, by its action produces the realization of the declared verb *Nou,* or protomatter, father of all the gods, and of all manifestation in the universe.

From the primordial waters of Nou came into being the self-engendered Atum rising up as a primeval hill, the symbol for which came to be the temple hill of the sun at Heliopolis, dwelling place of this high god manifesting as light and symbolized as an obelisk. The mount was now the image of mother earth, the great bringer forth, and "the pillar of heaven", or obelisk, was the symbol of fatherhood, "the rock that begot." "Oh Atum! When you came into being you rose up as a High Hill. You shone as

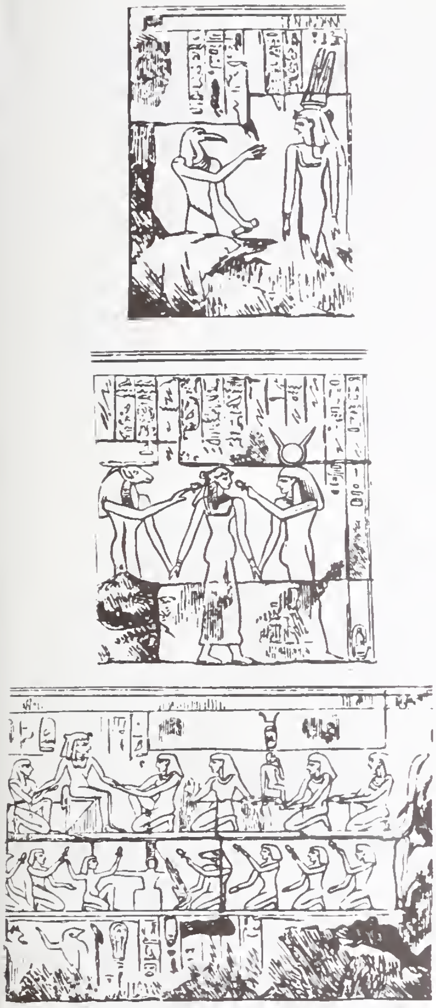
the Benben stone (or obelisk) in the Temple of the Phoenix at Heliopolis." The phoenix, or bennu bird, was, of course, the symbol of both Ra and Osiris. "For the Heliopolitan," says R. T. Rundle Clark in *Symbol and Myth in Ancient Egypt,* "morning was marked by the shining light on an erect pillar or pyramidion on a support or shaft which could reflect the rays of the rising sun. At the beginning, a light bird, the Phoenix, had alighted on the sacred stone, an obelisk, known as the Benben, to initiate the great age of the visible God."



When Atum, the aboriginal deity and ultimate but hidden godhead, at first alone in the universe, came into being, symbolized by the primeval serpent in the dark waters of the abyss, his act was symbolized as autoerotic. "In one sense," says Rundle Clark, "he is the Atum figure of Heliopolis performing creation by masturbation." Noting that masturbation was the most popular creation motif throughout Egyptian history, Clark quotes a pyramid text to the effect that Atum proceeded to masturbate himself in Heliopolis: "he put his penis in his hand that he might obtain the pleasure of emission thereby; and there were born brother and sister, Shu and Tefnut."

And so all of creation came into being. Shu, the elemental force representative of air, breath, the wind, was, in Africa, most especially the breeze of dawn and evening, the very breath of life, imaged by the Egyptians as a panting lion crouched upon the horizon, lifter-up of the darkness of the night sky. Tefnut, the other supporter

The symbolism of Nut, Geb, and Shu is based on the legend that originally earth and sky were together in total sexual union. Thus when the sky descends ritually upon the earth, Nut is impregnated by Geb. But Nut's father, Shu, so loved her, he separated her from her mate Geb, and, as air, held her aloft with his arms. Nut then gave birth to the stars and allowed them to sail across her belly.



This annunciation scene on the walls of the Temple of Luxor, says Massey, shows Thoth, the divine word, or *logos*, hailing the virgin queen, announcing she is to give birth to the coming son or sun. In the next scene the god Kneph (in conjunction with Hathor) gives life to the queen. Kneph, says Massey, is the Holy Ghost, or spirit that causes conception. Impregnation is apparent from the virgin's fuller form. Next, the mother is seated on the midwife's stool, the child in the hands of a nurse. In the scene of adoration (*below*) the child is enthroned, receiving homage from the gods and gifts from three wise men. The child announced, incarnate, born, and worshiped, says Massey, was the representative of the Aten-sun, the child-Christ of the Aten cult, the miraculous conception of the ever-virgin mother in the sky.

of the atmosphere, and eventually of world order, was moisture. Together Shu and Tefnut produced Seb (or Geb) the earth god, a phallic fellow, father of food, symbolized by the goose of plenty, and Nut, the sky goddess, who were kept apart by the atmosphere of Shu until Thoth, the god of wisdom, took pity on them and allowed them to unite to produce Osiris, Horus the Elder, Set, Isis, and Nephthys, all, in this guise, members of the solar system. And much of what actually occurred in the cataclysmic past of our system may be explained by the myth of the castration, death, and resurrection of Osiris as Horus the Younger, the returning sun, weakened after the tilt of the pole. Immanuel Velikovski, when asked which of the heavenly bodies in our sky suffered castration, replied laconically: Saturn, or Osiris. A remark about which a whole book might be written.

Gerald Massey complains that the wisdom of the Egyptians, hidden in their hieroglyphic language—at once their knowledge of both the physical and spiritual cosmos, obtainable in trance—was never really understood by Semite, Greek, or Roman. But Africans and American Indians could still summon spirits and commune with them, and even make them appear for others to see, or could travel to them in a trance. Among the Christians, says Massey, only the sects of gnostics, and such individual gnostics as Saint Paul, could detach from their bodily condition.

Tracing the texts of the Gospels of the Christian canon to their sources in ancient Egypt, Massey found that "from beginning to end they contain the Drama of the Mysteries of the Luni-Solar God, narrated as human history." The gnostics, he says, understood them to be mythical; the Christians took them for fact.

From the texts it is clear to Massey that the doctrine of the incarnation had been evolved and established in the Osirian religion at least four thousand years and possibly ten thousand years before it was "purloined and perverted in Christianity." It is so ancient that the source and origin had been forgotten and the direct means of proof lost sight of or obliterated except among the gnostics, who sacredly preserved their fragments of the ancient wisdom, "with here and there a copy of the *Book of the Dead,* done into Greek or Aramaic."

Massey claims sufficient warrant to affirm that Christ-the-anointed was a mystical figure which originated as the Egyptian mummy in the twofold character of Osiris in his death and Osiris in his resurrection; that is, as mortal

Horus, the Karast, and as Horus divinized as the anointed son. "Say what you will, or believe what you may, there is no other origin for Christ-the-anointed than Horus the Karast, anointed son of god the father."

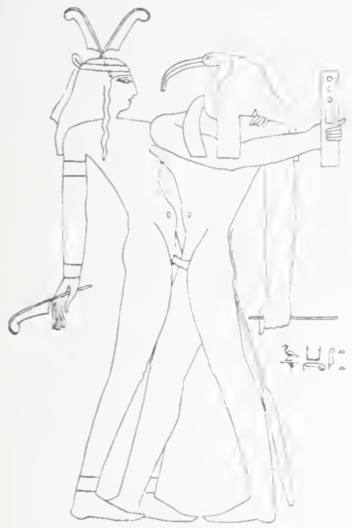
Furthermore, says Massey, none of those initiated in the esoteric wisdom ever looked upon the Kamite Iusa, or gnostic Horus, Jesus, Tammuz, Krishna, Buddha, Witoba, or any other of the many saviors as historic personalities. A gnostic arose in another life as a spirit, not as a human being. Egypt had no doctrine of the physical resurrection of the dead. All of these notions Massey considers a perversion of the original wisdom.

The creation of evil Massey considers a miscreation traceable to the Akkadian, Babylonian, Assyrian, and Hebrew theologies. Hebrews and Babylonians, he says, confused the Uraeus-serpent of life with the serpent of death. The tree of life was changed by the Babylonians into the tree of death. The serpent that offered fruit for food as Rannut, representing Mother Earth, was transformed into the evil serpent that "brought death into the world." The same types which represented evil in the Babylonian mythology represented good in the Egyptian. A god of eternal torment is a Christian ideal not an Egyptian one. "Theirs was the all-parental god, Father and Mother in one, whose heart was thought to bleed in every wound of suffering humanity, and whose son was represented in the character of the comforter." The Great Mother, no matter how hideously portrayed, was not originally evil, but the bringer-forth and renewer of life in earth and water. Nor, says Massey, were the elemental offspring evil; though imaged as monsters or zootypes, they were not wicked spirits as made out to be by the Euphrateans—the devils of Western theology.

The Egyptians, says Massey, "had no fall of man to encounter in the fallacious Christian sense. Consequently they had no need of a redeemer from the effects of that which had never occurred." There was indeed a fall, he says, but it was "from the foothold first attained by the Egyptians to the dismal swamp of the Assyrian and Hebrew legends."

Nor did the Egyptians rejoice over the death of their suffering savior "because his agony and shame and bloody sweat were falsely supposed to rescue them from the consequences of broken laws; on the contrary, they taught that everyone created his own Karma here, and that the past deeds made the future fate."

In Massey's reading of the Egyptian texts, Horus did what he did for the glory of his father, not to save the

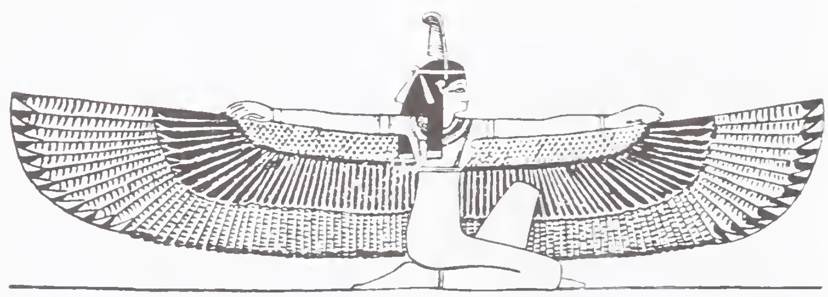


The Egyptian myths couple Maat, the protectoress of Truth and the Ibis-god Thoth, patron of Wisdom.

Maat, the female counterpart of Thoth, daughter of Ra, helped Ptah and Khnemu carry out the orderly creation ordered by Thoth. Goddess of the unalterable laws of heaven, she is "straight," "just," "true," "genuine," and "steadfast," and her emblem is the feather. All feminine neters, said Isha de Lubicz, are only revelation and manifestation of the great universal mother, for whom Maat is the divine wisdom that links the "divine" and the "natural" through consciousness. "Maat is universal consciousness, the consciousness of all consciousnesses."

souls of men from having to do the same. There was no vicarious salvation in the Egyptian view. Horus symbolized the justification of the righteous, not of the wicked. He did not come to save sinners from taking the trouble to save themselves. "He was an exemplar," notes Massey, "a model of the divine sonship; and his followers were to conform to his example."

For the Egyptian, eternal life was the ultimate reality. His god was just and righteous. The Egyptian did not pray for mercy, nor seek sentimental forgiveness for his sins. He knew his conduct now would count for the life hereafter. He must speak and act the truth. The standard of law was set up as Maat, the eternal rule of right. The Egyptian's creed was to fulfill Maat. Judgment with justice. The wickedness of the soul, said Hermes, is ignorance. Virtue is knowledge.



That the quest in Egypt was for the Christ within, the Christ of the Essene and the Gnostic, was at last driven home after World War II by an Alsatian archeologist with a Baltic title, R. A. Schwaller de Lubicz, who demonstrated that the sophisticated system of physics and metaphysics developed by the ancient Egyptians to account for the mechanics and purpose of the cosmos. With de Lubicz, Egyptology gained a true adept, not one of the ditchdigger or grave robber type of the nineteenth century, nor one of those of the twentieth who used the Rosetta Stone in a quest not for the Rose on the Cross, but for the acquisition of the rosette of the Legion of Honor.

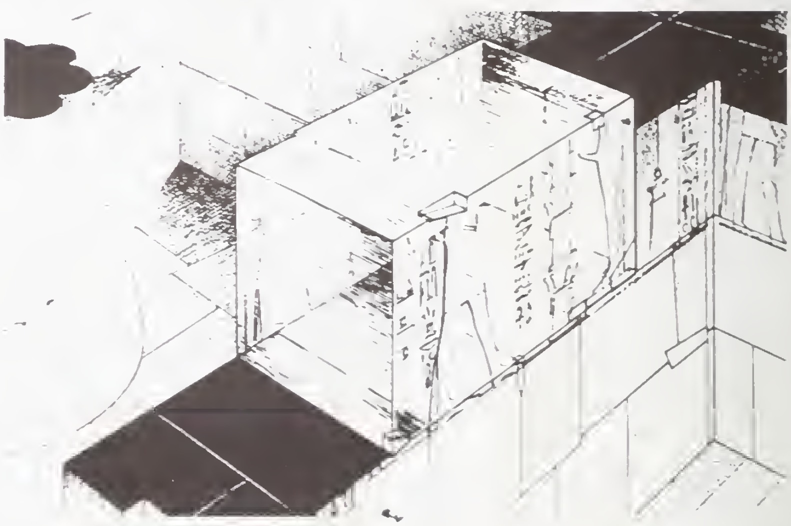
Like Rosenkreutz, Cagliostro, and Crowley, de Lubicz arrived in Egypt already an initiate, having worked his way through the disciplines of theosophy, anthroposophy, yoga, alchemy—for which he had a special laboratory—and the wisdom of the East. He too studied with Moslem and Sufi masters in North Africa. And his wife Isha, who was to put the initiatory wisdom of Egypt into the form of two novels, *Her-Bak Chick-Pea,* and *Her-Bak, Egyptian Initiate,* arrived in Egypt with six years of strict classical

Knowledge, wrote de Lubicz, can only be synthetic, so it can only be intelligibly transcribed by an architectural monument; that is to say, by a *simultaneity of plane and volume*, accompanied in Egypt by the symbolism of writing, of image, and of statuary. "To this is added an entire architectural *grammar*, represented by the form of the stone blocks, their joints, overlappings, by their 'transparencies' and 'transpositions' on the walls. There is also a subtle grammar where the finishing of an engraving or its rough aspect, the absence of essential parts—such as the eye, or the navel—the introversion of the right with the left, etc., come to play the role of accents, declinations, conjugations, or conjunctions."
The ancients had an accurate knowledge of the centers of life and intelligence, said de Lubicz, and knew all about the brain. In the temple, each vital center of the human body is clearly marked. "The glands and the vital relationships between the organs are figured by the scenes showing their correspondences with the *Neters* who control them; this throws a great light on the true sense of the pharaonic pantheon and on pantheism in general."
Isha pointed out that the advantage of the Egyptian teaching is that the authentic texts are in the very place where they were inscribed, unaltered by successive transcribers. The number, key, and symbol of the texts allows direct access to the esoteric meaning hidden beneath the apparent meaning. If you take note of anomalies in the texts, said Isha, the various arrangements of letters in each word, the different forms used for the same letter, the color of the signs, you will decipher the riddles. The *secret message* is in the fundamental metaphysical significance of the individual letters and their syllabic arrangement *irrespective* of the overt text, which may be perfectly banal. "All traditional teachings," said Isha de Lubicz, "considered the fire in the spinal column as the evolutionary element in man.

Egyptology, through which she had acquired a key to the secret reading of the hieroglyphs. In the miasmic underworld of modern Egyptological exegesis, the analytical commentaries appended to her fiction threw the clearest light onto the complex system of Egyptian symbology enshrouding its cosmological theology.

In the same Temple of Ramses II at Luxor where Champollion spent five months and Lebas fifteen, de Lubicz and his wife spent fifteen years. With the help of her daughter, Lucie Lamy, they devoted the years between 1937 and 1952 to measuring and reproducing with extraordinary finesse and accuracy the entire stonework, including every glyph, every stele, every joint. As a team they were able to find what Bruno and Kircher and Cagliostro had all intuited, the key to the Hermetic philosophy and religion secreted in the ancient glyphs. The Temple of Luxor they found to be a vast stonework symbol incorporating the totality of Egyptian wisdom: science, mathematics, geodesy, geography, geometry, medicine, astronomy, astrology, magic, myth, art, and symbolism. To de Lubicz this vast library, containing the totality of knowledge pertaining to universal creative power, embodied in the building itself, constituted the greatest achievement of New Kingdom Egypt.

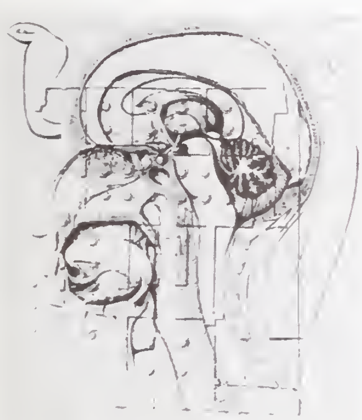
Not that the team could have made their discoveries any sooner. As late as 1881, when Gorringe researched the obelisks of Thebes, the temple was still covered by several meters of dirt and windblown sand. Only its southernmost part was accessible to view. In 1885 Gaston Maspero, director of antiquities for the Egyptian government, made the first serious attempt at excavating the area, revealing footings of walls, pylons, and columns buried beneath millennial layers of detritus. Thereafter the



backbreaking work was continued under the supervision of a series of archeologists down to the recent author of *The Obelisks of Egypt,* Labib Habachi.

As collaborators at Luxor, de Lubicz added to his team the expertise of a French Egyptologist, Alexandre Varille, who had worked ten years for the Luxor Archeological Institute, and an archeologist-architect, Clement Robichon, who had been digging in north Karnak for the French Institute of Oriental Archeology. And during the whole of their long stay in Luxor, Lucie Lamy copied, with minute care, the plans, bas-reliefs, and inscriptions on the walls of the Temple of Luxor, which enabled de Lubicz, when back in France, to compose over the next ten years his monumental work *Le temple de l'homme,* in which he was able to spell out that the Luxor temple symbolically represented man, cosmic man, in whom all the laws ordering the universe are inscribed.

The awakening of this fire, asleep at the base of the sacrum, and its passage through the different centers of the body, were part of the practical initiation into the acquisition of human mastery." To this she added: "The energy *ner,* active fire of the world, is specialized in man's marrow as *sa,* his vitality. A man who succeeds in becoming conscious of it can augment and use it at will. This controlled power is *wscr.* A man who has mastered it, is *ser.*" Isha explained: "The Sethian power of the testicles of Seth is mastered and sublimated into superhuman power." And she was explicit about the method: "It is through renenutet that the djed, the pillar of Osiris, is raised in nature and man, and it is she who when man has reawakened the fire of life in his djed leads it to the summit, the frontal ureaus that is the third eye of Horus. . . . This eye of fire masters the neters "or 'gods' and rules their blind powers."



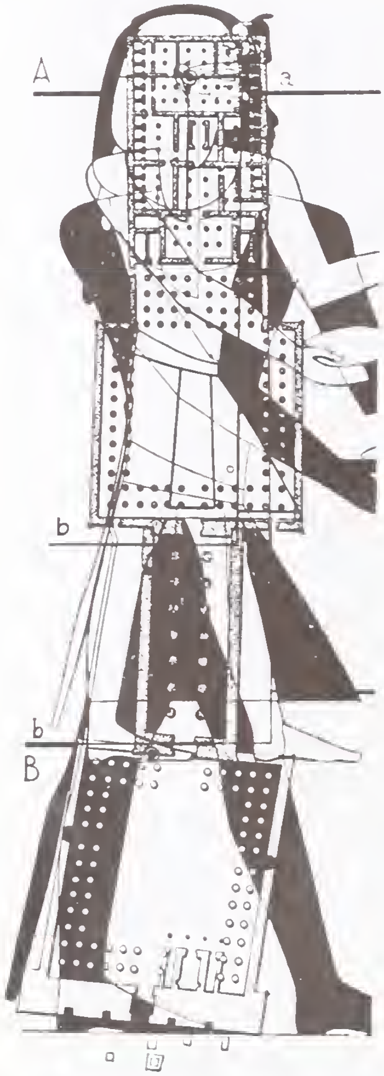
With this notion de Lubicz caused as great a shock to staid Egyptologists as had Champollion a century earlier. Yet R. T. Rundle Clark was to admit, at last, that "in recent years it has come to be realized that Egyptian art is nearly all symbolism. The architectural arrangements and decoration were a kind of mythical landscape. This was worked out down to the last detail of the furnishing; everything had a meaning or could be made to have one. Columns, capitals, walls, window-lattices, drainage outlets, gateways, screens and shrines all had significant traditional schemes. An Egyptian temple simultaneously appealed to the eye and the imagination."

De Lubicz discovered that it was by means of the harmonic relations in its design as a whole, and by the endlessly varied parts of its structure, that the temple, together with the mythological vignettes intaglioed in high or low relief, became a library in stone, one which told in bold lines the story of the creation of man, indicating his development stage by stage: a temple which recreated in artistic form man's relationship to the universe.

The proportions which de Lubicz found in the temple were those of pre-Adamic man, man before the Fall, and of perfected man, who, through his own efforts, regains his cosmic consciousness. Man, says de Lubicz, if he understands himself perfectly, understands the universe. "Man is not an image, a condensation of the Universe; man *is* the Universe."

The same theme is echoed by Kenneth Grant. "As man goes on unveiling and understanding the powers of his own constitution, he realizes that the macrocosm is contained within him, not *vice versa,* for Man—being the

To de Lubicz, the Temple of Luxor was a unique monument in that although all the initiatory temples of Egypt had as their goal the projection of the universe in man, at Luxor "the form and the proportions of the architecture superimpose themselves on the complete body of man which brings to the inscriptions (hieroglyphic ritual, bas-reliefs, transparencies, transpositions, relations given through the joints and geometric keys) a value of biological revelation, according to their situation on the human body, which in this case, plays the role of an atlas for the vital *functions*."



only complete Microcosm—he alone of all orders of existence has a link with, or possesses within himself, the potential of the entire gamut of manifestation."

De Lubicz formulated the axiom in what he calls his doctrine of athropocosm: We have nothing to discover outside of ourselves. The universe is neither an "imagination" nor a "will," but a projection of human consciousness. The reason for life, says de Lubicz, is to become conscious of self. The goal of life is cosmic consciousness, beyond all transient, mortal contingencies. The universe, he says, presents only an evolution of consciousness, from beginning to end, which is the return to its Cause. Thus the aim of every initiatory religion is to teach the way that leads to this ultimate merging.

Yet the ancient Egyptians distinguished two types of consciousness: an intelligence which *knows* this universe without having to reason it, and a cerebral intelligence, which de Lubicz qualifies as that of "fallen" Adamic man. Cerebral consciousness, peculiar to the animal kingdom and the human animal, requires the faculty of registering notions that are only acts of comparison, and this faculty the Egyptians located in the cerebral cortex and the double cerebral lobes.

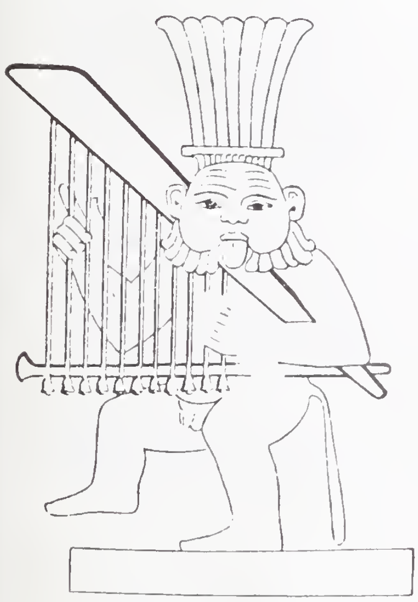
Cerebral man, says de Lubicz, is not a creator; his or her free will only allows for a decomposition of what is there, and the choice among the pieces with which to reconstruct an artificial whole. Cerebral man distinguishes what creates from what is created, and tries to separate the giver from the receiver, as if futilely hoping to sever the north from the south pole of a magnet.

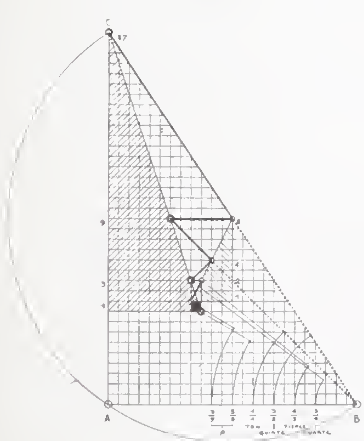
But the Temple of Luxor does not deal with cerebral man, rather with the spiritual being which inhabits a human body. To de Lubicz the temple served to guide the civilization of the Nile Valley toward the gestation of divine humanity out of the transitory human form. "The goal of the Temple was to elevate our being towards the Being which animates all." All of the temples extending along the length of the Nile represent together a global teaching, each temple consecrated to a divine principle, developing a particular theme, inseparable from the whole, just as the entire pantheon of Egyptian gods represent facets of a single supreme being.

In Egypt the temple was the expression of a self-perpetuating group of initiates responsible for keeping intact a wisdom, based on a precise knowledge of universal laws, throughout Egypt's long history, a sacred science passed on through myth, ritual, and music, based on number and measure, incorporated into structures and built into tombs and temples.

It was the same knowledge passed on to the builders of the great medieval cathedrals—a profound understanding of universal harmonic, rhythmic, and proportional laws, and a precise knowledge of the manner in which to employ these laws to create a desired effect. And the dimensions of the temple, like those of the Great Pyramid of Cheops, resolve themselves into fractions of terrestrial and cosmic measure. What stunning simplicity to build into the base of the Great Pyramid the foot to measure seconds of arc, 1.296 billion of which make the circumference of the earth, and a foot and a half, or cubit, to measure seconds of time *and* arc, $\frac{1{,}296{,}000{,}000}{1\frac{1}{2}}$ being the number of seconds of time *and* cubits in one revolution of the planet, or 864,000,000.

The Neter Bes, Egyptian god of music





An analysis of number had already been published by de Lubicz in 1917. There he explained that "properly to understand the real successive steps of creation one must first know the development of abstract number: how the many are derived from the one. Because it is evident," he wrote, "that the first Unity, or uncaused cause is indivisible. As a prime unity it is purely qualitative and without quantity."

Through an endless symphony of measures one slips with de Lubicz past Alice's looking glass into the world of Parmenides and Zeno, where everything is always one no matter how you slice it. Numbers are but names applied to the functions and principles upon which the universe is maintained. The interplay of numbers causes the phenomena of the physical world. Frequency oscillating between two poles produces the form apprehensible to the senses. The body, the earth, the stars, are but complex vibratory systems with harmonic overtones. To be, is to be in harmony with the universe. Man and the universe are linked harmonically. This is the message of the Sufi saints.

In Egypt the de Lubicz family found themselves dealing not with the remains of a corpse, but with "a witness to an active presence." For the ancient Egyptians the entire temple had to live. Its intricate alignments, its multiple asymmetries, made the whole temple oscillate about its several axes. The secret of its life, as discovered by de Lubicz, was the harmonic play of number, proportion, measure, and orientation. "We must once and for all conceive of the pharaonic temple," says de Lubicz, "as a seed in the process of bearing its fruit."

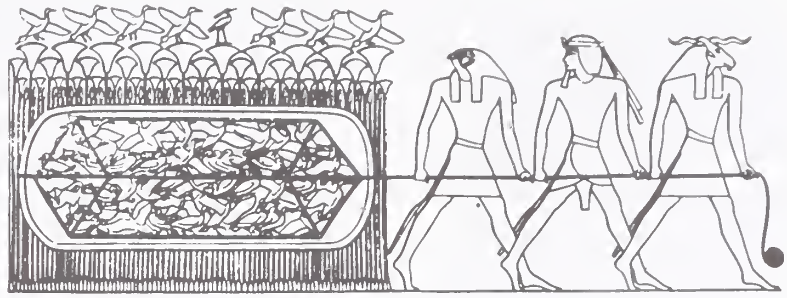
An exhaustive study of a single wall of a room within the covered temple, said de Lubicz, would require a book in itself. The orientation axes linking the temple to cosmic influences, the stone joints pointing to the physiological functions of the human body, the geometrical functions covering the numerical relations appropriate to the locations of the temple, the dimensions of the figures, the offerings, the attributes, the situation of the hieroglyphs in relation to the images and their ritual meaning—all must be taken into account. Each stone of the walls of the temple, he said, is cut according to preestablished measures; similarly, the stone beds were chosen according to an exact knowledge of the scene which was to be drawn there; the joints are situated in such a way as to cut, with intention, the head, feet, hands, attributes, etc. of the figures to be drawn. All of this concerns the hieroglyphic writing. The epigraphy alone never reveals the secret teaching of the sages. It is necessary to learn to *read the images.*

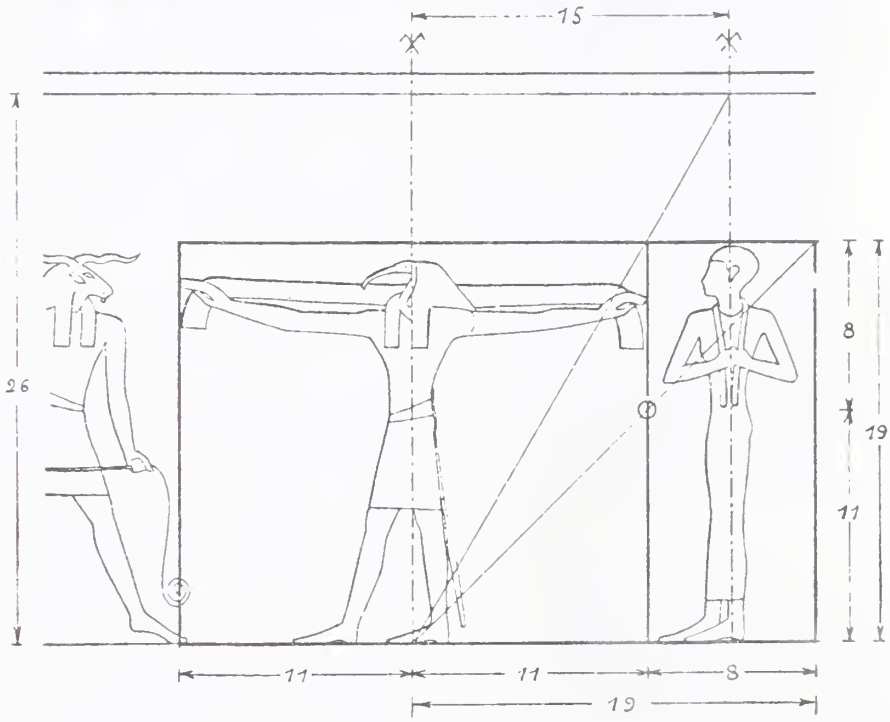
The Temple of Luxor is called Apet or Ipet of the Land of the South. The very name, says de Lubicz, is cabalistic. Ipet is the ancient Egyptian name of the female hippopotamus, symbol of the gestating womb. *Ipet,* he points out, derives from the root *ip,* which means "to count" or "to enumerate." Consequently gestation is identified with the act of counting, or multiplication. Phi, or the Golden Section, plays a dominant role in de Lubicz's identification of the Temple with man. He shows how the Golden Section, in no way a dead number, lies at the heart of what he calls the "primordial scission" of the One, engendering a universe that is both asymmetric and cyclical. Phi is the symbol of generation, of procreation, of growth in all directions; "it is the fire of life, the male action of sperm, the *logos* of the gospel of St. John," a symbol to which all of nature subscribes, from molluscs to giant redwoods, from the structure of bones to the ages of growth in man.

The discrete phases of growth as marked and carved into the temple stand in harmonious relationship to earlier and later stages. The various sections of the human body stand in complex but always harmonious relationship to each other. The entire temple explains the secret functions of the human organs and nerve centers. Every vital center is indicated. But these edifices, as Kircher was intuitively aware, speak a language addressed to spiritual man. And the architecture of the ancients was a living language. Only with the invention of printing, as Bruno lamented, was architectural teaching dethroned, the spirit eliminated, leaving the empty letter.

Like Enel, Schwaller de Lubicz saw the hieroglyphs not as overt phonetic signs, but as deeper Hermetic symbols conveying the subtle metaphysical realities of what he calls the "sacred science of the pharaohs." He saw in the glyphs a means of communicating the intuitively understood essence of life, one which slips through the net of language, something that can be glimpsed, like an aura, by not being viewed directly. The Egyptian symbols, says de Lubicz, were used as a deliberate means of evoking a deeper, spiritual understanding, as opposed to merely conveying information. They were pictorial devices to evoke an idea or a concept entirely, a complete hierarchy of meaning, bypassing intellect, moving straight to "the intelligence of the heart." They were magical symbols to evoke the form bound in the spell of matter. To be grasped, the symbol demanded a shift in consciousness, the same sort of shift which occurs when the print on the page of a novel is transformed into images of life.

This relief appears on the west side of the south wall of the hypostyle hall in Karnak, part of a scene called "Hunting Birds." In an adjoining relief, the figures of Thoth and Sechat were sculpted in relief by Seti I then intaglioed under Ramses II. In the hunting scene a net is filled with birds in a thicket of papyrus reeds surmounted by seven birds in flight separated in groups of three and four by a phoenix, or bennu bird. The horizontal rope is pulled by Horus with his falcon head, watched by the young pharaoh, while in the next panel, the horned Khnoum looks toward Thoth, master of numbers and measure, with his arms outstretched, indicating a fathom of 6 feet or 4 cubits. His proportion, said de Lubicz, indicates the essential numbers for a hexagon, the division of a cycle by six, and the means of translating curved into linear measure. This is no banal hunting scene, de Lubicz observed, but a symbolic one, tied to mythology. This is the location where Set was caught in a net by Horus. Sechat, standing by Toth, is described as the one who will conceive and raise the royal child, who, as Ra, will mount the throne of Horus. Here, said Schwaller, is a cabalistic scene which indicates the capture of an abstraction. He then proceeded to analyze the meaning of each single symbolic thread in the net.





The advantage of the system of symbols over the phonetic, says de Lubicz, is that the meaning of symbols lasts indefinitely, from lifetime to lifetime; and the fundamental purpose of the initiatory texts is to convey the truth of resurrection and reincarnation. To anyone unconvinced of this truth, the glyphs, says he, will remain a dead letter. And not only did the glyphs have a cosmic meaning, they were further amplified by the sound attributed to them, which, when reverberated, could magically key in the past. The technique was rediscovered by L. Ron Hubbard in Dianetics, where the mere repetition of a key word can bring into focus in full three-dimensional color and sound a whole scene from the past, no matter how remote. The whole of history, the whole of the "akashik record," is available to man merely by tuning his consciousness, perhaps by reciting a mantra. For cerebral man is but a shadow of the cosmic creature—whether aboriginal or umbilically tied to the darkness of Nuit—whose will, under love, can make the universe magically manifest.

The mythology of ancient Egypt abounds in sexual tales. Rundle Clark says "it shows that the Egyptians lived much closer to the dark Powers of the unconscious than we realize." During a truce between Horus and Seth, they go off to rest. In the night Seth violates Horus. Horus runs to his mother, Isis, with Seth's seed in his hand. Isis cuts off her son's "contaminated" hand and throws it into the water. In revenge Isis obtains some of her son's semen and sprinkles it on a lettuce in Seth's garden. Seth (who eats nothing but lettuce) becomes pregnant with the seed of Horus. Before the judges Seth claims that Horus is unworthy of the royal office because he allowed Seth to bugger him. Anthony S. Mercatante has another version: "During the night Seth had an erection and thrust his penis between Horus's legs in an attempt to rape him. But Horus put his hands between his thighs, catching Seth's semen."

Horus avenges his father's death by stealing the seed of Set's testicles.

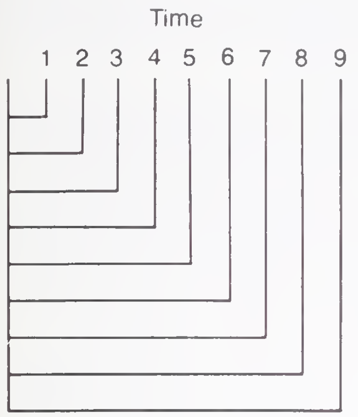
The gods of the Egyptians, called *neters,* phonetically related to nature, represented the powers of the cosmos—gravity, levity, magnetism, and light. They were concealed behind animal masks because, along the road of evolution, animals come to symbolize certain states of nature. And following the stages of life, as the principals took on different aspects, so did their names. Ptah, Sekhmet, and Nefertoum became Amon, Mut, and Khonsu in the human genesis. Ptah, says de Lubicz, a pure fire fallen to earth to be solidified as an obelisk in Memphis, became, in Amon, a water of lunar or solar fire. That which has been in Sekhmet a venusian water, becomes Mut, a lunar water, the former warm, the latter cold. It is necessary, says de Lubicz, to see in Amon a liquid coagulation substance, like the masculine sperm, and in Mut a substance liquid as well but susceptible of being coagulated by Amon.

Aor is the Egyptian word for "magic light," or electricity. It was the name de Lubicz received in the course of his own initiatory development. Aud or Od, also magic light, is the vibration of Set. Set and Horus, sometimes called Neter-wy, are "the two *neters,*" aspects of the universal light, one dark, material, fixed, contracted, satanic—Set; the other radiant, spiritual, penetrating, open—Horus. The paternal, constricting, styptic power of sperm, contracting, causes spirit to materialize. But spirit, says de Lubicz, fights to free itself by a counterreaction which is movement.

The biblical cabala speaks of a fallen archangel who brings with him the remembrance of the divine light, the chaos composed of Set, the mephitic Satan, and it speaks of Horus-Lucifer, who carries the light and causes it to reappear. This, says de Lubicz, is the same story which the pharaonic cabala describes as the struggle between Set and Horus—builders of the temple which is man. It is the eternal conflict in every creature who undergoes the contradictory attraction of the two powers: the horian, immutable light, and the sethian—atavisms attached to terrestrial form.

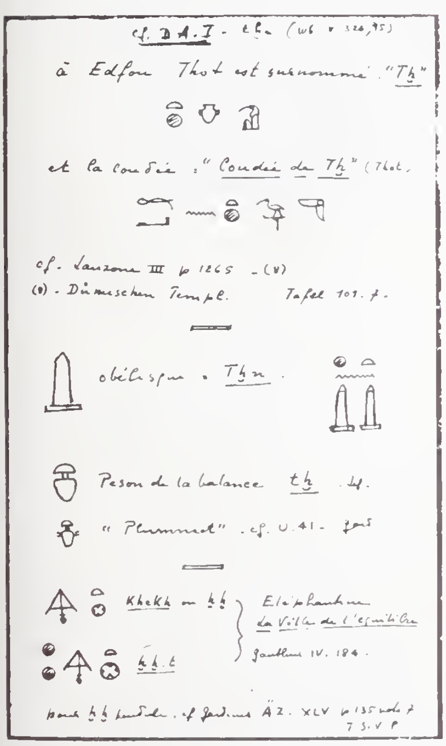
And Set and Horus are gravity and levity, aspects of the same fundamental energy. In Mesoamerica, Quetzalcoatl and Tezcatlipoca are depicted Januslike; one aspect dilates, the other contracts, and all of life is in the cyclical pulse between the two. This pulsation, this gravitational, levitational swing of the pendulum the Egyptians knew to be the heart of the matter, as their glyphs clearly show:

Among the unpublished papers of de Lubicz, written just before his death, is a monograph in which he shows how



Side = time
Surface = the distance covered
These surfaces superimposed one on the other form a stepped pyramid. As the distance covered increases by the square of the time it does so at a constant acceleration.
(from de Lubicz's notes)

Lucy Lamy's notes deciphering the Egyptian understanding of the fundamentals of physical science symbolized by the heart, plumate, and obelisk



the Egyptian obelisk incorporates the formula for gravity, with a geometric acceleration which grows by squares. This was an idea already formulated in *The Lost Solar System Discovered,* a remarkable mathematical opus produced in the middle of the nineteenth century by an obscure but brilliant researcher, John Wilson, who pointed out that the sectional axis of the obelisk may be regarded as symbolic of time, velocity, and distance, or the generator of lines, areas, and solids. With his equations Wilson endeavored to establish that obelisks represent the laws of motion when a body falls near the surface of the earth, or when a planet revolves in orbit. By his analysis of the pyramidal and hyperbolic temples of the past, he interpreted the ancient theory of the laws of gravitation as the key to understanding the mechanics of celestial motion.

The obelisk, according to Wilson, was called "the finger of God" because it indicates the laws by which the universe is governed. $\top$, said Wilson, is the symbol of time and distance as a body descends to earth. $\perp$ is the symbol for velocity and distance. The *crux ansata,* or sacred Tau, , symbol of the divinity of Osiris, he interpreted as symbolic of time, velocity, and distance of a falling body which cannot descend beyond the surface of the attracting orb or sphere. "But this sacred type of the eternal laws," he said, "appears to have become more and more obscure as the days of science declined, till ultimately it ceased to be intelligible; when, instead of this spiritual symbol, a physical one, palpable to the senses and adapted to the capacity of the unlearned, was substituted, and so the Phallic worship became embodied and revered in the religious rites of Egypt, India, Greece and Rome."

That the pull of gravity is the same for all falling bodies, and that only the mass of a body varies according to its distance from the center of the earth, depending on latitude and height above sea level, was known to the Egyptians millennia before Galileo. And they also knew that the force of gravity for any locality can be obtained by the number of oscillations in a plumb bob within a certain time—the number of swings in a pendulum being the same no matter what its weight. What varies the effect is the length of the string.

Sir William Flinders Petrie, founder of the British School of Archaeology in Egypt, and promulgator of scientific archaeology, showed how the double remen, a diagonal of one of the many Egyptian cubits, that of 29.161 inches, is virtually the natural length of a pendulum which swings 100,000 times in twenty-four hours at the latitude on which

Memphis lies. "There would have been no difficulty to the Egyptians," says Petrie, "in developing the use of his familiar plumb-bob to find this result."

And Livio C. Stecchini, perhaps the greatest scholar of the science of measure, that primary discipline without which there can be no physics, suggested, before his death, that the size of the base of each obelisk may have been deliberately designed to indicate the height above sea level at which the obelisk was raised.

To ferret out the truth, more research is needed into pylon, pyramid, and obelisk; but these two great pioneers in Egyptological physics and metaphysics, de Lubicz and Stecchini, have indeed left their mark. In his unfinished book on the canonical Jesus, Stecchini points out that whereas Hebrew justice was based on the strictest law of giving fair measure, when the spirited Nazarene suggested giving back five in return for three or not rewarding the fellow who buried his talent, they quickly nailed him to a cross.

Isha de Lubicz described her husband's final moments on earth as his features became illumined by an ecstatic smile. "Reality," he said, "is not at all what one imagines. . . . One must look in silence, without wishing to see . . . and accept pure nothingness . . . for what man calls nothing, *that* is Real: Oh, we are so blind! Isha, I will show you. The worst impediment to illumination has been my mental being. I see its game now. It has been my enemy all my life. I did not believe it could be so fierce! I sensed it was an obstacle, but I did not recognize all its ruses, all the forms it could take to mislead me. It is terrifying, Isha. I wish you too could see it, so as to help others free themselves from fear; for it is the mental which creates fear and doubt. . . . What is real is outside time and beyond 'good and evil.' It is not what appears to the senses."

POSTSCRIPT

Just as I forewent a final caption to the phoenix, a young friend appeared on my doorstep fresh from Egypt, unaware of the content of this book, and, unsolicited, began to recount adventures in the Saqqara region with a clairaudient lady. For some time my friend has been studying Egyptian glyphs, hoping to reconstitute the original sounds of the ancient language.

It was the full moon of the vernal equinox. In a Saggara tomb he found that his clairaudient friend could chant without understanding them the invocations to the Neters, or gods, appearing on the walls while my friend ad-libbed a translation. To their surprise they both felt a presence; forthwith the lady began to chant a stream of messages from what purported to be the ancient gods of Egypt, invoked by the sound of her voice. And what did they say? According to my friend, nothing more phenomenal than to express their pleasure that human beings had once more found the means of communicating with them for the welfare of the planet, and a preoccupied warning that we have become so out of touch with mother earth she may be on the point of spewing out the toxins with which we have poxed her body.

I did not press my friend, for he and the lady intend to publish the entire story of their contact, with all that was said and done. But it made me wonder about Dee and Crowley and company, and I thought again of Isha de Lubicz's statement that "to know a thing's real name is to know its power. And to pronounce it exactly is to free its

Was Crowiey on the track? To some extent, without questicn. Though he may or may not have garbled the answer. Isha de Lubicz is more crystalline when she has her aspirant initiate Her-bak ask about the meaning of three Egyptian words: "I am looking for the relation between *za,* magic power, *sa,* back, and *saa,* Sage." To which his master answers: "The power *za* has nothing to do with the projection of thought or will, unless in a popular reading and by extension. This word gives the active power of the fire whose channel is the vertebral column . . . there are various centres of residence and radiation in our body. It may be Sethian fire, consuming, destructive, when it is constrained or switched to sex or brain. That is why the back is said to belong to Seth. But when this fire is subtilised it is vivifying, quickening. This is the true magic fire, triple in its nature, giver of life or death."

"Is it a power to be feared then!" exclaims Her-bak. "Is it in all men?"

"It is latent in them," answers his guru, "but few know how to make use of it wisely, very few how to master it. It reaches its perfection in him when a man, being quickened, radiates it without effort of his own, life a life-giving sun. Such a man is *saa,* a wise man, in whom the Horus-fire masters the Seth-fire and subjects it to his service. The same fire as yet unevolved gives the characteristics and signature of the personality *sa* or *za* and in its spermatic capacity it transmits paternal characters to the son *sa* or *za*."

Another modern guru, Gopi Kirshna, wants to put modern men of science onto the trail of kundalini, which he calls "the greatest mystery of creation still lying unsolved and even unattended before us . . . a force present in the human body that is drawing humankind toward a sublime state of consciousness inconceivable for even the most intelligent mind that has not experienced it." Gopi Krishna is convinced that man is evolving toward a state of awareness in which the reality behind the universe can become perceptible, if only the activity of the reproductive mechanism can be made to stream inward and upward. "This reversal," he says, "true for both men and women, causes an amazing transformation in the cerebro-spinal system, leading to an explosion of consciousness. . . . On the arousal of kundalini, the nectarean substance flows into the head [as radiant, living energy] and then circulates in the body."

As he describes the phenomenon, the reproductive system is employed as a transfer center, where the life-energies are transformed into an ever more volatile and radiant energy that streams upward into the brain. This transformation, he explains, is built on the copiously produced "ambrosia" of the reproductive mechanism, working day and night. "The ambrosia is the nectarlike reproductive secretion which, at the highest point of ecstasy, pours into the brain with such an intensely pleasurable sensation that even the sexual orgasm pales into insignificance before it. This unbelievably rapturous sensation—pervading the whole of the spinal cord, the organs of generation and the brain—is nature's incentive to the effort directed at self-transcendance, as the orgasm is the incentive to the reproductive act." Like Bruno, Gopi Krishna asks: "Is the creator, or God, of such limited intelligence that he should build man in such a way that the sexual urge is the most awful impulse in him, attended with such an intense pleasure, and then rule that he is not to touch it?" Of course not: the object of the process is to release the self-conscious mind of man more and more from "the thraldom of the subconscious, to enable it to touch levels of cognition which, in its present fettered condition, it can never reach."

During the course of a genuine mystical experience, says Gopi Krishna, a higher dimension of consciousness intervenes, eclipsing the normal individuality, partially or wholly, for a period. "It then seems as if a new world, a new order of existence, or superhuman being has descended into view. There is an unmistakable enhanced perception of lights, color, beauty, goodness, virtue, and harmony which lend to superworldly appearance to the whole experience."

How the transformation of the genes is effected through a rejuvenative activity of the reproductive system, or the arousal of the Serpent Power, how the seminal fluid in men is sent in a cascading stream of radiant energy to the brain, and in women in the form of hormones and secretions—a secret so closely guarded by adepts of the past—Gopi Krishna promises to reveal in detail as a solution the problems of mankind. Certainly the arbitrary imposition of intolerable dogma enforced by torture cannot but be the very last form of rational brotherly or loving government. Yet it is what we have had for two thousand years. As the Founding Fathers of this republic fully understood, the only way for humans of different religious persuasions to live peaceably together is to live under the common law and refuse to fight or impose in matters or religion. This is what the obelisk stands for on the mall in Washington, D.C.

And the self-appointed arbiters of morality may learn the difference between erotic, livening, enamoring, and generative sex on the one hand and the world of porno, which can only exist under restriction, for who would deliberately look upon the corrupt if, all around, the woods and fields were full of young Dianas and their hornéd lovers.

Crowley suggested that nine-tenths of social misery not due to poverty arises from the hallucination of personal jealousy and ill-regulated passion. "There shall be no property in human flesh," says Aiwaz in *The Book of the Law*. "Nobody has the right to say what anyone else shall or shall not do with his or her body." Establish this principle of absolute respect for others, says Crowley, and the whole nightmare of sex is dispelled. "Blackmail and prostitution automatically lose their *raison d'être*."

As for contraception, abortion, sexual stasis, overpopulation, and the wars that ensue, for some millennia the

Chinese Taoist and the Hindu Tantric have solved these problems by the practice of highly satisfactory sexual intercourse without ejaculation, not the gross Roman notion of *coitus interruptus* but the more salubrious *coitus ad infinitum,* satisfying sexually and emotionally to both men and women, leading to a mystic fusion of the two in one.

So let us be loving and free, and intrepid, and let us stop arming and killing. For Augustine warned, karma imposes that every sword thrust pierces its wielder. Let us return to the gospel of the canonical Jesus, let us gently turn Roma back into Amor.

BIBLIOGRAPHICAL NOTE

In the filed bibliography for this opus there are over a thousand titles, far too many to list, yet each of value in its way; and I must have consulted thrice that many. The masters on the subject of obelisks, Michele Mercati, Anathasius Kircher, Georg Zoega, Cesare d'Onofrio, and above all, Erik Iversen, are credited in the text wherever possible. Some authors, such as Serge Hutin, have written a score of books every one of which touches on some facet of the subject. Books on or about Aleister Crowley fill several shelves. To have listed every volume on every subject dealt with would be tedious to all but the rare scholar who could not find them for himself. Rather than burden publisher and reader with an endless list, I am, through the publisher, available at any time to answer any bibliographical question and indicate the whereabouts of any publication hard to find.

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"Then this most holy land, the seat of palaces consecrated to divinity, and of temples, shall be full of sepulchres and dead bodies. O, Egypt, Egypt, fables alone shall remain of thy religion, and these, such as will be incredible to posterity, and words alone shall be left engraved in stones, narrating thy pious deeds."—Hermes Trismegistus

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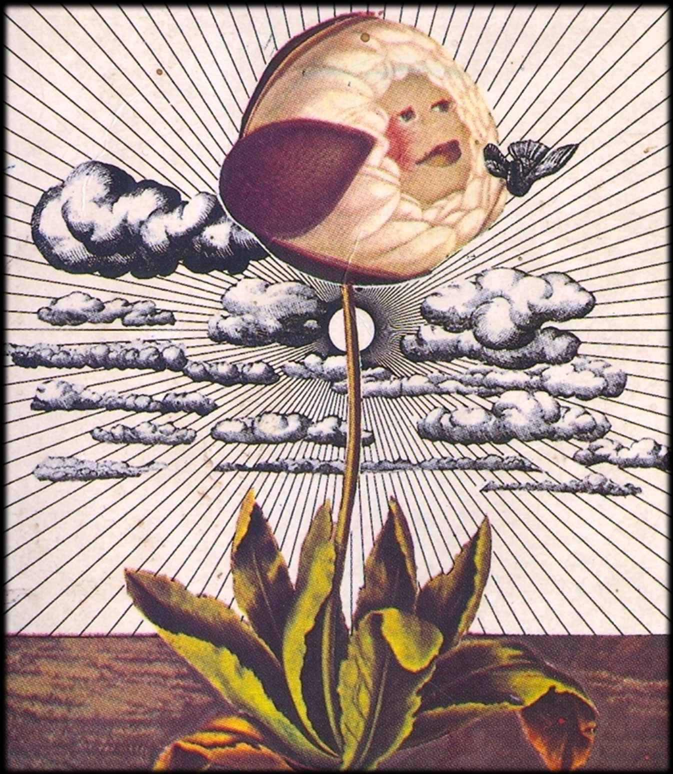
The Secret Life of Plants

A fascinating account of the

physical, emotional, and spiritual

between plants and man.

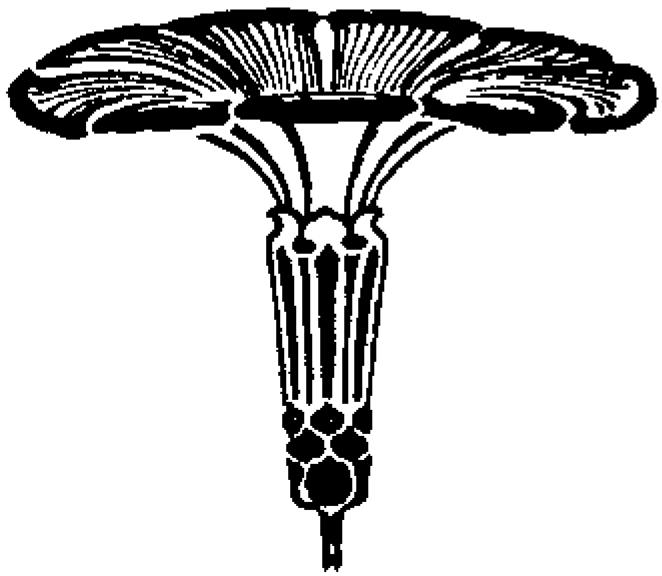


Peter Tompkins and Christopher Bird

authors of Secrets of the Soil

"Once in a while you find a book that stuns you. Its scope leaves you breathless. This is such a book." - *John White, San Francisco Chronicle*

THE SECRET LIFE OF PLANTS



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Lastly the authors are grateful to their respective helpmates, without whom the book would never have reached the printer.

Introduction

Short of Aphrodite, there is nothing lovelier on this planet than a flower, nor more essential than a plant. The true matrix of human life is the greensward covering mother earth. Without green plants we would neither breathe nor eat. On the undersurface of every leaf a million movable lips are engaged in devouring carbon dioxide and expelling oxygen. All together, 25 million square miles of leaf surface are daily engaged in this miracle of photosynthesis, producing oxygen and food for man and beast.

Of the 375 billion tons of food we consume each year the bulk comes from plants, which synthesize it out of air and soil with the help of sunlight. The remainder comes from animal products, which in turn are derived from plants. All the food, drink, intoxicants, drugs and medicines that keep man alive and, if properly used, radiantly healthy are ours through the sweetness of photosynthesis. Sugar produces all our starches, fats, oils, waxes, cellulose. From crib to coffin, man relies on cellulose as the basis for his shelter, clothing, fuel, fibers, basketry, cordage, musical instruments, and the paper on which he scribbles his philosophy. The abundance of plants profitably used by man is indicated by nearly six hundred pages in Uphof's *Dictionary of Economic Plants.* Agriculture--as the economists agree--is the basis for a nation's wealth. Instinctively aware of the aesthetic vibrations of plants, which are spiritually satisfying, human beings are happiest and most comfortable when living with flora. At birth, marriage, death, blossoms are prerequisites, as they are at mealtime or festivities. We give plants and flowers as tokens of love, of friendship, or homage, and of thanks for hospitality. Our houses are adorned with gardens, our cities with parks, our nations with national preserves. The first thing a woman does to make a room livable is to place a plant in it or a vase of fresh cut flowers. Most men, if pressed, might describe paradise, whether in heaven or on earth, as a garden filled with luxuriant orchids, uncut, frequented by a nymph or two.

Aristotle's dogma that plants have souls but no sensation lasted through the Middle Ages and into the eighteenth century, when Carl von Linné, grandfather of modem botany, declared that plants differ from animals and humans only in their lack of movement, a conceit which was shot down by the great nineteenth-century botanist Charles Darwin, who proved that every tendril has its power of independent movement. As Darwin put it, plants "acquire and display this power only when it is of some advantage to them."

At the beginning of the twentieth century a gifted Viennese biologist with the Gallic name of Raoul Francé put forth the idea, shocking to contemporary natural philosophers, that plants move their bodies as freely, easily, and gracefully as the most skilled animal or human, and that the only reason we don't appreciate the fact is that plants do so at a much slower pace than humans.

The roots of plants, said France, burrow inquiringly into the earth, the buds and twigs swing in definite circles, the leaves and blossoms bend and shiver with change, the tendrils circle questingly and reach out with ghostly arms to feel their surroundings. Man, said Francé, merely thinks plants motionless and feelingless because he will not take the time to watch them.

Poets and philosophers such as Johann Wolfgang von Goethe and Rudolf Steiner, who took the trouble to watch plants, discovered that they grow in opposite directions, partly burrowing into the ground as if attracted by gravity, partly shooting up into the air as if pulled by some form of antigravity, or levity.

Wormlike rootlets, which Darwin likened to a brain, burrow constantly downward with thin white threads, crowding themselves firmly into the soil, tasting it as they go. Small hollow chambers in which a ball of starch can rattle indicate to the root tips the direction of the pull of gravity.

When the earth is dry, the roots turn toward moister ground, finding their way into buried pipes, stretching, as in the case of the lowly alfalfa plant, as far as forty feet, developing an energy that can bore through concrete. No one has yet counted the roots of a tree, but a study of a single rye plant indicates a total of over 13 million rootlets with a combined length of 380 miles. On these rootlets of a rye plant are fine root hairs estimated to number some 14 billion with a total length of 6,600 miles, almost the distance from pole to pole.

As the special burrowing cells are worn out by contact with stones, pebbles, and large grains of sand, they are rapidly replaced, but when they reach a source of nourishment they die and are replaced by cells designed to dissolve mineral salts and collect the resulting elements.

This basic nourishment is passed from cell to cell up through the plant, which constitutes a single unit of protoplasm, a watery or gelatinous substance considered the basis of physical life.

The root is thus a water pump, with water acting as a universal solvent, raising elements from root to leaf, evaporating and falling back to earth to act once more as the medium for this chain of life. The leaves of an ordinary sunflower will transpire in a day as much water as a man perspires. On a hot day a single birch can absorb as much as four hundred quarts, exuding cooling moisture through its leaves.

No plant, says France, is without movement; all growth is a series of movements; plants are constantly preoccupied with bending, turning and quivering. He describes a summer day with thousands of polyplike arms reaching from a peaceful arbor, trembling, quivering in their eagerness for new support for the heavy stalk that grows behind them. When the tendril, which sweeps a full circle in sixty-seven minutes, finds a perch, within twenty seconds it starts to curve around the object, and within the hour has wound itself so firmly it is hard to tear away. The tendril then curls itself like a corkscrew and in so doing raises the vine to itself.

A climbing plant which needs a prop will creep toward the nearest support. Should this be shifted, the vine, within a few hours, will change its course into the new direction. Can the plant see the pole? Does it sense it in some unfathomed way? If a plant is growing between obstructions and cannot see a potential support it will unerringly grow toward a hidden support, avoiding the area where none exists.

Plants, says France, are capable of *intent*- they can stretch toward, or seek out, what they want in ways as mysterious as the most fantastic creations of romance.

Far from existing inertly, the inhabitants of the pasture-or what the ancient Hellenes called *botane*-appear to be able to perceive and to react to what is happening in their environment at a level of sophistication far surpassing that of humans.

The sundew plant will grasp at a fly with infallible accuracy, moving in just the right direction toward where the prey is to be found. Some parasitical plants can recognize the slightest trace of the odor of their victim, and will overcome all obstacles to crawl in its direction.

Plants seem to know which ants will steal their nectar, closing when these ants are about, opening only when there is enough dew on their stems to keep the ants from climbing. The more sophisticated acacia actually enlists the protective services of certain ants which it rewards with nectar in return for the ants' protection against other insects and herbivorous mammals.

Is it chance that plants grow into special shapes to adapt to the idiosyncrasies of insects which will pollinate them, luring these insects with special color and fragrance, rewarding them with their favorite nectar, devising extraordinary canals and Horal machinery with which to ensnare a bee so as to release it through a trap door only when the pollination process is completed?

Is it really nothing but a reflex or coincidence that a plant such as the orchid *Trichoceros parviflorus* will grow its petals to imitate the female of a species of fly so exactly that the male attempts to mate with it and in so doing pollinates the orchid? Is it pure chance that night-blossoming flowers grow white the better to attract night moths and night-flying butterflies, emitting a stronger fragrance at dusk, or that the carrion lily develops the smell of rotting meat in areas where only flies abound, whereas flowers which rely on the wind to cross-pollinate the species do not waste energy on making themselves beautiful, fragrant or appealing to insects, but remain relatively unattractive?

To protect themselves plants develop thorns, a bitter taste, or gummy secretions that catch and kill unfriendly insects. The timorous *Mimosa pudica* has a mechanism which reacts whenever a beetle or an ant or a worm crawls up its stem toward its delicate leaves: as the intruder touches a spur the stem raises, the leaves fold up, and the assailant is either rolled off the branch by the unexpected movement or is obliged to draw back in fright.

Some plants, unable to find nitrogen in swampy land, obtain it by devouring living creatures. There are more than five hundred varieties of carnivorous plants, eating any kind of meat from insect to beef, using endlessly cunning methods to capture their prey, from tentacles to sticky hairs to funnel-like traps. The tentacles of carnivorous plants are not only mouths but stomachs raised on poles with which to seize and eat their prey, to digest both meat and blood, and leave nothing but a skeleton. Insect-devouring sundews pay no attention to pebbles, bits of metal, or other foreign substances placed on their leaves, but are quick to sense the nourishment to be derived from a piece of meat. Darwin found that the sundew can be excited when a piece of thread is laid on it weighing no more than 1/78,000 of a grain. A tendril, which next to the rootlets constitutes the most sensitive portion of a plant, will bend if a piece of silk thread is laid across it weighing but .00025 of a gram.

The ingenuity of plants in devising forms of construction far exceeds that of human engineers. Man-made structures cannot match the supply strength of the long hollow tubes that support fantastic weights against terrific storms. A plant's use of fibers wrapped in spirals is a mechanism of great resistance against tearing not yet developed by human ingenuity. Cells elongate into sausages or Hat ribbons locked one to the other to form almost unbreakable cords. As a tree grows upward it scientifically thickens to support the greater weight.

The Australian eucalyptus can raise its head on a slim trunk above the ground 480 feet, or as high as the Great Pyramid of Cheops, and certain walnuts can hold a harvest of 100,000 nuts. The Virginia knotweed can tie a sailor's knot which is put to such a strain when it dries that it snaps; hurling the seeds to germinate as far as possible from mother.

Plants are even sentient to orientation and to the future. Frontiersmen and hunters in the prairies of the Mississippi Valley discovered a sunflower plant, *Silphium laciniatum,* whose leaves accurately indicate the points of the compass. Indian licorice, or *Arbrus precatorius,* is so keenly sensitive to all forms of electrical and magnetic influences it is used as a weather plant. Botanists who first experimented with it in London's Kew Gardens found in it a means for predicting cyclones, hurricanes, tornadoes, earthquakes and volcanic eruptions.

So accurate are alpine flowers about the seasons, they know when spring is coming and bore their way up through lingering snowbanks, developing their own heat with which to melt the snow.

Plants which react so certainly, so variously, and so promptly to the outer world, must, says Francé, have some means of communicating with the outer world, something comparable or superior to our senses. France insists that plants are constantly observing and recording events and phenomena of which man-trapped in his anthropocentric view of the world, subjectively revealed to him through his five senses-knows nothing.

Whereas plants have been almost universally looked upon as senseless automata, they have now been found to be able to distinguish between sounds inaudible to the human ear and color wavelengths such as infrared and ultraviolet invisible to the human eye; they are specially sensitive to X-rays and to the high frequency of television.

The whole vegetal world, says Francé, lives responsive to the movement of the earth and its satellite moon, to the movement of the other planets of our solar system, and one day will be shown to be affected by the stars and other cosmic bodies in the universe.

As the external form of a plant is kept a unit and restored whenever part of it is destroyed, Francé assumes there must be some conscious entity supervising the entire form , some intelligence directing the plant, either from within, or from without.

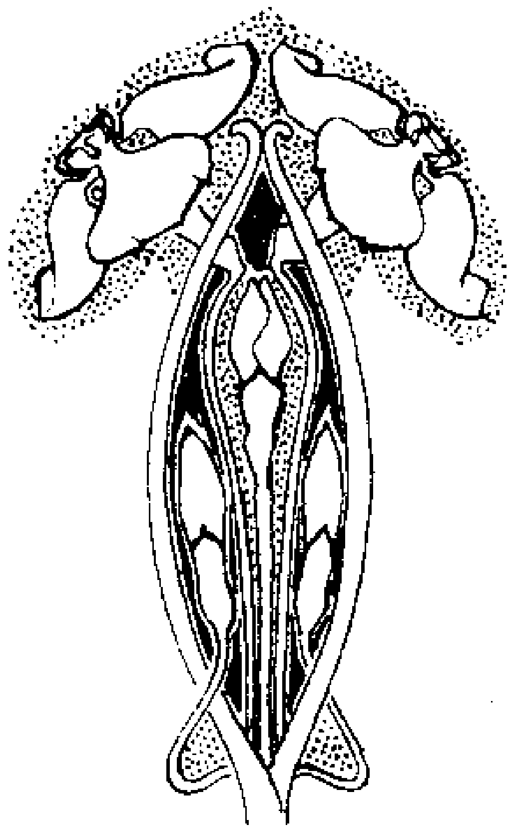
Over half a century ago Francé, who believed plants to be possessed of all the attributes of living creatures including "the most violent reaction against abuse and the most ardent gratitude for favors," could have written a *Secret Life of Plants,* but what he had already put into print was either ignored by the establishment or considered heretically shocking. What shocked them most was his suggestion that the awareness of plants might originate in a supramaterial world of cosmic beings to which, long before the birth of Christ, the Hindu sages referred as "devas" and which, as fairies, elves, gnomes, sylphs and a host of other creatures, were a matter of direct vision and experience to clairvoyants among the Celts and other sensitives. The idea was considered by vegetal scientists to be as charmingly jejune as it was hopelessly romantic.

It has taken the startling discoveries of several scientific minds in the 1960s to bring the plant world sharply back to the attention of mankind. Even so there are skeptics who find it hard to believe that plants may at last be the bridesmaids at a marriage of physics and metaphysics. Evidence now supports the vision of the poet and the philosopher that plants are living, breathing, communicating creatures, endowed with personality and the attributes of soul. It is only we, in our blindness, who have insisted on considering them automata. Most extraordinary, it now appears that plants may be ready, willing, and able to cooperate with humanity in the Herculean job of turning this planet back into a garden from the squalor and corruption of what England's pioneer ecologist William Cobbett would have called a "wen."

Part I

MODERN RESEARCH

CHAPTER I
Plants and ESP



The dust-grimed window 01 the office building lacing New York's Times Square reflected, as through a looking glass, an extraordinary corner 01 Wonderland. There was no White Rabbit with waistcoat and watch chain, only an elfin-eared fellow called Backster with a galvanometer and a house plant called *Dracaena massangeana.* The galvanometer was there because Cleve Backster was America's foremost lie-detector examiner; the dracaena because Backster's secretary felt the bare office should have a touch of green; Backster was there because of a fatal step taken in the 1960s which radically affected his Iife, and may equally affect the planet.

Backster's antics with his plants, headlined in the world press, became the subject of skits, cartoons, and lampoons; but the Pandora's box which he opened for science may never again be closed. Backster's discovery that plants appear to be sentient caused strong and varied reaction round the globe, despite the fact that Backster never claimed a discovery, only an uncovering of what has been known and forgotten. Wisely he chose to avoid publicity, and concentrated on establishing the absolute scientific bona fides of what has come to be known as the "Backster Effect."

The adventure started in 1966. Backster had been up all night in his school for polygraph examiners, where he teaches the art of lie detection to policemen and security agents from around the world. On impulse he decided to attach the electrodes of one of his lie detectors to the leaf of his dracaena. The dracaena is a tropical plant similar to a palm tree, with large leaves and a dense cluster of small flowers; it is known as the dragon tree (Latin *draco)* because of the popular myth that its resin yields dragon blood. Backster was curious to see if the leaf would be affected by water poured on its roots, and if so, how, and how soon.

As the plant thirstily sucked water up its stem, the galvanometer, to Backster's surprise, did not indicate less resistance, as might have been expected by the greater electrical conductivity of the moister plant. The pen on the graph paper, instead of trending upward, was trending downward, with a lot of sawtooth motion on the tracing.

A galvanometer is that part of a polygraph lie detector which, when attached to a human being by wires through which a weak current of electricity is run, will cause a needle to move, or a pen to make a tracing on a moving graph of paper, in response to mental images, or the slightest surges of human emotion. Invented at the end of the eighteenth century by a Viennese priest, Father Maximilian Hell, S.J., court astronomer to the Empress Maria Theresa, it was named after Luigi Galvani, the Italian physicist and physiologist who discovered "animal electricity." The galvanometer is now used in conjunction with an electrical circuit called a "Wheatstone bridge," in honor of the English physicist and inventor of the automatic telegraph, Sir Charles Wheatstone.

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In simple terms, the bridge balances resistance, so that the human body's electrical potential—or basic charge—can be measured as it fluctuates under the stimulus of thought and emotion. The standard police usage is to feed "carefully structured" questions to a suspect and watch for those which cause the needle to jump. Veteran examiners, such as Backster, claim they can identify deception from the patterns produced on the graph.

Backster's dragon tree, to his amazement, was giving him a reaction very similar to that of a human being experiencing an emotional stimulus of short duration. Could the plant be displaying emotion?

What happened to Backster in the next ten minutes was to revolutionize his life.

The most effective way to trigger in a human being a reaction strong enough to make the galvanometer jump is to threaten his or her well-being. Backster decided to do just that to the plant: he dunked a leaf of the dracaena in the cup of hot coffee perennially in his hand. There was no reaction to speak of on the meter. Backster studied the problem several minutes, then conceived a worse threat: he would burn the actual leaf to which the electrodes were attached. The instant he got the picture of flame in his mind, and before he could move for a match, there was a dramatic change in the tracing pattern on the graph in the form of a prolonged upward sweep of the recording pen. Backster had not moved, either toward the plant or toward the recording machine. Could the plant have been reading his mind?

When Backster left the room and returned with some matches, he found another sudden surge had registered on the chart, evidently caused by his determination to carry out the threat. Reluctantly he set about burning the leaf. This time there was a lower peak of reaction on the graph. Later, as he went through the motions of pretending he would burn the leaf, there was no reaction whatsoever. The plant appeared to be able to differentiate between real and pretended intent.

Backster felt like running into the street and shouting to the world, "Plants can think!" Instead he plunged into the most meticulous investigation of the phenomena in order to establish just how the plant was reacting to his thoughts, and through what medium.

His first move was to make sure he had not overlooked any logical explanation for the occurrence. Was there something extraordinary about the plant? About him? About the particular polygraph instrument?

When he and his collaborators, using other plants and other instruments in other locations all over the country, were able to make similar observations, the matter warranted further study. More than twenty-five different varieties of plants and fruits were tested, including lettuce, onions, oranges, and bananas. The observations, each similar to the others, required a new view of life, with some explosive connotations for science. Heretofore the debate between scientists and parapsychologists on the existence of ESP, or extrasensory perception, has been fierce, largely because of the difficulty of establishing unequivocally when such a phenomenon is actually occurring. The best that has been achieved so far in the field, by Dr. J. B. Rhine, who initiated his experiments in ESP at Duke University, has been to establish that with human beings the phenomenon seems to occur with greater odds than are attributable to chance.

Backster first considered his plants' capacity for picking up his intention to be some form of ESP; then he quarreled with the term. ESP is held to mean perception above and beyond varieties of the established five sensory perceptions of touch, sight, sound, smell, and taste. As plants give no evidence of eyes, ears, nose, or mouth, and as botanists since Darwin's time have never credited them with a nervous system, Backster concluded that the perceiving sense must be more basic.

This led him to hypothesize that the five senses in humans might be limiting factors overlying a more "primary perception," possibly common to all nature. "Maybe plants see better *without* eyes," Backster surmised: "better than humans do with them." With the five basic senses, humans have the choice, at will, of perceiving, perceiving poorly, not perceiving at all. "If you don't like the looks of something," said Backster, "you can look the other way, or not look. If everyone were to be in everyone else's mind all the time it would be chaos."

To discover what his plants could sense or feel, Backster enlarged his office, and set about creating a proper scientific laboratory, worthy of the space age.

During the next few months, chart after chart was obtained from all sorts of plants. The phenomenon appeared to persist even if the plant leaf was detached from the plant, or if it was trimmed to the size of the electrodes; amazingly, even if a leaf was shredded and redistributed between the electrode surfaces there was still a reaction on the chart. The plants reacted not only to threats from human beings, but to unformulated threats, such as the sudden appearance of a dog in the room or of a person who did not wish them well.

Backster was able to demonstrate to a group at Yale that the movements of a spider in the same room with a plant wired to his equipment could cause dramatic changes in the recorded pattern generated by the plant just *before* the spider started to scamper away from a human attempting to restrict its movement. "It seems," said Backster, "as if each of the spider's decisions to escape was being picked up by the plant, causing a reaction in the leaf."

Under normal circumstances, plants may be attuned to each other, said Backster, though when encountering animal life they tend to pay less attention to what another plant may be up to. "The last thing a plant expects is another plant to give it trouble. So long as there is animal life around, they seem to be attuned to animal life. Animals and people are mobile, and could need careful monitoring."

If a plant is threatened with overwhelming danger or damage, Backster observed that it reacts self-defensively in a way similar to an opossum—or, indeed, to a human being—by "passing out," or going into a deep faint. The phenomenon was dramatically demonstrated one day when a physiologist from Canada came to Backster's lab to witness the reaction of his plants. The first plant gave no response whatsoever. Nor did the second; nor the third. Backster checked his polygraph instruments, and tried a fourth and a fifth plant; still no success. Finally, on the sixth, there was enough reaction to demonstrate the phenomenon.

Curious to discover what could have influenced the other plants, Backster asked: "Does any part of your work involve harming plants?"

"Yes," the physiologist replied. "I terminate the plants I work with. I put them in an oven and roast them to obtain their dry weight for my analysis."

Forty-five minutes after the physiologist was safely on the way to the airport, each of Backster's plants once more responded fluidly on the graph.

This experience helped to bring Backster to the realization that plants could intentionally be put into a faint, or mesmerized, by humans, that something similar could be involved in the ritual of the slaughterer before an animal is killed in the kosher manner. Communicating with the victim, the killer may tranquilize it into a quiet death, also preventing its flesh from having a residue of "chemical fear," disagreeable to the palate and perhaps noxious to the consumer. This brought up the possibility that plants and succulent fruits might *wish* to be eaten, but only in a sort of loving ritual, with a real communication between the eater and the eaten—somehow akin to the Christian rite of Communion—instead of the usual heartless carnage.

"It may be," says Backster, "that a vegetable appreciates becoming part of another form of life rather than rotting on the ground, just as a human at death may experience relief to find himself in a higher realm of being."

On one occasion, to show that plants and single cells were picking up signals through some unexplained medium of communication, Backster provided a demonstration for the author of an article appearing in the Baltimore *Sun,* subsequently condensed in the *Reader's Digest.* Backster hooked a galvanometer to his philodendron, then addressed the writer as if it were *he* who was on the meter, and interrogated him about his year of birth.

Backster named each of seven years between 1925 and 1931 to which the reporter was instructed to answer with a uniform "No." Backster then selected from the chart the correct date, which had been indicated by the plant with an extra high flourish.

The same experiment was duplicated by a professional psychiatrist the medical director of the research ward at Rockland State Hospital in Orangeburg, New York, Dr. Aristide H. Esser. He and his collaborator Douglas Dean, a chemist at Newark College of Engineering, experimented with a male subject who brought along a philodendron he had nursed from a seedling and had cared for tenderly.

The two scientists attached a polygraph to the plant and then asked the owner a series of questions, to some of which he had been instructed to give false answers. The plant had no difficulty indicating through the galvanometer the questions which were falsely answered; Dr. Esser, who at first had laughed at Backster's claim, admitted, "I've had to eat my own words."

To see if a plant could display memory, a scheme was devised whereby Backster was to try to identify the secret killer of one of two plants. Six of Backster's polygraph students volunteered for the experiment, some of them veteran policemen. Blindfolded, the students drew from a hat folded slips of paper, on one of which were instructions to root up, stamp on, and thoroughly destroy one of two plants in a room. The criminal was to commit the crime in secret; neither Backster nor any of the other students was to know his identity; only the second plant would be a witness.

By attaching the surviving plant to a polygraph and parading the students one by one before it, Backster was able to establish the culprit. Sure enough, the plant gave no reaction to five of the students, but caused the meter to go wild whenever the actual culprit approached. Backster was careful to point out that the plant could have picked up and reflected the guilt feelings of the culprit; but as the villain had acted in the interests of science, and was not particularly guilty, it left the possibility that a plant could remember and recognize the source of severe harm to its fellow.

In another series of observations, Backster noted that a special communion or bond of affinity appeared to be created between a plant and its keeper, unaffected by distance. With the use of synchronized stopwatches, Backster was able to note that his plants continued to react to his thought and attention from the next room, from down the hall, even from several buildings away. Back from a fifteen-mile trip to New Jersey, Backster was able to establish that his plants had perked up and shown definite and positive signs of response—whether it was relief or welcome he could not tell—at the very moment he had decided to return to New York.

When Backster was away on a lecture tour and talked about his initial

1966 observation, showing a slide of the original dracaena, the plant, back in his office, would show a reaction on the chart at the very time he projected the slide.

Once attuned to a particular person, plants appeared to be able to maintain a link with that person, no matter where he went, even among thousands of people. On New Year's Eve in New York City, Backster went out into the bedlam of Times Square armed with a notebook and stopwatch. Mingling with the crowd, he noted his various actions, such as walking, running, going underground by way of subway stairs, nearly getting run over, and having a mild fracas with a news vendor. Back at the lab, he found that each of three plants, monitored independently, showed similar reactions to his slight emotional adventures.

To see if he could get a reaction from plants at a much greater distance, Backster experimented with a female friend to establish whether her plants remained attuned to her on a seven-hundred-mile plane ride across the United States. From synchronized clocks they found a definite reaction from the plants to the friend's emotional stress each time the plane touched down for its landing.

To test a plant's reaction at still greater distances, even millions of miles, to see if space is a limit to the "primary perception" of his plants, Backster would like the Mars probers to place a plant with a galvanometer on or near that planet so as to check by telemeter the plant's reaction to emotional changes in its caretaker at ground control on earth.

Since "telemetered" radio or TV signals traveling via electromagnetic waves at the speed of light take between six and six and one-half minutes to reach Mars and as many to return to Earth, the question was whether an emotional signal from an earthbound human would reach Mars faster than an electromagnetic wave or, as Backster suspects, the very instant it was sent. Were the round-trip time for a telemetered message to be cut in half it would indicate that mental or emotional messages operate outside time as we conceive it, and beyond the electromagnetic spectrum.

"We keep hearing about non-time-consuming communication from Eastern philosophic sources," says Backster. "They tell us that the universe is in balance; if it happens to go out of balance someplace, you

can't wait a hundred light-years for the imbalance to be detected and corrected. This non-time-consuming communication, this oneness among all living things, could be the answer."

Backster has no idea what kind of energy wave may carry man's thoughts or internal feelings to a plant. He has tried to screen a plant by placing it in a Faraday cage as well as in a lead container. Neither shield appeared in any way to block or jam the communication channel linking the plant to the human being. The carrier-wave equivalent, whatever it might be, Backster concluded, must somehow operate beyond the electromagnetic spectrum. It also appeared to operate from the macrocosm down to the microcosm.

One day when Backster happened to cut his finger and dabbed it with iodine, the plant that was being monitored on the polygraph immediately reacted, apparently to the death of some cells in Backster's finger. Though it might have been reacting to his emotional state at the sight of his own blood, or to the stinging of the iodine, Backster soon found a recognizable pattern in the graph whenever a plant was witnessing the death of some living tissue.

Could the plant, Backster wondered, be sensitive on a cellular level all the way down to the death of individual cells in its environment?

On another occasion the typical graph appeared as Backster was preparing to eat a cup of yogurt. This puzzled him till he realized there was a chemical preservative in the jam he was mixing into the yogurt that was terminating some of the live yogurt bacilli. Another inexplicable pattern on the chart was finally explained when it was realized the plants were reacting to hot water being poured down the drain, which was killing bacteria in the sink.

Backster's medical consultant, the New Jersey cytologist Dr. Howard Miller, concluded that some sort of "cellular consciousness" must be common to all life.

To explore this hypothesis Backster found a way of attaching electrodes to infusions of all sorts of single cells, such as amoeba, paramecium, yeast, mold cultures, scrapings from the human mouth, blood, and even sperm. All were subject to being monitored on the polygraph with charts just as interesting as those produced by the plants.

Sperm cells turned out to be surprisingly canny in that they seemed to be capable of identifying and reacting to the presence of their own donor, ignoring the presence of other males. Such observations seem to imply that some sort of total memory may go down to the single cell, and by inference that the brain may be just a switching mechanism, not necessarily a memory storage organ.

"Sentience," says Backster, "does not seem to stop at the cellular level. It may go down to the molecular, the atomic and even the subatomic. All sorts of things which have been conventionally considered to be inanimate may have to be re-evaluated."

Convinced of being on the track of a phenomenon of major importance to science, Backster was anxious to publish his findings in a scientific journal so that other scientists could check his results. Scientific methodology requires that a recorded reaction be repeatable by other scientists at other locations, with an adequate number of repetitions. This made the problem more difficult than anticipated.

To begin with, Backster found that plants can quickly become so attuned to human beings that it is not always possible to obtain exactly the same reactions with different experimenters. Incidents such as the "fainting" which occurred with the Canadian physiologist sometimes made it look as if there were no such thing as the Backster Effect. Personal involvement with an experiment, and even prior knowledge of the exact time an event was scheduled, was often enough to "tip off" a plant into noncooperation. This led Backster to the conclusion that animals subjected to excruciating vivisection may pick up the intent of their torturers and thus produce for them the very effects required in order to end the ordeal as rapidly as possible. Backster found that even if he and his colleagues discussed a project in their waiting room, the plants, three rooms away, could be affected by the imagery apparently generated by their conversation.

To make his point, Backster realized, he would have to devise an experiment in which all human involvement was removed. The entire process would have to be automated. Altogether it took Backster two and a half years and several thousand dollars, some of it provided by the Parapsychology Foundation, Inc., then headed by the late Eileen Garrett, to devise the right experiment and perfect the fully automated equipment necessary to carry it out. Different scientists of varying disciplines suggested an elaborate system of experimental controls.

The test Backster finally chose was to kill live cells by an automatic mechanism at a random time when no humans were in or near the office, and see if the plants reacted.

As sacrificial scapegoats Backster hit upon brine shrimp of the variety sold as food for tropical fish. It was important to the test that the victims demonstrate great vitality because it had been noted that tissue that is unhealthy or has begun to die no longer acts as a remote stimulus, is no longer capable of transmitting some type of warning. To see that brine shrimp are in good form is easy: in a normal condition, the males spend their whole time chasing and mounting females.

The device for "terminating" these playboy creatures consisted of a small dish which would automatically tip them into a pot of boiling water. A mechanical programmer actuated the device on a randomly selected occasion so that it was impossible for Backster or his assistants to know when the event would occur. As a control precaution against the actual mechanism of dumping registering on the charts, dishes were programmed at other times to dump plain water containing no brine shrimp.

Three plants would be attached to three separate galvanometers in three separate rooms. A fourth galvanometer was to be attached to a fixed-value resistor to indicate possible random variations caused by fluctuations in the power supply, or by electromagnetic disturbances occurring near or within the experiment's environment. Light and temperature would be kept uniform on all plants, which, as an extra precaution, would be brought from an outside source, passed through staging areas, and hardly handled before the experiment.

Plants selected for the experiment were of the *Philodendron cordatum* species because of its nice large leaves, firm enough to withstand comfortably the pressure of electrodes. Different plants of the same species would be used on successive test runs.

The scientific hypothesis which Backster wished to pursue was, properly phrased in the vernacular of science, that *"there exists an as yet* *undefined primary perception in plant life, that animal life termination can serve as a remotely located stimulus to demonstrate this perception capability, and that this perception facility in plants can be shown to function independently of human involvement."*

The experimental results showed that the plants did react strongly and synchronously to the death of the shrimp in boiling water. The automated monitoring system, checked by visiting scientists, showed that plants reacted consistently to the death of the shrimp in a ratio that was five to one against the possibility of chance.

The whole procedure of the experiment and its results were written up in a scientific paper published in the winter of 1968 in Volume X of *The International Journal of Parapsychology* under the title "Evidence of Primary Perception in Plant Life." It was now up to other scientists to see if they could repeat Backster's experiment and obtain the same results.

More than seven thousand scientists asked for reprints of the report on Backster's original research. Students and scientists at some two dozen American universities indicated they intended to attempt to duplicate Backster's experiments as soon as they could obtain the necessary equipment.* Foundations expressed interest in funding further experiments. The news media, which at first ignored Backster's paper, went into a flurry of excitement over the story once *National Wildlife* had the courage to take the plunge in February of 1969 with a feature article. This attracted such worldwide attention that secretaries and housewives began talking to their plants, and *Dracaena massangeana* became a household word.

Readers seemed to be most intrigued by the thought that an oak tree could actually quake at the approach of an axman, or that a carrot could shiver at the sight of rabbits, while the editors of *National Wildlife* were concerned that some of the applications of Backster's phenomenon to medical diagnosis, criminal investigation, and such fields as espionage were so fantastic that they dared not as yet repeat them in print.

Medical World News of March 21, 1969, commented that at last

*Backster has been loath to give out the names and places of these establishments so as not to have them importuned by outsiders until they have accomplished their tests and can make pondered announcements of their results at times of their own choosing.

ESP research might be "on the verge of achieving the scientific respectability that investigators of psychic phenomeña have sought in vain since 1882 when the British Society for Psychical Research was founded in Cambridge."

William M. Bondurant, an executive of the Mary Reynolds Babcock Foundation in Winston-Salem, North Carolina, produced a grant of $10,000 for Backster to pursue his research, commenting: "His work indicates there may be a primary form of instantaneous communication among all living things that transcends the physical laws we know now —and that seems to warrant looking into."

Backster was thus able to invest in more expensive equipment, including electrocardiographs and electroencephalographs. These instruments, normally used for measuring electrical emissions from heart and brain, had the advantage of not putting current through the plants, merely recording the difference in potential they discharged. The cardiograph enabled Backster to obtain readings more sensitive than the polygraph; the encephalograph gave him readings ten times more sensitive than the cardiograph.

A fortuitous occurrence led Backster into another whole realm of research. One evening, as he was about to feed a raw egg to his Doberman pinscher, Backster noticed that as he cracked the egg one of his plants attached to a polygraph reacted strenuously. The next evening he watched again as the same thing happened. Curious to see what the egg might be feeling, Backster attached it to a galvanometer, and was once more up to his ears in research.

For nine hours Backster got an active chart recording from the egg, corresponding to the rhythm of the heartbeats of the chicken embryo, the frequency being between 160 and 170 beats per minute, appropriate to an embryo three or four days along in incubation. Only the egg was store-bought, acquired at the local delicatessen, and was unfertilized. Later, breaking the egg and dissecting it, Backster was astonished to find that it contained no physical circulatory structure of any sort to account for the pulsation. He appeared to have tapped into some sort of force field not conventionally understood within the present body of scientific knowledge.

The only hint as to what sort of world he had wandered into came to Backster from the amazing experiments in the energy fields around plants, trees, humans, and even cells, carried out at the Yale Medical School in the 1930s and 1940s by the late Professor Harold Saxton Burr, which are only just beginning to be recognized and understood.

With these considerations Backster temporarily abandoned his experiments with plants to explore the implications of his egg discoveries, which appeared to have profound implications for the origin-of-life research—and are the makings of another whole book.

CHAPTER 2

Plants Can Read Your Mind

While Backster was developing his experiments in the eastern United States, a heavy-set research chemist working with International Business Machines in Los Gatos, California, was challenged to give a course in "creativity" for IBM engineers and scientists. It was only after Marcel Vogel had taken on the job that he realized the enormity of it. "How does one define creativity?" he found himself asking. "What is a creative person?" To answer these questions, Vogel, who had studied for years to become a Franciscan priest, began writing an outline for twelve two-hour seminars which he hoped would represent an ultimate challenge to his students.

Vogel's own probings into the realm of creativity had started when he was a boy, curious to know what caused the light in fireflies and glowworms. Finding little on luminescence in the libraries, Vogel informed his mother that he would write a book on the subject. Ten years later *Luminescence in Liquids and Solids and Their Practical Application* was published by Vogel in collaboration with Chicago University's Dr. Peter Pringsheim. Two years after that, Vogel incorporated his own company, called Vogel Luminescence, in San Francisco, which became a leader in the field. Over a period of fifteen years Vogel's firm developed a variety of new products: the red color seen on television screens; fluorescent crayons; tags for insecticides; a "black light" inspection kit to determine, from their urine, the secret trackways of rodents in cellars, sewers, and slums; and the psychedelic colors popular in "new age" posters.

By the mid-1950s Vogel became bored with his day-to-day tasks of administering a company and sold it to go to work for IBM. There he was able to devote his full time to research, delving into magnetics, optic-electrical devices, and liquid crystal systems, developing and patenting inventions of crucial significance to the storage of information in computers, and winning awards which adorn the walls of his San Jose home.

The turning point in the creativity course which Vogel was asked to give at IBM came when one of his students gave him an *Argosy* magazine with an article on Backster's work entitled "Do Plants Have Emotions?" Vogel's first reaction was to throw the article into the wastebasket, convinced that Backster was just another charlatan unworthy of serious consideration. Yet something about the idea gnawed at his mind. A few days later, Vogel retrieved the article, and completely reversed his opinion.

The article, read aloud to his seminar students, aroused both derision and curiosity. Out of this ruckus came the unanimous decision to experiment with plants. That same evening, one student called Vogel to announce that the latest issue of *Popular Electronics* referred to Backster's work, and included a wiring diagram for an instrument called a "psychanalyser," which would pick up and amplify reactions from plants and could be built for less than twenty-five dollars.

Vogel divided his class into three groups and challenged them to repeat some of Backster's accomplishments. By the end of the seminar, not one of the three teams had achieved any success. Vogel, on the other hand, was able to report that he had duplicated certain of Backster's results, and proceeded to demonstrate how plants anticipate the act of having their leaves torn, react with even greater alarm to the threat of being burnt or uprooted—more so even than if they are actually torn, burnt, or otherwise brutalized. Vogel wondered why he alone seemed to be successful. As a boy, he had been interested in anything which might explain the workings of the human mind. After dipping into books on magic, spiritualism, and hypnotic technique, he had given stage demonstrations as a teen-age hypnotist.

What particularly fascinated Vogel were Mesmer's theory of a universal fluid whose equilibrium or disturbance explained health or disease, Coué's ideas of autosuggestion as they related to painless childbirth and self-betterment, and the postulates of various writers on "psychic energy," a term popularized by Carl Jung, who, though he differentiated it from physical energy, believed it to be incommensurable.

Vogel reasoned that, if there was a "psychic energy," it must, like other forms of energy, be storable. But in what? Staring at the many chemicals on the shelves of his IBM laboratory, Vogel wondered which of them could be used to store this energy.

In his dilemma, he asked a spiritually gifted friend, Vivian Wiley, who went through the chemicals laid out for her and said that, in her judgment, none offered any promise of a solution for Vogel's problem. Vogel suggested she ignore his preconceived ideas about chemicals and use anything which might intuitively occur to her. Back in her garden, Vivian Wiley picked two leaves from a saxifrage, one of which she placed on her bedside table, the other in the living room. "Each day when I get up," she told Vogel, "I will look at the leaf by my bed and *will* that it continue to live; but I will pay no attention to the other. We will see what happens."

A month later, she asked Vogel to come to her house and bring a camera to photograph the leaves. Vogel could hardly believe what he saw. The leaf to which his friend had paid no attention was flaccid, turning brown and beginning to decay. The leaf on which she had focused daily attention was radiantly vital and green, just as if it had been freshly plucked from the garden. Some power appeared to be defying natural law, keeping the leaf in a healthy state. Curious to see if he could get the same results as his friend, Vogel picked three leaves from an elm outside his IBM laboratory; at home he laid them on a plate of glass near his bed.

Each day, before breakfast, Vogel stared concentratedly at the two outer leaves on the glass for about one minute, exhorting them lovingly to continue to live; the center leaf he assiduously ignored. In a week, the center leaf had turned brown and shriveled. The outer leaves were still green and healthy-looking. Most interesting to Vogel, the severed stems of the live leaves appeared to have healed the wounds caused by being ripped from the tree. Vivian Wiley continued her experiments and later showed Vogel the saxifrage leaf which she had kept green and alive for two long months while the control leaf was completely dehydrated and brown.

Vogel was convinced that he was witnessing the power of "psychic energy" in action. If the power of the mind could keep a leaf green way past its time, Vogel wondered what its effect might be on liquid crystals, an intensive study of which he was pursuing for IBM.

Trained in microscopy, Vogel had taken hundreds of color slides of liquid crystal behavior magnified up to three hundred times; when screened, they rival the works of a gifted abstract artist. While making the slides, Vogel realized that, by "relaxing his mind," he could sense activity not visually revealed in the microscopic field.

"I began to pick up things at the microscope which eluded others, not with ocular vision but with my mind's eye. After becoming aware of them," says Vogel, "I was led by some form of higher sensory awareness to adjust the lighting conditions to allow these phenomena to be optically recordable to the human eye or to a camera."

The conclusion at which Vogel arrived is that crystals are brought into a solid, or physical, state of existence by *pre-forms,* or ghost images of pure energy which *anticipate* the solids. Since plants could pick up intentions from a human, that of burning them, for example, there was no doubt in Vogel's mind that intent produced some kind of energy field.

By the fall of 1971, finding that his microscopic work was taking up most of his time, Vogel abandoned his research on plants. But when an article on this research quoting Dr. Gina Cerminara, psychologist and author of a popular book on the seer Edgar Cayce, appeared in the San Jose *Mercury*, and was wired by the Associated Press throughout the world, Vogel was besieged on the telephone for information, and was thus stimulated to continue.

Vogel realized that before he could observe with precision the effects on plants of human thoughts and emotion he would have to improve his technique of affixing electrodes to the plant leaves in such a way as to eliminate random electromagnetic frequencies, such as the hum of near-by vacuum cleaners, major sources of spurious data—or engineer's "noise"—which could cause the pen recorder to drift on the chart, and which obliged Backster to conduct most of his experiments between midnight and dawn.

Vogel also found that some of the philodendrons he worked with responded faster, others more slowly, some very distinctly, others less distinctly, and that not only plants but their individual leaves had their own unique personality and individuality. Leaves with a large electrical resistance were especially difficult to work with; fleshy leaves with a high water content were the best. Plants appeared to go through phases of activity and inactivity, full of response at certain times of the day or days of the month, "sluggish" or "morose" at other times.

To make sure that none of these recording effects was the result of faulty electroding, Vogel developed a mucilaginous substance composed of a solution of agar, with a thickener of karri gum, and salt. This paste he brushed onto the leaves before gently applying carefully polished one-by-one-and-a-half-inch stainless-steel electrodes. When the agar jelly hardened around the edges of the electronic pickups, it sealed their faces into a moist interior, virtually eliminating all the variability in signal output caused by pressure on leaves when clamped between ordinary electrodes. This system produced for Vogel a base line on the chart that was perfectly straight, without oscillations.

Having eliminated random influences, Vogel began a new round of experiments in the spring of 1971 to see if he could establish the exact moment when a philodendron entered into recordable communication with a human being. With a philodendron attached to a galvanometer which produced a straight base line, Vogel stood before the plant, completely relaxed, breathing deeply and almost touching it with outspread fingers. At the same time, he began to shower the plant with the same kind of affectionate emotion he would flow to a friend. Each time he did this, a series of ascending oscillations was described on the chart by the pen holder. At the same time Vogel could tangibly feel, on the palms of his hands, an outpouring from the plant of some sort of energy.

After three to five minutes, further release of emotion on Vogel's part evoked no further action from the plant, which seemed to have "discharged all its energy" in response to his ministrations. To Vogel, the interreaction between himself and the philodendron appeared to be on the same order as that evoked when lovers or close friends meet, the intensity of mutual response evoking a surge of energy until it is finally expended and must be recharged. Like lovers, both Vogel and the plant appeared to remain suffused with joy and contentment.

In a botanical nursery, Vogel found that he could easily pick out a particularly sensitive plant by running his hands over a group until he felt a slight cooling sensation followed by what he describes as a series of electrical pulses, indicating a powerful field. Increasing the distance between himself and the plant, Vogel found, like Backster, that he could get a similar reaction from it, first from outside the house, then from down the block, and even from his laboratory in Los Gatos, eight miles away.

In another experiment, Vogel wired two plants to the same recording machine and snipped a leaf from the first plant. The second plant responded to the hurt being inflicted on its neighbor, but *only when Vogel was paying attention to it!* If Vogel cut off a leaf while ignoring the second plant, the response was lacking. It was as if Vogel and the plant were lovers on a park bench, oblivious of passers-by until the attention of one lover became distracted from the other.

From his own experience, Vogel knew that masters of the art of Yoga, and teachers of other forms of deep meditation such as Zen, are unaware of disturbing influences around them when in meditative states. An electroencephalograph picks up from them quite a different set of brain waves than when the same persons are alert to the everyday world around them. It became clearer to Vogel that a certain focused state of consciousness on his part seemed to become an integral and balancing part of the circuitry required to monitor his plants. A plant could be awakened from somnolence to sensitivity by his giving up his normally conscious state and focusing a seemingly extra-conscious part of his mind on the exact notion that the plant be happy and feel loved, that it be blessed with healthy growth. In this way, man and plant seemed to interact, and, as a unit, pick up sensations from events, or third parties, which became recordable through the plant. The process of sensitizing both himself and the plant, Vogel found, could take only a few minutes or up to a half hour.

Asked to describe the process in detail, Vogel said that first he quiets the sensory responses of his body organs, then he becomes aware of an energetic relationship between the plant and himself. When a state of balance between the bioelectrical potential of both the plant and himself is achieved, the plant is no longer sensitive to noise, temperature, the normal electrical fields surrounding it, or other plants. It responds only to Vogel, who has effectively tuned himself to it—or perhaps simply hypnotizes it.

Vogel now felt confident enough to accept an invitation to make a public demonstration with a plant. On a local TV program in San Francisco, the plant, coupled to a pen recorder, gave a live illustration of varying states of Vogel's mind, running from irritation at an interviewer's questions to quiet tracings established when Vogel was in harmonious intercommunication with the plant. For the producer of ABC's television program *You Asked for It*, Vogel also demonstrated the plant's response to his or another person's thoughts, including a sudden release of strong emotion on command, followed by the act of his quieting the plant to normal reactions to its environment.

Invited to lecture to audiences who had heard of his experimentation, Vogel said unequivocally: "It is fact: man can and does communicate with plant life. Plants are living objects, sensitive, rooted in space. They may be blind, deaf, and dumb in the human sense, but there is no doubt in my mind that they are extremely sensitive instruments for measuring man's emotions. They radiate energy forces that are beneficial to man. One can feel these forces! They feed into one's own force field, which in turn feeds back energy to the plant." The American Indians, says Vogel, were keenly aware of these faculties. When in need, they would go into the woods. With their arms extended, they would place their backs to a pine tree in order to replenish themselves with its power.

When Vogel began to demonstrate plants' sensitivity to "states of attention" different from the supposed awareness which most humans like to call consciousness, he discovered that the reaction of skeptics or hostile observers could produce strange effects on him. By paying attention to negative attitudes emanating from an audience, Vogel found he could isolate the individuals emitting them and counter their effect with a deep breath, learned in Yoga instruction. He would then switch his mind to another mental image just as if he were turning a dial to a different setting.

"The feeling of hostility, of negativity, in an audience," says Vogel, "is one of the main barriers to effective communication. To counteract this force is one of the most difficult tasks in public demonstration of these plant experiments. If one cannot do this, the plant and therefore the equipment will 'go dead' and there is no response until a positive tie can be reestablished.

"It seems," he says, "that I act as a filtering system which limits the response of a plant to the outside environment. I can turn it off or on so that people and plant become mutually responsive. By charging the plant with some energy within me, I can cause the plant to build up a sensitivity for this kind of work. It is extremely important that one understand that the plant's response is, in my opinion, not that of an intelligence in plant form, but that the plant becomes an extension of oneself. One can then interact with the bioelectric field of the plant, or through it, with the thought processes and emotions in a third person."

Vogel concluded that a Life Force, or Cosmic Energy, surrounding all living things is sharable among plants, animals, and humans. Through such sharing, a person and a plant become one. "This oneness is what makes possible a mutual sensitivity allowing plant and man not only to intercommunicate, but to record these communications via the plant on a recording chart."

Because his observations indicated there was an interchange, even a commingling or fusion of energies when plant and man commune, Vogel wondered whether an exceptionally sensitive individual could get *into* a plant, as was reported of the sixteenth-century German mystic Jakob Boehme, who, as a young man, became illumined and described being able to see in another dimension.

Boehme said he could look at a growing plant and suddenly, by willing to do so, mingle with that plant, be part of the plant, feel its life "struggling toward the light." He said he was able to share the simple ambitions of the plant and "rejoice with a joyously growing leaf."

One day Vogel was visited in San Jose by Debbie Sapp, a quiet, self-effacing girl who impressed Vogel with her initial ability to enter into instant rapport with his philodendron, as established by his instrumentation.

When the plant was entirely calm, he asked her, point blank: "Can you get into that plant?" Debbie nodded assent, and her face took on an attitude of quiet repose, of detachment, as if she were far away in another universe. Immediately the recording pen began to trace a pattern of undulations revealing to Vogel that the plant was receiving an unusual amount of energy.

Debbie later described what happened in writing:

> Mr. Vogel asked me to relax and project myself into the philodendron. Several things took place as I began to carry out his request.
>
> First, I wondered exactly how I could get inside a plant. I made a conscious decision to let my imagination take over and found myself entering the main stem through a doorway at its base. Once inside, I saw the moving cells and water traveling upward through the stem, and let myself move with this upward flow.
>
> Approaching the spreading leaves in my imagination, I could feel myself being drawn from an imaginary world into a realm over which I had no control. There were no mental pictures, but rather a feeling that I was becoming part of, and filling out, a broad expansive surface. This seemed to me to be describable only as pure consciousness.
>
> I felt acceptance and positive protection by the plant. There was no sense of time, just a feeling of unity in existence and in space. I smiled spontaneously and let myself be one with the plant.
>
> Then Mr. Vogel asked me to relax. When he said this, I realized I was very tired but peaceful. All of my energy had been with the plant.

Vogel, who was observing the recording on the chart, noticed an abrupt stop when the girl "came out" of the plant. On later occasions, when the girl "re-entered" the plant, she was able to describe the inner makeup of its cells and their structure in detail. She specifically noted that one of the leaves had been badly burned by an electrode. When Vogel detached the electrode, he found a hole almost all the way through the leaf.

Vogel has since tried the same experiment with dozens of other people, having them go into a single leaf and look at the individual cells within it. All gave consistent descriptions of various parts of the cellular body down to the detailed organization of the DNA molecules. From the experiment, Vogel came to the conclusion: "We can move into individual cells in our own bodies and, depending on our state of mind, affect them in various ways. One day, this may explain the cause of disease."

The ability to go into a plant and analyze what part of it is hurt was demonstrated on TV film on Good Friday, 1973, when Vogel and Dr. Tom Montelbono, who had been working with him for over a year, were filmed during plant experimentation by a TV production team from CBS. It was highly embarrassing to both researchers that the plant seemed not to respond. Vogel asked Montelbono to see if there was something wrong with the electroding. Instead of tampering with the electrodes, Montelbono, to the astonishment of the CBS technicians, sat where he was and after a moment's concentration announced that damaged cells in the upper right-hand corner of the electroded part of the leaf were shorting the electrical circuit. In the presence of the TV men the electrodes were removed and the leaf was found to be damaged exactly where Montelbono had said.

Because Vogel knows that, among all humans, children are the most "open-minded," he has begun to teach children how to interact with plants. First, he asks them to feel a leaf, describe its temperature, consistency, and texture in detail. Next, he lets them bend leaves and become aware of their resilience before going on to pet the leaves gently by stroking their upper and under sides. If his pupils take pleasure in describing to him the sensations they feel, Vogel asks them to take their

hands away from the leaves and try to feel a force or energy emanating from them. Many of the children instantly described a rippling or tingling sensation.

Vogel noticed that those children who felt the strongest sensations were wholly engrossed in what they were doing. Once they felt the tingling, he would say: "Now completely relax and feel the give-and-take of the energy. When you feel it pulsing, gently move your hand up and down over the leaf." Following his directions, the young experimenters could easily see that, when they brought their hands down, the leaves fell away. By continued repetition of this motion, the leaves would begin to oscillate. With the use of both hands, the experimenters could actually get a plant to sway. As they gained confidence, Vogel urged them to move further and further away from the plant.

"This is basic training," says Vogel, "to develop an expanded awareness of a force which is not visible. The awareness established, they see they can operate with this force."

Adults, according to Vogel, are much less successful than children, which leads him to surmise that many scientists are not going to be able to repeat his or Backster's experiments in laboratories. "If they approach the experimentation in a mechanistic way," says Vogel, "and don't enter into mutual communication with their plants and treat them as friends, they will fail. It is essential to have an open mind that eliminates all preconceptions before beginning experiments." Indeed, Vogel was told by one doctor working at the California Psychical Society that he had had not a single result, though he had worked for months. The same is true for one of Denver's most renowned psychoanalysts.

"Hundreds of laboratory workers around the world," says Vogel, "are going to be just as frustrated and disappointed as these men until they appreciate that the empathy between plant and human is the *key*, and learn how to establish it. No amount of checking in laboratories is going to prove a thing until the experiments are done by properly trained observers. Spiritual development is indispensable. But this runs counter to the philosophy of many scientists, who do not realize that creative experimentation means that the *experimenters must become part of their experiments.*"

This highlights the difference in approach between Vogel and Backster, indicating, perhaps, that Vogel is establishing a type of hypnotic control over his plants, whereas Backster says that his plants, left strictly alone, will quite normally react to their environment.

Vogel says that even when a person *can* affect a plant, the result is not always a happy one. He asked one of his friends, a clinical psychologist, who had come to see for himself if there was any truth to the plant research, to project a strong emotion to a philodendron fifteen feet away. The plant surged into an instantaneous and intense reaction and then, suddenly, "went dead." When Vogel asked the psychologist what had gone through his mind, the man answered that he had mentally compared Vogel's plant with his own philodendron at home, and thought how inferior Vogel's was to his. The "feelings" of Vogel's plant were evidently so badly hurt that it refused to respond for the rest of the day; in fact, it sulked for almost two weeks. Vogel could not doubt that plants have a definite aversion to certain humans, or, more exactly, to what those humans are thinking.

This being true, Vogel considered it possible, one day, to read a person's thoughts through a plant. Something of the sort had already taken place. Vogel had asked a nuclear physicist to mentally "work" on a technical problem. As the man was cogitating, Vogel's plant registered a series of tracings on the recorder for 118 seconds. When the tracing fell back to base line, Vogel informed his scientist friend that he had stopped his train of thought. The friend corroborated.

Vogel wondered if he had actually captured a process on a chart via a plant. After a few minutes, he asked the physicist to think of his wife. When the physicist did so, the plant again recorded a tracing, this time for 105 seconds. It seemed to Vogel that, right before him in his living room, a plant was picking up and passing on a man's mental impressions of his wife. If one could interpret such tracings, could one not know what the man was thinking?

After a break for a cup of coffee, Vogel almost casually asked his friend to think once more of his wife in the same way he had thought of her before. The plant registered another 105-second-long tracing very similar to the first. To Vogel this was the first time a plant seemed to have recorded a similar thought spectrogram and duplicated it.

"By pursuing such experiments," says Vogel, "we may have a means of technically identifying energies coming from the human mind, translating them, and feeding them back into an as yet undeveloped device. A whole evening of thinking may be made explicit."

Entertaining a group of skeptical psychologists, medical doctors, and computer programmers at his house, Vogel let them look over his equipment for hidden devices and gimmicks which they insisted must exist, then asked them to sit in a circle and talk so as to see what reactions the plant might pick up. For an hour the group conversed on several topics with hardly a response from the plant. Just as they had all concluded that the whole thing was a fake, one of them said: "How about sex?" To their mutual surprise, the plant came to life, the pen recorder oscillating wildly on the chart. This led to speculation that talking of sex could stir up in the atmosphere some sort of sexual energy such as the "orgone" discovered and described by Dr. Wilhelm Reich, and that the ancient fertility rites in which humans had sexual intercourse in freshly seeded fields might indeed have stimulated plants to grow.

The plant also responded to spooky stories told in a darkened room lit only by a red-shaded candle. At certain points in a story, such as: "The door of the mysterious cabin in the forest began slowly to open," or, "Suddenly there appeared around the corner a strange man with a knife in his hand," or "Charles bent down and raised the lid of the coffin," the plant seemed to pay closer attention. To Vogel, this was evidence that a plant can measure "figments of the imagination," being converted to energy by the group as a whole.

Dr. Hal Puthoff, a physicist at the Stanford Research Institute in Palo Alto, invited Vogel and five other scientists to witness the effects he was getting by hooking up a chicken egg to the electro-psychometer, or "E-meter," developed by L. Ron Hubbard, the founder of Scientology. The E-meter's function is almost identical to that of the psychoanalyzer which Vogel had first used with his seminar students. Puthoff attempted to demonstrate that the egg wired to the E-meter would respond when another egg was broken. He broke three separate eggs, but nothing happened. After asking Puthoff if he could try, Vogel put his hand over an egg and related to it exactly as he had learned to relate to his plants. In one minute, the needle on the E-meter's galvanometer dial began to move and finally "pinned." Vogel backed ten feet away and got gyrations from the needle by opening and closing his hands. Though Puthoff and several others present tried to do the same, all failed.

The needle's movement, once thought to be affected by resistance on the skin of humans attached to electrodes, is known as Galvanic Skin Response, or GSR. Since plants have no skin, in the human sense, the term for the effect on plants has been changed to Psycho-Galvanic Response, or PGR.

"The PGR," says Vogel, "exists not only in plants, but in all living forms. The directive action of the mind focuses this energy and, on command, releases the force in a series of pulses which can pass through glass, metals, and other materials. No one yet knows exactly what they are."

In Russia, a psychic called Nina Kulagina can turn the needle of a compass without touching it but she has to do it with her hands near the compass; more impressive feats have been demonstrated at Stanford University, especially by the remarkably sensitive Ingo Swann, who attributes his success to techniques he learned in Scientology. With nothing but his will power, Swann has been able to affect a mechanism in the university's most thoroughly shielded "quark" chamber, buried deep underground in a vault of liquid helium, impenetrable to any known wave length of the electromagnetic spectrum, astonishing the academic physicists who watched him perform what they considered to be an impossible feat.

Vogel stresses that experiments with plants can be extremely dangerous to those who do not have the ability properly to alter their states of consciousness. "Focused thought," says Vogel, "can exert a tremendous effect on the body of a person in a higher mental state, if he lets his emotions interfere."

No one, says Vogel, who is not in sound bodily health should become involved with plants or any other kind of psychic research. Though he has not been able to prove it, Vogel feels that a special diet of vegetables, fruits, and nuts, rich in minerals and proteins, allows the body to build the kind of energy necessary for such work. "One draws energy at high levels," he said, "and this requires good nutrition."

Asked how the higher energies, such as thought, might operate on the physical bodies of living organisms, Vogel says he has now begun to speculate on the strange properties of water. As a crystallographer, he is interested in the fact that, unlike most salts, which have one crystalline form, core samples of glacier ice have more than thirty different forms. "Uninitiated persons, when first looking at them," says Vogel, "could conclude that they were observing as many different substances. And they would be right in their own way because water is a real mystery."

Vogel makes the prediction, which he stresses is as yet far from established fact, that since living things all have a high water content, the vitality of a person must be in some way related to the rate of respiration. As water moves around the body and through its pores, charges are built. Vogel's first clue about his postulate on water came from the fact that some "psychics" have lost several pounds of body weight during sessions in which they expended vital, or psychic, energy. "If we could weigh a person doing psychic research on a sensitive scale," suggests Vogel, "we would find that there is a loss of weight in each case. It is a water loss, as it is in persons who go on crash diets."

Whatever the future brings, Vogel believes that his research with plants can help man to the recognition of long-ignored truths. By developing simple training kits, which he is presently designing, he thinks he can teach children to release their emotions and watch the effects in a measurable way.

"They can thus learn the art of *loving,*" says Vogel, "and know truly that when they think a thought they release a tremendous power or force in space. By knowing that they *are* their thoughts, they will know how to use thinking to achieve spiritual, emotional, and intellectual growth.

"This is no machine to measure brain waves or any gimmick to help people to become seers or mystics," Vogel insists, "but one to help children to become *simple, honest human beings.*"

Asked to sum up the importance of his research with plants, Vogel replied: "So much of the ills and suffering in life comes from our inability to release stresses and forces within us. When a person rejects us, we rebel inside and we *hold on to this rejection.* This builds a stress which, as Dr. Wilhelm Reich showed so long ago, becomes locked in as muscular tension, and if not unlocked, depletes the body's energy field and alters its chemistry. My research with plants indicates one pathway to deliverance."

For Marcel Vogel, plants have opened new horizons. The vegetal kingdom seems capable of picking up messages of intent, benign or malicious, that are inherently more truthful than when translated into words—a talent which all human beings may share but which they have momentarily occluded.

Two young Californian students of humanistic psychology and Hindu philosophy, Randall Fontes and Robert Swanson, have now pursued Vogel's quarry into unbeaten ground. Using sophisticated equipment lent them by the IBM researcher, they have made a series of discoveries so surprising that despite their youth they have been granted funds and equipment by established universities to further probe the mysteries of plant communication.

Fontes' and Swanson's first discovery came virtually by accident when one noticed that the other's yawning was being picked up by a plant in the form of energy surges. Instead of ignoring the phenomenon as improbable, the two students followed up the clue remembering that in ancient Hindu texts an exaggerated yawn was considered a means by which a tired person could be recharged with vivifying *shakhti*, a postulated energy filling the universe.

With the help of Dr. Norman Goldstein, a professor of biology at State University in Hayward, California, Fontes went on to discover an electrical potential traveling from cell to cell in the ivy philodendron which gives a strong indication of the presence of a hitherto unsuspected simple nervous system. As a result, Fontes has been invited to direct a project at the Science Unlimited Research Foundation in San Antonio, Texas, on the effects of human consciousness on living organisms. Meanwhile, Swanson is cooperating in the setting up of a parapsychologically oriented counseling center at the John F. Kennedy University in Martinez, California, where one of Swanson's goals is to determine just which people affect plants telepathically and which do not.

CHAPTER 3

Plants That Open Doors

Next to probe the mysteries of plant communication was an "electronics specialist" from West Paterson, New Jersey, who happened to hear Backster interviewed on a radio program hosted by Long John Nebel. An assiduous investigator of ESP and of the phenomenon of remote hypnotism, Pierre Paul Sauvin was equally at home in the "state of the art" and "feasibility considerations" of the engineer, mostly because of his training and employment for several large corporations, including Aerospace and International Telephone and Telegraph.

When Long John—a professional skeptic—roped Backster into a corner to get him to describe some practical uses for his discovery of primary perception in plants, Backster first suggested the exotic notion that in jungle warfare soldiers in dangerous territory could wire up the local plants to act as "stress alarm indicators" and avoid being ambushed. "But if you really want to make a psychologist sit up and take notice," Backster told Long John, "you could instrument a plant to activate a small electric train, getting it to move back and forth on no other command than that of human emotion."

This notion, though singularly impractical, could be spelled out in Sauvin's electronics jargon as an "anxiety response device," and so fired him that he turned his bachelor quarters in a house overlooking the Passaic River into a Merlin's cave of electronic equipment.

Sauvin claims that many of his insights and ideas for inventions come to him in psychic flashes, as if he were merely acting as a medium. He says he sometimes gets the factual data necessary for an invention without fully understanding the principle, or how it relates to the whole, and must get further details by questions addressed to "levels beyond."

Using high-voltage generators which produce the sort of lightning arcs usually associated with Dr. Frankenstein, Sauvin can put 27,000 volts through his body and remotely activate a large doughnut bulb filled with helium to serve as an electronic ouija board, its dark rings flowing in one direction or the other in answer to his questions. He also developed a system guaranteed to hypnotize *anyone,* even the most recalcitrant, by placing the subject on an unstable platform in a pitch-black room and swaying before him a rainbow pattern of light that causes him to lose his balance.

With such exotic expertise it was not long before Sauvin had a toy electric train running round a track and reversing its direction through nothing but his thought and emotion relayed to a plant. He was able not only successfully to demonstrate the phenomenon before an audience of sixty in Madison, New Jersey, but to make the train start and stop at will under the klieg lights of a television studio.

As the engine moved around the track it would activate a switch leading to Sauvin's body in such a way as to give him a sharp electric shock. Just ahead on the track, another switch was wired to a galvanometer attached to an ordinary philodendron. As the philodendron picked up Sauvin's emotional reaction at being shocked, the galvanometer needle would jump and throw the switch, reversing the train. The next step was for Sauvin simply to remember the sensation of being shocked and project it in order for the plant to activate the switch.

Though Sauvin had long been interested in parapsychology and was fascinated with the psychological implications of a plant responding to human thought and emotion, his main preoccupation was the development of a foolproof plant device that could be activated by any human being. For Sauvin's purposes it did not matter whether the plant was in any way rational or feeling, so long as it could reliably pick up his emotional signal and trigger the switch. Whether plants were "conscious" or not, Sauvin was convinced they had an energy field similar to the energy field generated by a human being, and that somehow an interaction of these fields could be put to use. The problem was to develop equipment sensitive enough to take advantage of the phenomenon in an absolutely reliable way.

Perusing the endless stream of trade journals that passed across his desk as a technical writer for ITT, Sauvin was struck by a series of articles in *Popular Electronics*, on unusual electronic circuits and exotic weaponry, by a mysterious writer named L. George Lawrence. The author, intrigued by the Russian development of animal guidance systems for training cats to pilot nonjammable air-to-air missiles right onto target, speculated in his articles on training plants to respond to the presence of selected objects and images, evidently for a similar purpose. Rumored to be a high government official involved in security research writing under a pseudonym, Lawrence is in fact a European-born engineer, formerly a professor of audio-visual arts at San Bernardino College in California, presently the director of his own independent research institute.

Unfortunately, the components for sophisticated circuits such as those devised by Lawrence—though worth mere pennies, in terms of materials—would cost thousands of dollars of engineering man-hours to produce, and were in any case not available on the market. But from one of Sauvin's jobs as a specifications engineer on a large government contract he had salvaged what might be just the right pieces—some phase-looplocked discriminators pressed into microelectronic silicon wafers that had been junked by the lab as unfit for the temperature requirements of space.

With these "chips" Sauvin was able to build a Wheatstone bridge for measuring electrical potential with alternating instead of direct current, and an automatic gain control circuit by means of which he hoped to be able to distinguish very fine changes in the energy fields of plants. The sensitivity achieved was one hundred times greater than could be obtained with Backster's galvanometer and eliminated enormous amounts of electronic "noise."

What Sauvin was now measuring was no longer voltage amplitude but phase shift, or the fine lag between two running voltages. The result gave Sauvin an instrument roughly comparable to an ordinary light-dimmer switch, in which a plant leaf acted as the switch. Variations of apparent resistance in the leaf would cause a light to get brighter or dimmer depending on the response of the plant to outside effects.

As soon as his device was functioning, Sauvin set about monitoring plants around the clock. To catch the tiniest nuances of phase shift Sauvin hooked his plants to an oscilloscope, a big electronic green eye with a figure eight of light whose loops changed shape as the current from a plant varied, making patterns much like the fluttering of the wings of a butterfly. Simultaneously, a varying tone was produced by current run through an amplified tone oscillator which enabled Sauvin to hear minute changes in vibrations, and know how his plants were reacting. A bank of tape recorders kept a permanent record of the oscillating tone, along with a monotonous beep every second from a WWV international time-signal broadcast. With a stopwatch Sauvin could run a check on the effect he was having on his plants from a distance, whether down the street, at ITT, or off on a holiday.

Some of Sauvin's Merlin equipment now came into its own, especially a complex system of automatic phone-answering and recording devices. For some years Sauvin had been carrying on a moonlighting operation writing for various specialized magazines, under various pseudonyms while retaining his regular job. To keep his cover and not arouse the displeasure of his masters at ITT and yet be able to consult with his editors and answer their queries any time during the day, Sauvin had devised an ingenious system. By means of a small radio transmitter strapped to his leg and a battery of automated and preprogrammed tape machines at home he could communicate via his home phone, receiving messages and giving answers, all from his desk at ITT. For various editors to identify themselves to Sauvin's automatic equipment he developed such simple tricks as having an editor run his finger along a pocket comb close to the phone mouthpiece, generating an easily identifiable sound wave which would trigger from the automatic equipment the appropriate reply. As a cover for his own low-toned conversations from his desk, Sauvin developed the habit of humming to himself most of the time he was at work, soon becoming known as the "hummer" of ITT.

This Rube Goldberg equipment served Sauvin admirably for remote-controlled communication with his plants. He could call his own number and speak to his plants directly; he could monitor the tones of their response via the amplified audio-oscillator, and from wherever he might be he could control the light, color, temperature, or recording equipment in his quarters.

When electroding his plants Sauvin gradually realized that like Vogel he could obtain the best results from plants with which he established a special mental rapport. This he would accomplish by putting himself into a light trance, wishing the plant well, tenderly touching or washing its leaves, till he could feel his own energy emanations entering and interplaying with those of the plant.

Like Backster, Sauvin found that his plants reacted most strongly to the death of living cells in their environment, and most consistently to the death of human cells. He also found in the course of his various experiments that the simplest signal he could transmit to his plants, extrasensorily, to which they would respond with a sharp enough reaction, was to give himself a light electric shock, the very simplest method being to swivel his desk chair and then ground the accumulated static charge by touching his finger to his metal desk. His plants several miles away would react with an instant surge. Just as with the train experiment, Sauvin eventually found that he merely needed to remember or re-feel a shock for his plants to pick up the signal, even from as far away as his holiday cottage eighty miles north of his West Paterson lab.

As Sauvin's main problem remained that of getting his plants to be sharply attuned to his person rather than to their immediate enviro ment, when he was away for several days, he had to devise some mea of attracting his plants' attention even more effectively than addressi them over the long-distance phone. As his plants reacted most strong to any damage done to himself or to any part of his own energy fie he experimented with *remotely* killing a few cells of his body in t presence of the plants. The system worked admirably. The problem w to obtain cells that would remain alive for protracted periods. Blo worked well enough, hair was difficult to kill, but sperm worked best all, because, as Sauvin explained, it was easier to obtain than bleedi and much less painful.

These experiments led Sauvin to wonder if plants might not react ju as well to emotions of pleasure and joy as to pain and shock. Not on was he tired of shocking himself, he was afraid that repeated shocks his plants, even indirect ones, might be unpleasantly loading his karm Sauvin soon found that his plants did react to joy and pleasure, but wi wave patterns that were not sharp enough to trigger a switch reliab Undaunted, Sauvin decided on a more daring experiment. During holiday with a girl friend at his lakeside cottage he established that h plants, eighty miles away, would react with very high peaks on the to oscillator to the acute pleasure of sexual climax, going right off the t at the moment of orgasm. All of which was very interesting and cou be turned into a commercially marketable device for jealous wives monitor their philandering husbands, by means of a potted begonia. B it was not yet conducive to a simple, foolproof system of getting a pla to trigger a switch consistently.

There was no question in Sauvin's mind that he could affect a pla at a distance; but he could not rely on the system for any really sensiti fail-safe purpose because his plant might at any time react to som stimulus in its own environment, such as the sudden appearance of a c or of a bird outside the window snapping up an insect. Sauvin therefo wired three plants, each set in a different room, and thus in a differe environment, to a single circuit which could only be activated if all thr plants reacted synchronously. By keeping the plants in separate enviro ments Sauvin hoped the required stimulus would be synchronous on when it came from him, wherever he might be. This was still not positively foolproof, because at times one plant or the other might not fully react to the stimulus, but it was a step forward in that it prevented any random stimulus from affecting all three plants at once.

Sauvin was now anxious to release his data confirming Backster's findings and to make public his own contribution to a science which he felt had a potential for the world no less great than Marconi's use of radio waves. But in a country where government and industrial executives are less interested in the quaint notion of communing with nature than in developing sophisticated weapons of offense and the gadgetry of mind surveillance, Sauvin had a hard time finding either a sponsor or an audience.

Unable to interest the mass media, or such conservative journals as *Science* or *Scientific American*, Sauvin decided to angle his material to the engineering and mechanical journals to which he was already a regular contributor. To incite the interest of the editor of a car magazine he concocted a story about a device that would enable him to start his car by remote control by means of thought waves to a plant. With the help of a small radio transmitter this proved to be a simple enough operation, the only technical difficulty being the designing of a gadget that would give just the right pressure to the ignition key, repeat the pressure if the engine failed to catch, and release pressure the moment it did.

The device was designed to appeal to a citizen with the prospect of being able to wake up on a frosty morning and get his car and heater started while still comfortably enjoying his breakfast. But for Sauvin there was one defect: a plant was not really needed; the device could be operated directly by radio. To include his beloved plants in a worthwhile gadget attractive to automobile and home owners, Sauvin cooked up a system whereby a man returning on a snowy night could approach his garage and signal his pet philodendron to open the doors. Here the plant's function of responding only to its master would make it admirably burglar-proof.

To arouse the interest of serious scientists who might wish to provide Sauvin with the necessary funds for a proper lab, Sauvin hit upon the idea of showing that an airplane could be flown by thought control wit the aid of his plants attached to his sensitive devices. For years Sauvin already a licensed pilot, had enjoyed the hobby of flying model plane some with a wing spread as large as six feet, controlling them entirel from the ground by radio signals, getting them to bank, loop, speed up slow down, and even land. By a slight adaptation to his transmitte equipment Sauvin is able to start, stop, or affect the speed of a mode plane in flight by transmitting a thought to a plant.

In the sensitivity of plants Sauvin also saw a means of detecting potential hijacker at an airport before such a criminal could board plane and endanger passengers. He therefore suggested "Operation Sky jack," a system whereby plants could be used in conjunction with galva nometers and other sensitive devices to pick up the turbulent emotion of a hijacker being screened by security, the problem at an airport bein to safeguard not only the lives of passengers but their rights as citizen not to be subjected to unwarranted search.

Already the U.S. Army has taken an interest in the project. At For Belvoir, Virginia, funds have been provided for research on plants. Th Army is interested in devising ways of measuring the emotional re sponses of people via plants, without having to sensitize the plants t a special person beforehand.

The Navy is also showing interest. Eldon Byrd, an operations analy with the Advanced Planning and Analysis Staff of the Naval Ordnan Laboratory in Silver Spring, Maryland, has been duplicating Backster experiments with some success. A member of the American Society fo Cybernetics and senior member of the Institute for Electrical and Ele tronic Engineers, Byrd attached the electrodes of a polygraph to th leaves of a plant, and has been observing definite fluctuations of th polygraph needle as the plant responds to various stimuli. Like Backste Byrd found that by merely thinking of harming a plant's leaf it w possible to make the polygraph needle jump. Byrd's experiments i volved monitoring a plant's reaction to stimuli from water, infrared ar ultraviolet light, fire, physical stress, and dismemberment.

Byrd believes the galvanometrical effect produced by a plant is n caused by electrical resistance in the leaf, but by a change of bi potential in the cells from outside to the inside membrane, as defined by the Swedish Dr. L. Karlson, who has shown that a cluster of cells can change polarity, though the energy which causes cells to become polarized is not known. Byrd believes that a voltage change in the cells is what is being measured, and that it is the mechanism of consciousness which causes the change in potential.

Byrd's research supports Backster's observations that plants exhibit a quality of awareness and an empathy to other organisms that are stimulated in their presence. Like Backster, Byrd also found a major problem in his experiments to be the plants' tendency to "faint" under excess stress, suddenly ceasing to respond even to the most basic stimuli, such as light and heat. Like Backster and Sauvin, Byrd was able to demonstrate on television a plant's reaction to various stimuli, including his *intent* to burn it. On camera Byrd got a plant to respond to his shaking a spider in a pill box. The plant responded with about a second's delay, the response continuing as long as a minute. He also got a strong reaction when cutting the leaf from another plant.

Byrd, who has a master's degree in medical engineering from George Washington University and is a member of Mensa, a worldwide organization whose primary requirement is an extremely high intelligence quotient, has no ready solution to explain the apparent response of plants to human thoughts, and is open to widely disparate explanations, including alterations of the earth's magnetic field, supernatural and spiritual phenomena, and the mysterious mechanics of bioplasma. In a paper presented in 1972 to the American Society of Cybernetics, Byrd reviewed numerous Russian experiments with thought transmission via "bioplasma," which certain Soviet scientists claim to be a previously undiscovered form of energy.

In May, 1973, Byrd began to set up an experiment to instrument the tiny leaves of *Mimosa pudica,* which are so sensitive that they collapse when touched. Byrd believes that, by using a thin wire barely touching a mimosa leaf, he can pick up through a special amplifier minute changes in voltage or resistance. Also available to Byrd is one of the world's finest chart recorders, made in West Germany by Siemens, which shoots out more than three feet of recording paper per second with the patterns recorded by a jet of ink only a few microns wide. With these devices Byrd hopes to be able to pick up plant reactions which have hitherto gone unnoticed.

Byrd is also planning to work with a primitive marine alga, *Acetabularia cremulata,* which, though two inches long, is made up of only a single cell. If this monocellular plant exhibits the "Backster Effect," Byrd will then surgically remove its nucleus. If it then fails to respond, Byrd hopes this will offer proof that the genetic material in the nuclei of plant cells is chiefly responsible for plant response.

A revolutionary new lie-detector device known as a Psychological Stress Evaluator has also been made available to Byrd, along with lab space and facilities, by Allan Bell, inventor of the device, who is president of Dektor Counter Intelligence Systems, a firm he recently formed with two other ex-intelligence officers. The device, tested by monitoring twenty-five segments of the television program *To Tell the Truth,* is said to have picked the persons who were telling the truth with 94.7 percent accuracy. The theory behind the device is that the human voice normally operates in both audible frequencies and inaudible frequency modulations, except when a person is under stress. According to the inventors of the device, when the inaudible FM vibrations disappear from the voice under stress, the ear does not note the difference, but the machine can trace the fluctuations on a chart. Byrd is now working on a means of adapting the device for employment in conjunction with plants.

In Japan a soft-spoken doctor of philosophy and successful electronics engineer from Kamakura, a charmingly gardened retreat not far from Yokohama harbor, has developed a similar lie detector into a device with the most fabulous results yet achieved in the plant kingdom. A regular consultant on lie detection for the Japanese police, Dr. Ken Hashimoto read about Backster's laboratory experiments and decided to wire one of the family cactuses to an ordinary polygraph by means of acupuncture needles.

His intent was more revolutionary than Backster's, Sauvin's or Byrd's. He hoped to enter into actual conversation with a plant; to do so he counted on an improvement he had made in the Japanese procedure for lie detection. To simplify and make less expensive the process of police interrogation, Dr. Hashimoto developed a system, similar to Dektor's, whereby nothing more than a cassette tape is needed to record the reactions of a suspect. Electronically transposing the modulations of the suspect's voice, Hashimoto was able to produce on a paper a running graph reliable enough to pass muster in a Japanese law court.

It now dawned on Hashimoto that by reversing the system he might be able to transform the tracings from a graph into modulated sounds, giving voice to a plant. His first experiments with a cactus similar to the giant saguaro of California and the Arizona desert, but much smaller, were a failure. Loath to conclude that either Backster's reports or his own equipment was defective, Hashimoto decided that it might be he who was having trouble communicating with the plant, despite the fact that he is one of Japan's leading researchers into psychic phenomena.

His wife, on the other hand, who loves plants and is renowned for her "green thumb," soon got sensational results. As Mrs. Hashimoto assured the plant that she loved it, there was an instant response from the cactus. Transformed and amplified by Dr. Hashimoto's electronic equipment, the sound produced by the plant was like the high-pitched hum of very-high-voltage wires heard from a distance, except that it was more like a song, the rhythm and tone being varied and pleasant, at times even warm and almost jolly.

John Francis Dougherty, a young American from Marina Del Rey, California, who witnessed one of these conversations, says it sounded as if Mrs. Hashimoto, speaking in modulated Japanese, was being answered by the plant in modulated "cactese." Dougherty further reports that the Hashimotos became so intimate with their plant that they were soon able to teach it to count and add up to twenty. In answer to a query as to how much two and two make, the plant would respond with sounds which, when transcribed back into inked tracings, produced four distinct and conjoined peaks.

Dr. Hashimoto, who got his doctorate from Tokyo University, and is chief of the Hashimoto Electronics Research Center, as well as managing director and chief of research for the Fuji Electronic Industries—which produce the huge animated electrical signs that illumine Tokyo

—has since demonstrated the adding capacities of his cactus to audiences all over Japan.

Asked to explain the phenomenon of his talking and adding cactus, Dr. Hashimoto, who is also, surprisingly, one of Japan's best-selling authors—his *Introduction to ESP* is in its sixtieth printing and his *Mystery of the Fourth Dimensional World* is in its eightieth—answered that there are many phenomena that cannot be explained by the theories of present-day physics. He believes there is a world beyond the present three-dimensional world defined by physics, that this three-dimensional world is merely a shadow of a fourth-dimensional, nonmaterial world. He further believes that this fourth-dimensional world controls the three-dimensional material world through what he calls "mind concentration" or what others call psychokinesis, or mind-over-matter.

The possibilities of such mind control being used for either good or evil on this planet is the problem now facing these researchers. Since Sauvin's ordination as a minister at the Psychic Science Temple of Metaphysics, he has become a strong pacifist, abhorrent of the use of thought-controlled weapons against animals and plants as well as humans. Though he has taken out business certificates on such devices—which put him on record as the inventor—he is loath to disclose his most sensitive invention, code-named Device 13, for fear that it could quickly be developed by the Department of Defense into a foolproof thought-controlled guided missile. The temple's spiritual leader, the Reverend R. William Daut, is a trumpet medium, one who communicates with those who have departed by going into trance and having a trumpet levitate in a semidarkened room; through it the voices of the departed speak. Made of three pieces of aluminum in the shape of a cheerleader's megaphone, the trumpet has no electronic or other gimmicks. The voices simply seem to materialize out of thin air, at times recognizable as individuals known to the listeners and at others as guiding spirits; often included are such extraneous sound effects as the distant barking of dogs.

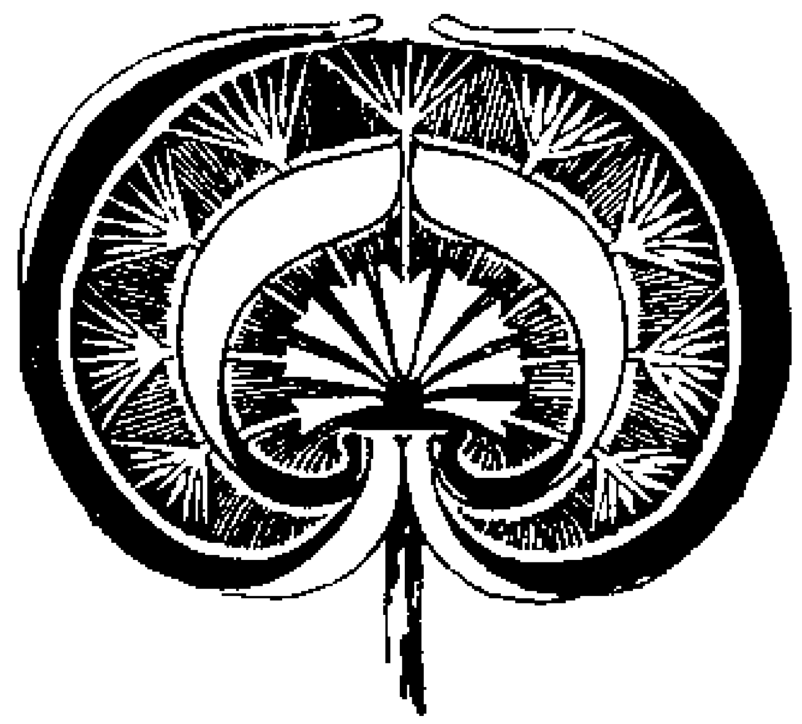
Sauvin says the purpose of the exercise is to convey enlightenment, to give profound and beautiful inspirational messages on wisdom, love, and the continuity of life. True religion, says Dr. Daut, is universal intelligence. "There is no death. There are no dead. Reformation is never denied us, here or hereafter."

The trumpet system, says Sauvin, is no more unusual than that of the Oracle at Delphi or of the talking statues of the initiate priests of ancient Egypt; the doctrines, familiar since the erection of temples, include: the fatherhood of God, the brotherhood of man, immortality of the soul, communication between departed human spirits and living mortals, personal responsibility with compensation and retribution, a path of eternal progress open to every soul by the path of eternal good, nature's laws, both spiritual and physical, and now communion with plants.

If communication of nonverbal messages turns out, as the evidence hints, to transcend limitations of time and space, and to take place via some spectrum of energies which is unrelated to what humans call "electromagnetic," the idea of a dialogue with unseen intelligences active in planes beyond that of man's self-limitations, such as was practiced by mystics of the caliber of Jakob Boehme, may no longer seem far-fetched. If we find the means to receive such messages we may reopen the doors to the cosmos.

CHAPTER 4

Visitors from Space



One day late in October of 1971, a blue Volkswagen "bug" carrying some unusual scientific equipment drove into Oak Grove Park near Temecula, a tiny southern California village near the Pechenga Indian Reservation, not far from the famous Mount Palomar Observatory. Out of the driver's seat stepped a forty-seven-year-old Silesian-born electronics engineer—L. George Lawrence. With a field assistant he had come to this remote desertlike spot to record signals from wild-growing oak trees, cacti, and yuccas. Lawrence chose the park because, in his words, it is "an electromagnetic 'deep-fringe' area, with no man-made interferences, and thus ideal for getting clean, uncontaminated plant reactions."

An important difference between Lawrence's apparatus for capturing plant signals and that of Backster, Vogel and Sauvin is that it incorporates, in a temperature-controlled bath, living vegetal tissue shielded behind a Faraday tube that screens out even the slightest electromagnetic interference. Lawrence found that living vegetal tissue is able to perceive signals far more delicately than electronic sensors. It is his belief that *biological* radiations transmitted by living things are best received by a *biological* medium.

Lawrence's equipment also differs significantly from that of the other experimenters in that it dispenses with the need to use electrodes on plants if they are far enough away from their neighbors to rule out signal interference, as is usually the case in desert areas. Instead, Lawrence simply trains a lensless tube with a wide aperture—the optical axes of which parallel the design axis of the Faraday tube—at a target plant. At greater distances he substitutes a telescope for the lensless tube, and makes the plant more visible by hanging a white cloth on it.

Lawrence's living tissue can pick up a directional signal from distances up to *one mile away.* To stimulate his plant subjects into distinct reactions he "dumps a premeasured quantity of electricity into them," activating the stimulus by remote control with a timer which allows him to walk or drive back to the sensing station. His exploratory experiments are made during colder seasons when most vegetation is dormant, so as to be doubly sure that spurious signals from other plants are not garbling his measurements.

Perturbations in the living tissue of his recorder are detected, not visually through a penrecorder, but aurally by means of a continuous, low even whistle, similar to that produced by a sine-wave generator, which changes into a series of distinct pulses whenever it is disturbed by signals from a plant.

On the day of their arrival at Oak Grove Park in 1971 Lawrence and his assistant took a break for a late-afternoon snack, seating themselves about ten yards from their instrument, which was left pointing randomly at the sky.

As Lawrence bit into a Hebrew National knockwurst, the steady whistling sound from his equipment was interrupted by a series of distinct pulsations. Lawrence, who had not yet digested the knockwurst, but had well digested the Backster effect, thought the signals might have been caused by his killing some of the cells in the sausage. Second thoughts reminded him that kosher sausage is biologically dead. As Lawrence checked his instrumentation, the audio signal, to his amazement, continued to produce a distinct chain of pulses for over half an hour before the even whistle returned, indicating that nothing more was being received. The signals had to be coming from somewhere, and since his device had been continuously pointed upward toward the heavens, Lawrence was faced with the fantastic thought that *something or someone was transmitting from outer space.*

The implications of the phenomenon were such that on their way home Lawrence and his partner could not avoid discussing them though, for the moment, they decided not to make public their finding in the event that not true signals but "bugs" in their equipment could have produced what they had heard. The possibility of life beyond earth was both disturbing and exciting to them. Hints about life elsewhere have so far been vague, including the discovery of "organized elements" or organisms in meteorites, and infrared spectra on Mars, which imply organic molecules. There are also rare nonrandom radio interstellar signals whose reception was claimed by Tesla and Marconi, but they were so ridiculed that they were finally reduced to silence; and there are intergalactic radio emissions from pulsars.

Loath to jump to a premature conclusion that he had picked up an intelligent signal from trillions of miles away through a plant tissue, Lawrence spent several months improving his equipment into what he termed a "biodynamic field station designed for interstellar signal reception."

By April of 1972, his equipment was sufficiently refined for him to attempt to point it once more in the same direction which had brought the reaction at the time of the sausage biting. As a laser expert and author of the first technical book on that subject to appear in Europe, Lawrence had carefully noted the direction in which his apparatus had been pointing and had determined that it was aligned on Ursa Major, a seven-star constellation in the region of the north celestial pole, popularly called the Big Dipper. To insure that the equipment would be located as far away from life forms as possible, Lawrence drove out to the Pisgah Crater, a volcanic butte at twenty-three-hundred-feet elevation in the middle of the arid Mojave Desert. The crater is surrounded by some thirty square miles of flat lava beds with not so much as a blade of grass. Aligning his telescope—coupled with the Faraday tube, a camera, an electromagnetic interference monitor, and the tissue chamber—to celestial coordinates 10 hours 40 minutes plus 56 degrees, which gave him the general direction for Ursa Major, Lawrence switched on his audio signal. After a ninety-minute interval, his equipment again picked up a recognizable, though briefer, pattern of signals. According to Lawrence, the periods between rapid series of pulses ranged from approximately three to ten minutes over a stretch of several hours as he monitored a single spot in the heavens.

Having thus successfully repeated his 1971 observations, Lawrence began to wonder whether he had not accidentally stumbled on a scientific discovery of major proportions. He had no idea from where the signals might be coming or what or who was sending them, but it seemed to him highly possible that galactic drift played some role in their origin. "The signals might be spilling over from the galactic equator, which has a dense star population," said Lawrence. "We could be getting something from that area rather than from the Big Dipper."

After the Mojave Desert confirmation of his first observations, Lawrence continued tests from his residence-laboratory, pointing his machine at the same coordinates, leaving it on round the clock. Lawrence says that he had to wait weeks and sometimes months for the signals to come through but, when they did, the reception of something was unmistakable. One signal produced a brr-r-r-r-r beep-beep-beep type of audio pulse which Lawrence maintains no earthly entity has achieved.

Pressed to speculate on the nature of the strange signals, Lawrence stated: "I don't believe they are directed at earthlings. I think we are dealing with transmissions between peer groups, and because we don't know anything about *biological communications* we are simply excluded from these 'conversations.' I also believe that the energy transmitted must be fantastically high since our instrumentation is not at all sophisticated and it would take a tremendous amount of power to create any response in it from such astronomical distances. The signals, therefore, may be of an emergency nature. Something may be happening up there and someone may be desperately calling for help."

Deciding that his findings may be of crucial significance and could herald a new and as yet unimagined system of communication, Lawrence has sent a copy of his October, 1971, tape, together with a seven-page report, to the Smithsonian Institution in Washington, D.C., where it is preserved as a potentially historical scientific document. The report concludes:

> An apparent train of interstellar communication signals of unknown origin and destination has been observed. Since interception was made by biological sensors, a biological-type signal transmission must be assumed. Test experiments were conducted in an electromagnetic deep-fringe area, the equipment itself being impervious to electromagnetic radiation. Follow-up tests revealed no equipment defects. Because interstellar listening experiments are not conducted on a routine basis, the suggestion is advanced that verification tests should be conducted elsewhere, possibly on a global scale. The phenomenon is too important to be ignored.

Lawrence says the instrumentation tape, as a mere audio presentation, is unpleasant to listen to, but reviewers of the tape have conceded that "a fascinating degree of enchantment" tends to emerge after the tape has been played back three or more times, typically over a period of weeks.

The tape contains a short, incremental series of deep harmonious oscillations resembling nonsense chatter or background modulations. An intelligent character of the overall pulse train is implied by discrete spacing patterns, apparent repetitions of sequences, and highly attenuated electromagnetic noise.

Lawrence looks forward to the day when he can arrange for computer analysis of the taped signals, which might be able to provide additional clues to their nature. They are far too rapid to allow manual extraction of the data. Even so, he is not too optimistic that such analysis can produce concrete results. "If the signals are of a personal nature, no means known to modern computer technology will be able to decipher them," he says. "We simply do not have today bionic-type computers which could collect seemingly random data and come up with a concise and rational readout."

Lawrence's most important conclusion, that biological-type sensors are needed in order to intercept biological signals, applies particularly to communications from outer space. As he puts it: "Standard electronics are next to worthless here, since 'bio-signals' apparently reside outside of the known electromagnetic spectrum."

Lawrence points out that in the 1950s scientists who had previously insisted that our small planet was unique in the universe began to admit, on the basis of careful celestial observations and other inferences, that we may not be alone in the cosmic immensity, and to concede the possible existence of extraterrestrials, whose development might be far superior to our own.

In the early nineteenth century Karl Friedrich Gauss—the German mathematician and physicist for whom an electromagnetic unit of magnetic flux density is named—proposed that man might make known his presence on earth to cosmic beings by cutting huge swaths hundreds of miles long in the Siberian taiga to form a right angle. This was followed by the suggestion of the Austrian astronomer J. J. von Littrow that geometric canals be dug in the Sahara, filled with kerosene, and set aflame at night; and the recommendation of the French scientist Charles Gros that a vast mirror be built to reflect sunlight directly at Mars.

These farfetched ideas were updated when, in the summer of 1927, radio observations were made which in the framework of then existing knowledge seemed to imply that earth might be under the scrutiny of communications satellites of extraterrestrial origin. Jorgen Hals, a Norwegian radio engineer, while listening to a short-wave radio station transmitting from Eindhoven in the Netherlands, heard weird echoes for which he could not account. Nor could a number of Dutch and British professors and technicians who carried out a series of experiments to confirm Hals's findings.

The puzzling anomaly was all but forgotten until the early 1950s, when various specialists began to put forward a theory of extraterrestrial interference to explain it. The theorists intrepidly assumed the intermittent existence of an interstellar communications probe designed, first, to monitor solar systems for intelligent life, then retransmit radio-frequency emanations from such life, including earthlings, back to a distant "home-world." Though these far-out interpretations were discounted, even mocked, by the mainstream of scientific opinion, their critics became far less vocal when another series of observations was made, this time involving a television signal which appeared to have been received after a mysterious delay of over three years.

In September, 1953, C. W. Bradley of London picked up the call letters of the American station KLEE-TV in Houston, Texas, on his living-room television tube. Over the next several months the same letters were observed on TV screens in the offices of Atlantic Electronics Ltd. in the English city of Lancaster. What was eerie about these receptions was not that the TV signal had been sent from so far away, since this happens often enough to cause no surprise, but that the signal had been sent about three years prior to the time of its reception, the call letters KLEE having been changed to KPRC in 1950. Explanations that the signals could have been stored in a "plasma cloud" hovering above the earth which released the data in a broadcast for all to see gave no reasons as to how this could have been done or why, and suggestions that the whole thing was merely a meaningless—though extremely expensive—hoax seem far-fetched.

Spurred by the mysteries of these phenomena, American researchers began seriously to consider interstellar communications via radio. But radio was soon ruled out after it was realized that its wavelengths could be absorbed by interstellar gas clouds and nebulae, blocked by various shielding layers around hoped-for faraway target planets, or affected by cosmic radio noise. Only one possible wavelength remained to reach such targets, the much shorter and more penetrating one emitted by neutral galactic hydrogen.

But terrestrials still hoped to receive radio waves from space. In 1960 Dr. Frank Drake initiated Project Ozma—named for the princess who became ruler of the fictional kingdom of Oz—which used a huge circular radio telescope eighty-five feet in diameter at the National Radio Astronomy Observatory near Greenbank, West Virginia. Drake and his colleagues hoped to detect possible intelligent extraterrestrial transmissions from the regions of two nearby stars, Tau Ceti and Epsilon Eridani. Only recently was it discovered that orbiting Epsilon Eridani is a massive planet six times the weight of Jupiter, largest of the nine planets now known to revolve around the sun.

Although Ozma failed to obtain results, scientists are still hotly pursuing the subject of communication with extraterrestrial intelligences, the phrase being now shortened into the acronym CETI.

In the summer of 1971, a group of American scientists at the National Aeronautics and Space Administration's Ames Research Center completed studies for a new Project Cyclops, which proposed a network of ten thousand radio dish telescopes, forming a collective surface of several square kilometers, to be mounted on rails and spread across one hundred square miles of the New Mexican desert. Requiring a cybernetic "nervous system" of brand-new supercomputers, Cyclops was estimated by Charles Seeger of New Mexico State University to cost five billion dollars. In light of the stringent cutbacks in the U.S. space-research funding, it is unlikely that Cyclops will become a reality. This leaves the field to a huge radio telescope more than half a kilometer in diameter currently under construction at the Astrophysical Observatory in the Soviet Crimea.

All of these projects, Lawrence complains, assume that signals must come by radio since that is the most efficient means of communication known to the scientists of this planet. If they converted to his idea of receiving biological signals, Lawrence feels they would have a much better chance. The notion is echoed by Joseph F. Goodavage, author of *Astrology: The Space Age Science*, who, in an article for *Saga* magazine (January, 1973), stated: "Rigid enforcement of established Scientific Method, as a kind of quasi-religion—with its burdensome ritual and tradition—may be the most serious obstacle in the path of direct communication between *Homo sapiens* and other civilizations that may be thriving throughout interstellar, intergalactic space."

Employed as an instrumentation engineer for a Los Angeles space-science corporation, Lawrence decided to design some more sophisticated transducers—or converters of one type of input energy into another type of output energy. Knowing that a mechanical device which could use heat, environmental pressure, electrostatic fields, and gravitational changes simultaneously was not up to the task, he theorized that a plant might be able to turn the trick because it had the necessary components built in by nature.

When he began to study the problem in 1963, Lawrence found he could get no help from plant specialists and biologists because none of them knew enough physics, and especially electronics, to visualize what he was driving at. In his search for a biological system for radiating and receiving signals, Lawrence began by going over the experiments made in the 1920s by the Russian histologist Alexander Gurwitsch and his wife, who proclaimed that all living cells produce an invisible radiation. Gurwitsch had noticed that the cells in the tips of onion roots seemed to be dividing at a definite rhythm. Believing this due to an extra unexplained source of physical energy, Gurwitsch wondered whether it might not come from nearby cells.

To test out his theory he mounted one root tip in a horizontally oriented thin glass tube to act as a ray gun. This he pointed at a similar onion root tip, also protected in a tube, but with a small area on one side exposed naked to serve as a target. After three hours of exposure, Gurwitsch examined sections from the target root under his microscope. When he compared the number of cell divisions, he found 25 percent more in the exposed, irradiated area. The receiver root had seemingly picked up a vital energy from its sender neighbor.

To try to block the emission, Gurwitsch repeated the experiment with a thin shield of quartz between the roots, but obtained essentially the same results. However, when the quartz was coated with gelatin, or a simple sheet of glass was substituted, no enhanced cell division could be observed. Since glass and gelatin were known to block various ultraviolet frequencies on the electromagnetic spectrum, Gurwitsch concluded that the rays emitted by the cells of an onion root tip must be as short as or shorter than ultraviolet. Because they apparently increased cell division, or "mitosis," he called them "mitogenetic rays."

Gurwitsch's findings had created a furor in the scientific world as laboratories hastened to check them. Since the wavelengths claimed for the new rays were more powerful than the ultraviolet frequencies which reach the earth from the sun, many biologists could not believe that living processes were capable of generating them. In Paris two researchers reported similar results; in Moscow one of Gurwitsch's own countrymen showed that he could increase the budding of yeast more than 25 percent by exposing it to "mitogenetic" rays from onion roots.

A pair of scientists at the Siemens and Halske Electric Company near Berlin came to the verdict that the radiation was a fact; and in Frankfort, a researcher actually succeeded in measuring it, not through its effect on vegetal life, but with electrical instruments. On the other hand, equally reliable Anglo-Saxon investigators could detect no effects. In the United States, when the prestigious Academy of Sciences issued a report that Gurwitsch's discovery was not replicable, and therefore strongly suggested it might be the product of his imagination, Gurwitsch was sped into limbo.

Though Lawrence lacked an ultraviolet spectrometer to detect "mitogenetic" radiation, he was fascinated by Gurwitsch's system of *directing* the energy. His observations also nudged Lawrence almost involuntarily to the position that there was a psychological, or "mental," factor involved in Gurwitsch's maverick work. Continuing to probe further with a sensitive high-impedance device of his own design, Lawrence sought to discover whether individual cells in a quarter-inch slice of onion, attached to a Wheatstone bridge and an electrometer, would react to various stimuli. He found that they seemed to respond to irritations such as a puff of smoke, or even to his mental image of their destruction, in about one hundred milliseconds, or one tenth of a second.

What seemed most odd to Lawrence was that the reaction of the onion tissue seemed to change depending on whether he, or someone else, was directing thought at it. People with "psychic gifts" seemed to elicit much stronger responses than the practical-minded Lawrence. As he commented: "If one can cause, or get something to cause, harm to a cell—assuming that the cell has a cellular consciousness—the reaction pattern in it will change from experimenter to experimenter."

About this time Lawrence came across Backster's work and decided to build a sophisticated psycho-galvanic analyzer or plant response detector. With his new equipment, Lawrence got a series of "wild" tracings from his plants; but, because of what he retrospectively calls his "ignorance and classical Prussian orthodoxy," he ascribed these effects to faults in his instrumentation. Nevertheless, his suspicion that plant tissues could pick up human thought and emotion slowly became more concrete in the light of Backster's achievements. Lawrence was reminded that years previously Sir James Jeans, the British astronomer, had written that "the stream of human knowledge is impartially heading toward a non-mechanical reality: the Universe begins to look more like a great *thought* than a great machine. Mind no longer appears as an accidental intruder into the realm of matter. We are beginning to suspect that we ought rather to hail it as the creator and governor of this realm."

In October of 1969, Lawrence began to publish a series of popular articles based on his reading and research, the first of which appeared as "Electronics and the Living Plant" in *Electronics World*. Lawrence told his readers that, for the first time in the millennia since the first green leaves poked their heads out of Paleozoic swamps, plants were at last beginning to be studied for their "electrodynamic properties."

Four main questions, said Lawrence, were starting to attract serious attention: Could plants be integrated with electronic readouts to form major data sensors and transducers? Could they be trained to respond to the presence of selected objects and images? Were their alleged supersensory perceptions verifiable? Of the 350,000 plant species known to science, which were the most promising from the electronic point of view?

Providing detailed instructions for investigating the behavior of living plant cells with microelectrodes, Lawrence also reported that in the "Moon Garden" developed by Republic Aviation at Farmingdale, New York, scientists had been able in the 1960s to induce what appeared to be "nervous breakdown" and "complete frustration" in plants being tested as possible space foods and that, even earlier, in his laboratory at East Grinstead, Sussex, England, L. Ron Hubbard, founder of Scien tology, had noted that plants dislike certain types of artificial light, such as the cold light emitted by sodium street lamps, which can cause them to come out in a cold sweat clearly visible on their foliage.

Lawrence warned his readers that work with plants was not just a matter of electronic expertise and that working with the Backster Effect involved much more than the mere ability to construct top-quality electronic equipment. "There are certain qualities here," he wrote, "which do not enter into normal experimental situations. According to those experimenting in this area, it is necessary to have a 'green thumb' and, most important, a genuine love for plants."

Half a year later Lawrence followed up his revelations with an even more controversial article in the same magazine, entitled "Electronics and Parapsychology." Lawrence's article began by asking: "Does man possess latent sensitivities that have been stifled by modern communications systems?" He then pointed out that although the fledgling science of parapsychology, long suspect because of an occult background, was having to fight for acceptance, the application of electronic instruments was permitting dramatic new experiments and bringing forth stunning discoveries which might rival the orthodox communications arts and sciences currently in use.

Stressing that the need for machine systems capable of testing ESP in an unbiased, impartial manner had been recognized fifty years ago, when an Italian scientist, Federico Cazzamalli, developed an ultra-high-frequency apparatus for testing human telepathy, Lawrence reported that the Italian's experiments had never been repeated because the Fascist dictator Benito Mussolini had declared the work secret.

A fascinating offspring of Cazzamalli's ideas and machine, continued Lawrence, is an apparatus called the "Integratron," researched by George W. van Tassel, a self-taught inventor living in Yucca Valley, California, not far from the Giant Rock airport. Developed over twenty years, and still under construction, van Tassel's contrivance is housed in a non-metallic domelike structure thirty-eight feet high and fifty-eight feet in diameter, which looks like an astronomical observatory. It is an electrostatic, magnetic generator with armatures over four times larger than any others in existence. The *Proceedings* of van Tassel's College of Universal Wisdom state that the fields generated by his machine encompass its entire structure and this is why the dome contains no nails, bolts, or metal but is held together like a Chinese puzzle and is six times stronger than the commercial building code requires. When completed it promises, says van Tassel, not only to help solve the problem of extraterrestrial communication, but to afford such possibilities as rejuvenation of body cells, an antigravity force, and the ultimate of psychic experiences: time travel.

What puzzles orthodox scientists and makes skeptics of many of them is a lack of any working theory to cover this kind of phenomenon. One scientist, Dr. W. G. Roll, in his presidential address to the 7th Annual Convention of the Parapsychological Association held in Oxford, England, in 1964, postulated "psi-fields," which might be analogous to electromagnetic or gravitational fields, possibly possessed by all objects, living and nonliving, which could react with known physical fields and with one another. Another theory, put forward by Dr. G. D. Wasserman at the Ciba Foundation Symposium in 1956, leans on quantum mechanics. Wasserman suggests that "psi-fields," which enable persons to have paranormal experiences, are due to the reception of inconceivably small "quanta of energy," far more minute than those which can be absorbed by matter fields of classical physics.

The Backster Effect and other related considerations, says Lawrence, "lead to the idea that psi is but a part of a so-called 'paranormal matrix' —a unique communications grid which binds all life together. Its phenomena apparently work on a multi-input basis which operates beyond currently known physical laws." Within this framework, says Lawrence, plants, after sensitization or conditioning by their owners can reach a state of communication in which they are able to react to their owners' emotions or states of mind even when they are far away.

In the June, 1971, issue of *Popular Electronics,* Lawrence provides any researcher wishing to investigate communication with plants with detailed diagrams and a parts list for a "response detector" allowing for extremely sensitive tests.

Warning that constant repetition was an important factor in such testing, Lawrence stated that if a plant specimen is stimulated continuously, badly injured, or infrequently watered, it would tire quickly, or even lapse into shock and die. Researchers were therefore cautioned to be gentle with their plants and allow them to recuperate after experimentation. The area in which plants live must be quiet, added Lawrence, "so that the stimuli can be effectively applied with a minimum of power-line noise or disturbances from radio-frequency transmission to cause faulty indications."

Lawrence's ideas about plants were corroborated and elaborated by the experience of a Czech publisher and student of physiological psychology, Jan Merta, now living in Canada, whose psychic gifts allow him to plunge an iron bar into a blacksmith's forge, heat it to incandescence, then calmly brush sparks off its white-hot end with his bare hand as easily as he would rub dust from a shelf.

Freshly settled in Canada, Merta supported himself for two months by working as a troubleshooter for a large Montreal grower and importer of tropical plants. When clients in office and residential buildings complained that their plants were getting sick, Merta was sent to ascertain the trouble. Because he also took care of thousands of plants in the firm's extensive greenhouses, Merta noticed that the effects of loneliness produced when a plant is taken away from hundreds of its friends often caused it such a shock that it would pine, even die; however, when returned to the greenhouse, it immediately perked up and regained its normal green health.

As the result of hundreds of "house calls," Merta noticed that plants throve better when constantly communicated with by office workers and home owners than if left to themselves. Examples of the majestic *Ficus benjamini,* nearly thirty feet tall, transported from Florida, though in excellent condition upon arrival, when placed around a fountain in a shopping center's indoor circular solarium started to wilt within two days in spite of careful watering and feeding. Yet those in heavily traveled passageways leading to the solarium retained their radiant vigor. To Merta this was a sure sign that the *Ficus* enjoyed being admired by the passers-by.

In 1970, when Lawrence read that in the Ukraine radio frequencies and ultrasonic vibrations had been used to stimulate cereal grain seeds to produce higher yields as far back as the early 1930s and that the United States Department of Agriculture had successfully experimented in the same way, he gave up his college position and set about independently developing advanced equipment with which he hopes that seed grains can be provoked, on a commercial scale, to grow better and faster. "If a plant seedling can be stimulated on a parapsychological basis, as the famous plant breeder Luther Burbank knew, then I don't see why," says Lawrence, "we can't transmit specific signals to whole fields of crops to stimulate their growth without all these damned soil-killing fertilizers."

In the February, 1971, issue of *Popular Electronics* Lawrence presented his own experimental arrangement to test his theories about stimulating plant growth in an extremely high-voltage electrostatic field. It is the invention and use of cheap chemical fertilizers, he asserted, which has suppressed the ideas of countless engineers about how to nourish plants electrically. With nitrate pollution from these fertilizers threatening the world's ecological panorama and its water supply, he urges that these ideas be revived.

Acting on his own advice, Lawrence is working up patent applications on special sound-type plant stimulation techniques, which he is combining with Backster Effect methods in order to stimulate his plants in a wireless fashion. This effort has turned Lawrence the engineer into Lawrence the philosopher. "There was a time, when I was a child, when the whole world seemed alive and knowing," he wrote in *Organic Gardening and Farming*. "Trees were friends and as George Eliot put it: 'Flowers see us and know what we're thinking about.' Then came a time when plants just grew, silently and without emotion. But today, I'm entering a second childhood, as least as far as plants are concerned."

Lawrence, torn between his interest in stimulating plant growth electrically and his projects to achieve interstellar communication, feels that the effort to contact extraterrestrial life is more important in the long run because "if routine results can be achieved in CETI, many questions attached to riddles in the plant kingdom will be answered as a consequence.

On June 5, 1973, the research division of Anchor College of Truth in San Bernardino announced that it was inaugurating the world's first biological-type interstellar communications observatory under the direction of L. George Lawrence, now also a vice-president of Anchor. For the new research program Lawrence has designed what he calls a Stellartron, which combines in one three-ton instrument the features of a radio telescope and the biological signal-receiving system of the biodynamic field station.

Anchor president, Ed Johnson, told the press that since radio astronomy had failed to detect intelligent signals from space, the college was backing Lawrence's idea that radio transmission was out of date and that biological communication should be given a trial.

Pointing out that in our own galaxy alone there are some 200 billion stars, Lawrence says that if one assumed each of them to have at least five companion planets, a total of one trillion might consequently be available for study. Even if only one planet in a thousand has intelligent life this would amount to one billion in our galaxy alone. Multiplied by the ten billion galaxies believed to comprise the observable universe, then there may be 10,000,000,000,000,000,000 planets capable of sending some kind of signal to Earth.

Anchor's founder, Reverend Alvin M. Harrell, thinks that contact with another race in the universe will trigger a tremendous explosion of knowledge. As Harrell says: "Given the destructive brutality of humankind, we may expect any newly discovered civilization to be infinitely more loving and compassionate than we are."

"Perhaps plants are the true extraterrestrials," Lawrence observes, "for they converted an early mineral world into a habitat suitable for man by processes that border on near-perfect magic! What remains to be done now is to remove all traces of occultism and make plant response, including communications phenomena, a verifiable component of orthodox physics. Our instrumentation concepts reflect this effort."

If Lawrence is on the right track, the ardently desired prospect of producing hardware to move man into the vastness of interstellar space on Columbian voyages of discovery will be rendered as obsolete as Columbus's flagship, *Santa Maria*. Lawrence's research, suggesting as it does that intelligences are communicating instantly across distances requiring millions of light-years to reach, indicates that what is needed is not spaceships but the proper "telephone numbers" to contact them. Though the work is still in an exploratory stage, his biodynamic field station may be a step toward plugging into the universal switchboard, with plants as the pretty, cheerful and efficient co-operators.

CHAPTER 5

Latest Soviet Discoveries

In Russia, millions of newspaper readers were introduced to the ideas that plants communicate their feelings to man in October, 1970, when *Pravda* published an article entitled "What Leaves Tell Us."

"Plants talk . . . yes, they scream," declared the official organ of the Communist party. "It only *seems* that they accept their misfortunes submissively and silently bear pain." *Pravda*'s reporter, V. Chertkov, tells how he witnessed these extraordinary goings-on in Moscow when he visited the Laboratory for Artificial Climate at the renowned Timiryazev Academy of Agricultural Sciences.

Before my eyes a barley sprout literally cried out when its roots were plunged into hot water. True, the plant's "voice" was registered only by a special and extremely sensitive electronic instrument which revealed a "bottomless vale of tears" on a broad paper band. As though it had gone crazy, the recording pen wriggled out on the white track the death agony of the barley sprout, although, to look at the little plant itself, one would never have guessed what it was going through. While its leaves, green as ever, stood upright, the plant's "organism" was already dying. Some kind of "brain" cells within it were telling us what was happening.

Pravda's reporter also interviewed Professor Ivan Isidorovich Gunar, head of the academy's Department of Plant Physiology, who, together with his staff, had performed hundreds of experiments, all of which confirm the presence of electrical impulses in plants similar to the well-known nerve impulses in man. The *Pravda* article noted that Gunar talked about plants as he would about people, distinguishing their individual habits, characteristics, and proclivities. "He even appears to converse with them," Chertkov wrote, "and it seems to me that his plants pay attention to this good, graying man. Only persons invested with certain power are like this. I have even been told of a test pilot who talked to his misbehaving airplane, and I myself have met an old captain who talked with his ship."

When Gunar's chief assistant, Leonid A. Panishkin, a former engineer, was asked by the *Pravda* reporter why he gave up the technology in which he was trained in order to work in Gunar's laboratory, he replied: "Well, there I used to be involved with metallurgy; here there is life." He was echoed by another young laboratory worker, Tatiana Tsimbalist, who affirmed that since she had come to work with Gunar she had "learned to look at nature with different eyes."

Panishkin said he was particularly interested in searching out those conditions which might best suit the specific needs of plants and how "our green friends"—as the *Pravda* reporter termed them—react to light and darkness. By using a special lamp which shone with the same intensity as the sun's rays reaching earth he had found that plants tired in an overextended day and needed rest at night. He hoped that it might one day be possible for plants to turn lights on or off in a greenhouse at will: "a live electric relay."

The studies of the Gunar team may open up new vistas in plant breeding, since in their laboratory it has been found that individual plants more resistant to heat, cold, and other climatological factors can be "selected" within minutes by testing them with their instruments, although these qualities have heretofore taken geneticists years to establish.

In the summer of 1971, an American delegation from the Association for Research and Enlightenment (ARE), founded by the seer and healer Edgar Cayce at Virginia Beach, Virginia, visited Russia. The Americans —four medical doctors, two psychologists, one physicist, and two educators—were shown a film by Panishkin entitled *Are Plants Sentient?* The film demonstrated effects produced on plants by environmental factors such as sunlight, wind, clouds, the dark of night, the tactual stimulus from flies and bees, injuries produced by chemicals and burning, and even the very proximity of a vine to a structure to which it might cling. The film showed further that the immersion of a plant in chloroform vapor eliminates the characteristic biopotential pulse normally apparent when a leaf is given a sharp blow; it also indicated that the Russians are now studying the characteristics of these pulses to establish the relative degree of a plant's health.

One of the American doctors, William McGarey, head of the ARE medical research center in Phoenix, Arizona, stated in his report that the intriguing part of the movie was the method used to record the data. Time-lapse photography made the plants seem to dance as they grew. Flowers opened and closed with the coming of darkness as if they were creatures living in a different time zone. All injury-induced changes were recorded by a sensitive polygraph attached to the plants.

In April, 1972, *Weltwoche*, a Swiss newspaper published in Zurich, came out with an account of both Backster's and Gunar's work which it said had taken place simultaneously and independently. That same week the Swiss article was translated into Russian in a weekly review of the foreign press, *Za Rubezhom* (*Abroad*) published in Moscow by the USSR's Union of Journalists, under the caption: "The Wonderful World of Plants." These scientists, said the Russian version, are "proposing that plants receive signals and transmit them through special channels to a given center, where they process the information and prepare answering reactions. This nervous center could be located in root tissues which expand and contract like heart muscle in man. The experiments showed that plants have a definite life rhythm and die when they don't get regular periods of rest and quiet."

The *Weltwoche* article also caught the attention of the editors of the Moscow newspaper *Izvestiya,* who assigned their reporter M. Matveyev to do a story for the paper's weekly magazine supplement. Though the newsman referred to Backster's suggestion that plants might have memory, language, and even rudiments of altruism, he strangely omitted Backster's most startling discovery, that his philodendron had perceived his *intent* to harm it.

Deciding (the *Izvestiya* reporter told his readers) that a "sensation was being propagated in Western newspapers," Matveyev traveled to Leningrad, where he interviewed Vladimir Grigorievich Karamanov, director of the Laboratory of Biocybernetics of the Institute of Agrophysics, in order to get an authoritative opinion.

The Institute of Agrophysics was founded over forty years ago at the behest of the renowned solid-state physicist, Academician Abram Feodorovich Ioffe, who became particularly interested in the practical application of physics to the design of new products, first in industry, then in agriculture. After the institute opened its doors, Karamanov, then a young biologist, was inspired by Ioffe to familiarize himself with the world of semiconductors and cybernetics and, in due course, began building microthermistors, weight tensiometers, and other instruments to register the temperature of plants, the flow rate of fluid in their stems and leaves, the intensity of their transpiration, their growth rates, and characteristics of their radiation. He was soon picking up detailed information on when and how much a plant wants to drink, whether it craves more nourishment or is too hot or cold. In the first issue of *Reports of the USSR Academy of Sciences* for 1959, Karamanov published "The Application of Automation and Cybernetics to Plant Husbandry."

According to the *Izvestiya* reporter, Karamanov showed that an ordinary bean plant had acquired the equivalent of "hands" to signal an instrumental brain how much light it needed. When the brain sent the

"hands" signals, "they had only to press a switch, and the plant was thus afforded the capability of independently establishing the optimal length of its 'day' and 'night.' " Later, the same bean plant, having acquired the equivalent of "legs," was able instrumentally to signal whenever it wanted water. "Showing itself to be a fully rational being," the account continued, "it did not guzzle the water indiscriminately but limited itself to a two-minute drink each hour, thus regulating its water need with the help of an artificial mechanism.

"This was a genuine scientific and technical sensation," concluded the *Izvestiya* reporter, "a clear demonstration of twentieth-century man's technical abilities."

Asked whether he thought Backster had discovered something new, Karamanov somewhat condescendingly replied: "Nothing of the sort! That plants are able to perceive the surrounding world is a truth as old as the world itself. Without perception, adaptation does not and cannot exist. If plants had no sense organs and didn't have a means of transmitting and processing information with their own language and memory, they would inevitably perish."

Karamanov, who throughout the interview made not a single comment on plants' ability to perceive human thought and emotion—Backster's really sensational discovery—and seemed oblivious of Backster's success in getting his philodendron to recognize a "plant assassin," rhetorically asked the *Izvestiya* reporter: "Can plants discern shapes? Can they, for instance, differentiate a man causing them hurt from another who waters them?" Replying to his own question, while at the same time putting Backster into what he considered to be a proper perspective for Soviet readers, Karamanov said: "Today I cannot answer such a question. And not because I doubt that Backster's experiments were immaculately set up and repeatedly performed, though perhaps a door slammed, or a draft wafted into the room, or something else. The fact is that neither he, nor we, nor anyone else in the world is yet ready to decipher *all* plant responses, hear and understand what they 'say' to one another, or what they 'shout' at us."

Karamanov also predicted that in the long run it would be possible cybernetically to direct all the physiological processes of plants not, as he put it, "for the sake of sensation, but for the advantage of plants themselves." When plants are able to auto-regulate their environment and establish optimal conditions for their own growth with the help of electronic instruments, said Karamanov, this should be a long step toward larger harvests of cereal grains, vegetables, and fruits. Making clear that the achievements were not just around the corner, Karamanov added, "We are not still learning to talk with plants and understand their peculiar language. We are working out criteria which will help us to control the life of plants. Along this difficult but fascinating road, a multitude of surprises still await us."

The *Izvestiya* article was followed that summer by a story in the monthly magazine *Nauka i Religiya* (*Science and Religion*), which has the dual aim of putting forward the latest findings in world science while at the same time playing down—in a section headed "The Theory and Practice of Atheism"—the church-defended notion of a spiritual world hierarchically beyond that of man.

The article's author, engineer A. Merkulov, going further than the *Izvestiya* weekend supplement, recounted how the plant of the "American criminologist" Backster had not only responded to the scalding death of brine shrimp but also to the killer of its vegetal neighbor. Such response to people's moods, added Merkulov, had also been detected at the state university in Alma Ata, capital of the Soviet Kazakh Republic, the apple orchard of the Soviet Union. There scientists have found that plants repeatedly react to their owners' illnesses and to their emotional states.

Noting that plants had long ago been shown to have "short-term memory," Merkulov said that this fact too had been confirmed by the Kazakh scientists. Beans, potatoes, wheat, and crowfoot (*Ranunculus*) after proper "instruction" seemed to have the capability of remembering the frequency of flashes from a xenon-hydrogen lamp. The plants repeated the pulsations with what Merkulov called "exceptional accuracy," and since crowfoot was able to repeat a given frequency after a pause as long as eighteen hours it was possible to speak of "long-term" memory in plants.

The scientists next went on, according to Merkulov, to condition a

philodendron to recognize when a piece of mineralized rock was put beside it. Using the system developed by Pavlov with dogs, whereby he discovered the "conditioned reflex," the Kazakh scientists simultaneously "punished" a philodendron with an electrical shock each time a mineralized ore was placed next to it. They reported that, after conditioning, the same plant, anticipating the hurtful shock, would get "emotionally upset" whenever the block of ore was put beside it. Furthermore, said the Kazakh scientists, the plant could distinguish between mineralized ore and a similar piece of barren rock containing no minerals, a feat which might indicate that plants will one day be used in geological prospecting.

Merkulov concluded his reportage with the idea that the *control* of all processes in plant growth was the ultimate goal of all the new experimentation. In an institute of physics in the Siberian city of Krasnoyarsk, he wrote, "Physicists are even now regulating the growth of a monocellular seaweed, *Chlorella*. Experiments are continuing and becoming increasingly complex, and there is no doubt that in the not-distant future scientists will be able to control the growth, not only of the simplest, but of higher plants."

Merkulov beguiled his readers with the idea that this control might well be possible over great distances. "By studying how to 'understand' plants," he prophesied, "man may create automatic contrivances which themselves will watch over fields in such a way that, at any given moment, they can satisfy the every need of crops. The day is not far away when scientists will also work out a theory on the adaptation and resistance of plants to unpleasant conditions in their environment which will encompass how they react to irritants, and to stimulators and herbicides as well."

Toward the end of 1972 Soviet readers were given more food for thought in an article "Flower Recall" published in the popular color-illustrated *Znaniya Sila* (*Knowledge Is Power*), one of the many magazines issued by the Knowledge Society, the leading organization for popular science in the USSR. This time its author was not a news-hungry journalist or an inspired engineer but a professor and doctor of psychological sciences, V. N. Pushkin. Far from suggesting that the

American criminologist Backster had really not discovered anything new, Pushkin began with a complete description of Backster's shrimp experiment. He then let his readers in on the fact that one of his young colleagues, V. M. Fetisov, had made him aware of Backster's accomplishments in the first place, and had been so determined to work with the Backster Effect that he had persuaded Pushkin to take part in the experiments. Fetisov brought an ordinary potted geranium from his home and attached it to an encephalograph.

As Fetisov was making his first attempts to get a response from his pet plant, Georgi Angushev, a Bulgarian student working up a dissertation in psychology at the Lenin Pedagogical Institute in Moscow, heard about the Fetisov-Pushkin experiments and came to their laboratory to see what was going on. Pushkin described Angushev as a talented researcher with many qualities, the most important of which to their "psycho-botanical experiments," as he termed them, was the fact that the Bulgarian was an excellent hypnotist.

Fetisov and Pushkin surmised that a hypnotized person should be able to send emotions to a plant more directly and spontaneously than a person in a normal state. Hypnotizing a young girl by the name of Tanya, who was described by Pushkin as of "lively temperament and spontaneous emotionality," they first implanted in her the notion that she was one of the most beautiful women in the world, then the notion that she was freezing in harsh raw weather. At each change in the girl's mood the plant, which was attached to an encephalograph, responded with an appropriate pattern on the graph. "We were able," says Pushkin, "to get an electrical reaction as many times as we worked, even to the most arbitrary commands."

To obviate criticism that the plant's response was only the result of chance events taking place in the room, the Muscovite psychologists switched on their encephalograph and let it run for long periods between their experiments. But the instrument never registered any reaction of the kind evoked in the plant by the emotions suggested to a hypnotized subject.

Pushkin and Fetisov decided to see whether the plant could detect a lie, as Backster had claimed. It was suggested to Tanya that she think

of a number from 1 to 10. At the same time she was told she would never reveal the number, even if pressed to do so. When the researchers counted slowly from 1 to 10, pausing after each digit to inquire whether it was the one she had thought of, each time Tanya responded with a decisive "No!" Though the psychologists could not see any difference in her answers, the plant gave a specific and clear reaction to her internal state when the number 5 was counted. It was the number which Tanya had selected and promised not to reveal.

In his conclusion Pushkin stated that he felt strongly that by pursuing the course initiated by Backster it might be possible to make advances into the thorny problem of the human brain's functioning, which Pavlov over half a century ago had called the "crown of earthly nature." Seizing the opportunity for a political remark, Pushkin reminded those who might look askance at his and Fetisov's new research that at the opening of Moscow Institute of Psychology in 1914 Pavlov had declared that the task of unlocking the mysteries of the brain and its activity was "so unexpressibly enormous and complex that it depends on the totality of thought's resources, namely, complete freedom, and bold deviation from set patterns of research."

Using Pavlov as a shield against what he obviously thought would be attacks from his professional colleagues, Pushkin stressed that the renowned physiologist's statement was as up to date in 1972 as when he had made it. Lest his message not ring clear, he added: "Experience in the development of natural sciences, especially physics, has shown that one should not fear new discoveries, however paradoxical they might seem at first glance."

In his conclusion, the Moscow professor speculated that vegetal cells in the flower react to processes taking place in the nervous system of human subjects or in what is vaguely referred to as their "emotional states." Seeking a meaning for the flower's reaction, Pushkin wrote: "Perhaps between two informational systems, the plant cells and the nervous system, a specific link exists. The language of the plant cell may be related to that of the nerve cell. These wholly different living cells seemed to be able to 'understand' one another."

Pushkin further theorized that in the cells of a flower there take place processes somehow related to mentation and asserted that man's psyche—a word which he says is as yet entirely undefined even by the "ologists" of his own discipline—and the perception, thought, and memory connected to it are all just a specialization of processes existing at the level of vegetal cells.

Pushkin asserts that this conclusion is most important since it will open new thinking about the origin of the nervous system. Noting that in the development of science many different answers have been proposed for what constitutes the actual informational material in human thought, Pushkin skipped lightly over various theories, ranging from the one that holds nerve cells to be elements of a living cybernetic computer to the one which claims that not the cells but the molecules of matter within them may be the basic informational units.

"What is actually irritating the flower?" asked Pushkin, then answered that it might turn out to be some kind of biophysical structure, the ejection of which beyond the confines of the human organism takes place the moment a marked emotional state is reached and carries information about the person from whom it is ejected. Whatever the truth may turn out to be, continued Pushkin, one thing is sure: "Research into the plant and man interrelationships can shed light on some of the most urgent problems in contemporary psychology."

The magic and mystery of the world of plants lying behind these scientific doings have also recently become the subject of a new book entitled *Grass* by a popular slavophile writer, Vladimir Soloukhin, which appeared in four issues of the three-million-circulation magazine *Nauka i Zhizn (Science and Life)* at the end of 1972. Born a country boy in a village outside the ancient city of Vladimir in northern Russia, Soloukhin became fascinated with the *Pravda* account of Gunar's work and wondered why it had not evoked more excitement among his fellow Russians.

"Perhaps the elements of memory in plants are superficially treated," he writes, "but at least there they are in black and white! Yet no one calls his friends or neighbors, no one shouts in a drunken voice over the telephone: Have you heard the news? Plants can feel! They can feel pain! They cry out! Plants remember everything!"

When Soloukhin began to telephone his own friends in excitement he learned from one of them that a prominent member of the Soviet Academy of Sciences, working in Akademgorodok, the new town inhabited almost exclusively by research scientists on the outskirts of Siberia's largest industrial center, Novosibirsk, had stated:

> Don't be amazed! We too are carrying out many experiments of this kind and they all point to one thing: plants have memory. They are able to gather impressions and retain them over long periods. We had a man molest, even torture, a geranium for several days in a row. He pinched it, tore it, pricked its leaves with a needle, dripped acid on its living tissues, burned it with a lighted match, and cut its roots. Another man took tender care of the same geranium, watered it, worked its soil, sprayed it with fresh water, supported its heavy branches, and treated its burns and wounds. When we electroded our instruments to the plant, what do you think? No sooner did the torturer come near the plant than the recorder of the instrument began to go wild. The plant didn't just get "nervous"; it was afraid, it was horrified. If it could have, it would have either thrown itself out the window or attacked its torturer. Hardly had this inquisitor left and the good man taken his place near the plant than the geranium was appeased, its impulses died down, the recorder traced out smooth—one might almost say tender—lines on the graph.

In addition to a plant's ability to recognize friend and foe, Soviet researchers also noted that one plant supplied with water can somehow share it with a deprived neighbor. In one institute of research a cornstalk planted in a glass container was denied water for several weeks. Yet it did not die; it remained as healthy as other cornstalks planted in normal conditions nearby. In some way, say Soviet botanists, water was transferred from healthy plants to the "prisoner" in the jar. Yet they have no idea how this was accomplished.

As fantastic as this may seem, a kind of plant-to-plant transfer has been taking place in England in experiments begun in 1972 by Dr. A. R. Bailey. Two plants in an artificially lit greenhouse in which temperature, humidity, and light were carefully controlled were suffering from lack of water. Bailey and his collaborator measured the voltages generated between two parts of both plants. When one plant was watered from the outside through plastic tubes, the other plant reacted. As Bailey told the British Society of Dowsers: "There was no electrical connection between them, no physical connection whatsoever, but somehow one plant picked up what was going on with the other."

Soloukhin, in his book *Grass,* the title of which conveys, as with Carl Sandburg, Walt Whitman, or Pete Seeger, the most extended meaning of the word "grass," or indeed everything growing, took to task the lack of sensitivity to the vegetal world around them on the part of the Soviet populace. Targets of his criticism included agricultural bureaucrats, individual collective farmers, lumber executives, and even salesgirls in Moscow flower shops.

"Human observation," writes Soloukhin ironically in the opening chapter of *Grass,* "is so precise that we begin to notice the very air we breathe only when it is insufficient for our needs. More exactly, I should say 'value' rather than 'notice.' We do not really value air, or even think about it, so long as we can breathe normally, without difficulty." He adds that, though man prides himself on his vast array of knowledge, he is like a radio technician who knows how to repair a receiver without understanding the theoretical essence of radio waves, or like our cavemen ancestors who put fire to use while unaware of the process of rapid oxidation. Even today, says Soloukhin, we squander heat and light yet have not the slightest clue to, or interest in, their original essence.

Man is equally callous, says Soloukhin, about the fact that the land around him is green. "We trample grasses into dirt, we strip the land with bulldozers and caterpillar treads, we cover it with concrete and hot asphalt. Disposing of wastes from our infernal industrial machines we dump upon it crude oil, rubbish, acids, alkalis, and other poisons. But is there that much grass? I, for one, can imagine man in a boundless, grassless wilderness, the product of a cosmic, or perhaps humanly noncosmic, catastrophe."

Seeking to re-evoke wonder for nature in the hearts of an overurbanized Soviet youth, Soloukhin tells the story of a prisoner who, incarcerated in a dank cell, finds among the pages of an old book, given him by a kindly jailer, a tiny seed smaller than a pinhead. Overcome with emotion at the first visible sign of real life he has seen for years, the prisoner imagines that the microscopic seed is all that remains from the

former luxuriant and festive plant kingdom in the great world outside the prison. Planting the seed in a bit of earth in the sole corner of the cell afforded a ray of sunlight, and watering it with his tears, the prisoner waits for a wonder to unfold.

Soloukhin accepts this wonder as a true miracle ignored by man only because it is repeated thousands of billions of times daily. Even if all the world's chemical and physical laboratories with their complex reagents, precise analyses, and electronic microscopes were placed at the prisoner's disposal, he continues, even if the prisoner studied the seed's every cell, atom, and atomic nucleus, he still would not be able to read the mysterious program lying within the seed, to lift the impenetrable veil which could cause it to transform itself into a juicy carrot, a branch of sweet-scented dill, or a radiant-colored aster.

Soloukhin was fascinated with the statement by I. Zabelin, doctor of geographical sciences and Moscow University professor, who in his article "Dangerous Delusions" in one of the USSR's leading opinion forums, *Literaturnaya Gazetta,* wrote: "We are only beginning to comprehend the language of nature, its soul, its reason. The 'inner world' of plants is hidden from our gaze behind seventy-seven seals." Though these lines were in no way emphasized in the printed column, says Soloukhin, "they appeared to me as bold-face type."

During a trip to Paris, Soloukhin was happy to observe florist shops scattered in all, and even the poorest, districts of the French capital. Finding a decent bouquet of flowers in the Soviet capital, he says, can become the object of a day-long search.

Soloukhin has recently attacked the obtuse views of Soviet agricultural officials. Writing in the October, 1972, issue of *Literaturnaya Gazetta,* he deplores the abandon with which generations-old natural Russian meadowlands have been allowed to deteriorate while fields needed for cereal crops are being plowed and planted to grasses for animal fodder. "We could cover Europe with hay and green grass from our meadows and build a haystack extending from the Mediterranean to Scandinavia," writes Soloukhin. "Well, why don't we?" His rhetorical question only provoked an angry rebuttal from the USSR's Deputy Minister of Agriculture, who insisted on upholding the status quo.

In a battle similar to that taking place in the United States and other countries, Soloukhin is unremittingly denouncing unecologically minded industrialists in his country, who are turning the rivers and lakes into cesspools, and despoiling its forests, all in the name of increased production. Seeking to reverse a half century of Communist dicta, this "passionate lover of nature, its defender and bard"—to quote one of Soloukhin's publishers—exhorts his countrymen to cooperate with, rather than subdue, nature.

That the Soviets are bent on introducing the idea of substituting for the burning of coal, oil, and natural gas—three forms of preserved solar energy originally captured by plants—new, more direct, and pollution-free ways to tap the sun was revealed by an article in the first 1973 issue of *Khimiya i Zhizn (Chemistry and Life).* The article pointed to the research of the American Nobel Prize winner Melvin Calvin in photosynthesis, wherein he discovered that plant chlorophyll under the influence of the sun's rays can give up electrons to a semiconductor such as zinc oxide. Melvin and his co-workers created a "green photoelement," which produced a current of approximately 0.1 microamperes per square centimeter. After several minutes, said the Soviet magazine, the plant chlorophyll becomes desensitized or "exhausted," but its life could be extended by the addition of hydroquinone to the salt solution which acts as an electrolyte. The chlorophyll seems to act as a kind of electron pump passing electrons from the hydroquinone to the semiconductor.

Calvin has calculated that a chlorophyll photoelement with an area of ten square meters could yield a kilowatt of power. He has theorized that in the next quarter century such photoelements could be manufactured on an industrial scale and would be a hundred times cheaper than silicone solar batteries now being experimented with.

Even if the direct conversion of sunlight into energy via plant chlorophyll is not realized by the year 2000, says *Chemistry and Life,* it wouldn't put too much of a burden on man to wait a few decades longer when he considers the millions of years it took to convert plants into coal.

As Soviet readers were being offered the notion that plants could one day directly produce energy for man's needs from the sun, Professor Gunar, together with an increasing number of young Soviet scientists,

was continuing to probe the awareness of plants to determine, for instance, how their reactions may serve as an index of frost, cold, and heat resistance in varieties of barley and cucumbers and of disease potentials in potatoes.

A clue to where Professor Gunar got the original inspiration to launch his series of detailed and ongoing studies on plants, which were to have such repercussions throughout the Soviet republics, is to be found in an article published in 1958 by A. M. Sinyukhin. This colleague of Gunar's refers to an outstanding Indian physiologist and biophysicist whose work was buried during his lifetime by Western science and hardly ever cited since his death. As early as 1920 Kliment Arkadievich Timiryazev, in whose honor the Moscow Agricultural Academy is named, heralded this work as introducing a new epoch in the development of world science. This unheralded genius, wrote Timiryazev, developed an apparatus, startling in its simplicity and sensitivity, to counter the entrenched idea of the German botanists that communication in plant tissue was simply hydrostatic. In so doing, he was able to measure in hundredths of a second the time needed for a signal to travel along the stems of various plants.

Sinyukhin made clear that the USSR's plant men were so impressed by the achievements of this Indian scientist that they were going to mount a research campaign based directly upon his long-ignored conclusions. In December, 1958, a pontifical meeting was held in the main conference hall of the USSR Academy of Sciences in celebration of the hundredth anniversary of the Indian sage's birth. Three leading academicians summed up for the huge crowd assembled the fantastic breakthroughs which the Indian had made not only in plant physiology but in physics and in the vital and up to then unheard-of links between these distinct disciplines.

"Many years, during the course of which whirlwind developments have taken place in biophysics," said A. V. Lebedinskii, one of the leading Russian pioneers in radiobiology and space medicine, "separate us from the time this Indian's work appeared. But, reading his works today, one still senses in them an unexpected and fruitful source of a whole chain of ideas in contemporary science."

In this great work, said another speaker, "The green world of plants, seeming to us so immobile and insensitive, came miraculously to life and appeared no less, and often even more, sensitive than animals and man."

Six years later the Soviet Union honored this neglected scientist by publishing in two handsomely illustrated volumes his selected works, together with copious commentaries including one entire book which had first made its appearance over half a century before, in 1902: *Response in the Living and Non-Living.* In these works Sir Jagadis Chandra Bose managed to accomplish the essential requirement of the twentieth century: an amalgamation of the wisdom of the ancient East with the precise scientific techniques and language of the modern West.

PART II

PIONEERS OF PLANT MYSTERIES

CHAPTER 6

Plant Life Magnified 100 Million Times

On the eastern coast of the subcontinent of India, in the old state of Bengal, there stands on four acres of ground off the Acharya Prafullachandra Road, north of Calcutta University, a complex of buildings made of fine grayish and purple sandstone in the classical design of pre-Mohammedan India. The main edifice, known as the Indian Temple of Science, bears an inscription: "This temple is dedicated to the feet of God for bringing honor to India and happiness to the world."

Just inside the entrance are glass cases containing a series of intriguing instruments devised more than fifty years ago to measure the growth and behavior of plants, down to their minutest detail, by magnification of these processes up to 100 million times. The instruments stand in their cases, in mute testimony to the genius of a great Bengali scientist whose work united in one man the fields of physics, physiology, and psychology, and who found out more about plants than anyone before and perhaps after him, but who remains almost unmentioned in classical histories of subjects in which he specialized.

The buildings and their gardens are the Institute of Research built by Sir Jagadis Chandra Bose, of whose work in the field of plant physiology the *Encyclopaedia Britannica* could only say, nearly half a century after his death, that it was so much in advance of his time it could not be precisely evaluated.

When Bose was still a child, his father had already painfully discerned in 1852 the main impact of the British education system on Indian children: the imposition of a slavish and monotonous imitation of all things Western and the requirement to learn by rote. The senior Bose, therefore, sent his son to a simple village *pathasala* rather than a colonial primary school.

At the age of four the boy was carried to his classroom on the shoulders of a reformed gang robber, or *dacoit,* who could find employment after a long jail term with no one but Bose's father. From this *dacoit* the boy absorbed stories of savage battles and adventurous escapades, but was also exposed to the natural goodness of a man who had been befriended after being rejected by society as a criminal. "No nurse," Bose wrote in his later life, "could have been kinder than this leader of lawless men. Though he scoffed at the juridical strictures of society, he had the deepest veneration for natural moral law."

Bose's early contacts with the peasantry also were crucial to his own appreciation of the world. Much later he told an academic gathering: "It was from those who till the ground and make the land blossom with green verdure, from the sons of fisher-folk who told stories of the strange creatures that frequented the depths of mighty rivers and of stagnant pools, that I first derived a lesson of that which constituted true manhood. From them, too, I drew my love of nature."

When Bose graduated from St. Xavier's College, his brilliant teacher Father Lafont was so impressed by the young man's aptitude in physics and mathematics that he wanted him to go to England and read for the Civil Service examinations. Bose's father, who had personally experienced the deadening nature of that profession, advised his son to become, not an administrator, but a scholar, with the prospect of ruling nobody but himself.

At Christ College Bose was taught physics, chemistry, and botanical sciences by such luminaries as Lord Rayleigh, discoverer of argon in the air, and Francis Darwin, son of the evolutionary theorist. Having passed his tripos examinations, Bose went on to take a bachelor's degree in science the following year at London University. But when Bose was appointed professor of physics at Calcutta's Presidency College, reputedly the best in India, the appointment was protested by the college's principal and by the director of Bengal's public instruction, who maintained the all too usual view that no Indian was competent to teach science.

To get back at Bose for being recommended over their heads by a letter from the Postmaster General to the Viceroy, they offered him a special appointment at a salary only half that of the English professors, and gave him no facilities to carry on research. In protest Bose refused to touch his monthly salary check for three years, which obliged him to live in bitter deprivation, the more so as his father had fallen heavily into debt.

That Bose was brilliant as a teacher was attested by the fact that no roll call had to be instituted in his classroom, which was always packed to the walls. Bowing to his obvious talents, the authorities who had snubbed him finally gave him a position at full pay.

Although Bose had no resources other than his own salary, a twenty-square-foot room to serve as a laboratory, and an illiterate tinsmith whom he trained as his mechanic, he began work in 1894 to see if he could improve the instruments recently devised by Heinrich Rudolph Hertz to transmit "Hertzian" or radio waves through the air. Hertz, who died that same year at the premature age of thirty-seven, had startled the world of physics by fulfilling in his laboratory the prediction of the Scottish physicist James Clerk Maxwell, nearly twenty years before, that the waves of any "electrical disturbance in the ether"—the variety and scope of which was far from known—would, like those of visible light, be reflective, refractible, and polarizable.

While Marconi in Bologna was still trying to transmit electric signals through space without wires, a race he was to win officially against similar efforts by Lodge in England, Muirhead in the United States, and Popov in Russia, Bose had already succeeded. In 1895, the year before Marconi's patent was issued, at a meeting in the Calcutta town hall, presided over by Sir Alexander Mackenzie, the lieutenant-governor of Bengal, Bose transmitted electric waves from the lecture hall through three intervening walls—and Mackenzie's portly body—to a room seventy-five feet away, where they tripped a relay which threw a heavy iron ball, fired off a pistol, and blew up a small mine.

Bose's accomplishments now began to attract the attention of the British Royal Society (equivalent of the academy of sciences in other countries), which, at Lord Rayleigh's behest, invited Bose to publish a paper in its proceedings on the "Determination of the Wave Length of Electric Radiation," and offered him a subsidy from its parliamentary grant for the advancement of science. This was followed by Bose's being awarded a doctorate of science by London University.

The *Electrician*, leading journal in its field, came forward to suggest that, on the basis of Bose's work, it might now become practical to place electromagnetic transmitters in lighthouses and receivers on ships to offer mariners a "third eye" capable of penetrating fog.

In England Bose gave a lecture on his apparatus for investigating electromagnetic waves before a meeting of the British Association for the Advancement of Science in Liverpool, which so impressed Lord Kelvin that he limped up to the ladies' gallery to congratulate Bose's beautiful wife in the most glowing terms on her husband's brilliant work. This triumph was followed in January, 1897, by an invitation to address the Royal Institution at one of its Friday Evening Discourses, which, since the institute's establishment, had become the principal venue for announcements of fresh and momentous investigations and discoveries.

Of Bose's address the *Times* wrote: "The originality of the achievement is enhanced by the fact that Dr. Bose had to do the work in addition to his incessant duties and with apparatus and appliances which

in this country would be deemed altogether inadequate." The *Spectator*, echoing this accolade, announced: "There is something of rare interest in the spectacle of a Bengali of the purest descent lecturing in London to an audience of appreciative European savants upon one of the most recondite branches of modern physical science."

Back in India, Bose was buoyed to find that a communication signed by Lord Lister, president of the Royal Society, and by other scientific luminaries, had been sent to the Secretary of State for India, recommending that a center for research and advanced teaching in physics "worthy of that great Empire" be established under Bose's direction at Presidency College.

Despite this recommendation, and an immediate grant by the Imperial Government of £40,000 to set up the center forthwith, mean-minded, jealous functionaries in the Bengal Education Department succeeded in so tying up the project that it never came to fruition. Only the gesture of his fellow Bengali, the poet Rabindranath Tagore, later to win the Nobel Prize for literature, alleviated Bose's disappointment: Tagore came specially to greet him and not finding him at home left a huge magnolia blossom in token of his tribute.

Doggedly pursuing his research whenever the press of his teaching duties in the backbiting climate of the college offered him a spare moment, Bose published in 1898 four papers on the behavior of electric waves, in the *Proceedings of the Royal Society* and in Great Britain's foremost popular scientific journal, *Nature*.

In 1899 Bose noticed the strange fact that his metallic coherer for receiving radio waves became less sensitive if continuously used but returned to normal after a period of rest. This led him to the conclusion that metals, however inconceivably, might exhibit a recovery from fatigue similar to that which took place in tired animals and people. Further work began to convince Bose that the boundary line between so-called "nonliving" metals and "living" organisms was tenuous indeed. Spontaneously moving from the domain of physics into that of physiology, Bose began a comparative study of the curves of molecular reaction in inorganic substance and those in living animal tissue.

To his awe and surprise, the curves produced by slightly warmed magnetic oxide of iron showed striking resemblance to those of muscles. In both, response and recovery diminished with exertion, and the consequent fatigue could be removed by gentle massage or by exposure to a bath of warm water. Other metal components reacted in animal-like ways. A metal surface etched with acid when polished to remove all trace of the etching exhibited reactions in its acid-treated sections which could not be elicited in those nontreated. Bose ascribed to the affected sections some kind of lingering memory of the treatment. In potassium he found that the power of recovery was almost totally lost if it was treated with various foreign substances; this seemed to parallel the reactions of muscular tissue to poisons.

In a presentation to the International Congress of Physics, held in 1900 at the Paris Exhibition, entitled "De la Généralité des Phénomènes Moléculaires Produits par l'Electricité sur la Matière Inorganique et sur la Matière Vivante," Bose stressed the "fundamental unity among the apparent diversity of nature," concluding that "it is difficult to draw a line and say that here the physical phenomenon ends and here the physiological begins." The congress was *"bouleversé"* by Bose's earth-shaking suggestion that the gulf between the animate and inanimate might not be as broad and unspannable as generally believed; its secretary declared himself "stunned."

The enthusiasm of his fellow physicists was, however, not matched by the coterie of physiologists who were invited the following September to a meeting of the physics section of the British Association for the Advancement of Science at Bradford. Because Bose's research overlapped onto territory which they considered their private preserve, the physiologists listened with hostile silence while Bose read a paper contending that Hertzian waves could be used as a stimulating agent on tissues, and that metal response was analogous to that of tissues. To meet the physiologists on their ground, Bose meticulously adapted his experiments to an accepted "electromotive variation" to which they were accustomed, and again got similar curves of muscles and metals responding to the effects of fatigue or of stimulating, depressing, and poisoning drugs.

Shortly thereafter it dawned on Bose that if the striking continuity between such extremes as metals and animal life were real he should also

be able to get similar effects in ordinary vegetable plants, which, because they were held to have no nervous systems, were universally reckoned as unresponsive. Picking several horse-chestnut leaves from a tree in the garden next to his lab, Bose found that they responded to various "blows" in much the same way as had his metals and muscles. Excited by the results, he betook himself to his greengrocer and purchased a bag of carrots and turnips, which, of all vegetables, appeared the most stolidly nonsentient, and found them to be highly sensitive. When he chloroformed plants, Bose discovered that they were as successfully anesthetized as animals, and that when the narcotic vapor was blown away by fresh air like animals they revived. Using chloroform to tranquilize a huge pine tree, Bose was able to uproot it and transplant it without the usually fatal shock of such operations.

When Sir Michael Foster, secretary of the Royal Society, came to Bose's laboratory one morning to see for himself what was happening and Bose showed the Cambridge veteran some of his recordings, the older man said jocularly: "Come now, Bose, what is the novelty of this curve? We have known it for at least half a century!"

"But what do you think it is?" Bose persisted quietly.

"Why, a curve of muscle response, of course!" said Foster testily.

Looking at the professor from the depths of his haunting brown eyes, Bose said firmly: "Pardon me, but it is the response of metallic tin!"

Foster was aghast. "What?" he shouted, jumping from his chair, "Tin? Did you say tin?"

When Bose showed him all his results, Foster was as thrilled as he was astounded. On the spot, he invited Bose to give an account of his discoveries at another Friday Evening Discourse at the Royal Institution and offered to communicate his paper personally to the Royal Society in order to secure his priority. At the evening meeting of May 10, 1901, Bose marshaled all the results obtained over four years and demonstrated each one of them with a comprehensive series of experiments before ending with a peroration:

> I have shown you this evening autographic records of the history of stress and strain in the living and non-living. How similar are the writings! So similar indeed that you cannot tell one apart from the other. Among such phenomena, how can we draw a line of demarcation and say, here

the physical ends, and there the physiological begins? Such absolute barriers do not exist.

It was when I came upon the mute witness of these self-made records, and perceived in them one phase of a pervading unity that bears within it all things—the mote that quivers in ripples of light, the teeming life upon our earth, and the radiant suns that shine above us—it was then that I understood for the first time a little of that message proclaimed by my ancestors on the banks of the Ganges thirty centuries ago: "They who see but one, in all the changing manifoldness of this universe, unto them belongs Eternal Truth—unto none else, unto none else!"

Bose's lecture was warmly received and to his surprise his views went unchallenged, despite the metaphysical note at its end. Sir William Crookes even urged that the last quotation not be omitted when the address was published. Sir Robert Austen, one of the world's authorities on metals, praised Bose for his faultless arguments, saying, "I have all my life studied the properties of metals and am happy to think that they have life." He confessed confidentially that he had formed a similar opinion but had been rebuffed when he had once hesitantly hinted at it before the Royal Institution.

A month later, when Bose repeated his lecture and demonstrations before the Royal Society, he received an unexpected blow from "the grand old man of physiological science in England," Sir John Burdon-Sanderson, whose principal work had been a study of muscle behavior and the movements of the Venus's flytrap to which Darwin had first called his attention. As Burdon-Sanderson was *the* authority on electro-physiology, all turned to him to open the discussion which followed Bose's speech.

Burdon-Sanderson began by complimenting Bose on his acknowledged work in physics but followed with the remark that it was "a great pity" that he had wandered from his own field of study to areas which belonged properly to the physiologist. Since Bose's paper was still under consideration for publication he suggested that its title be changed from "Electrical Response in . . ." to "Certain Physical Reactions in . . . ," thus leaving to the physiologists the term "response" with which physicists should not be concerned. As for the electrical responses of ordinary plants, which Bose had described at the end of his address, Burdon-

Sanderson denied categorically that such were possible, since "he himself had tried for many years past to obtain them and had never succeeded."

In his reply Bose said candidly he understood that the *facts* experimentally demonstrated were not questioned by his critic. If, therefore, he was not being impugned on the basis of this evidence, but was being asked to make modifications which altered the whole purpose and meaning of his presentation, on the basis of *authority* alone, he would have to decline. It seemed to Bose inexplicable, he said, that any doctrine could be advocated before the Royal Society which suggested that knowledge could not advance beyond known bounds. Unless he was shown on scientific grounds where his experiments were faulty or defective, he would insist his paper be published as he had written it. At the end of his rebuttal, when no one rose to break the icy silence which hung over the hall, the meeting was adjourned.

Because of doubt thrown on his work by so eminent an expert as Burdon-Sanderson, and to put down a younger man who had so outspokenly challenged his senior, the society voted not to follow up Bose's "preliminary notice" with the full publication of his paper in its *Proceedings*, and instead buried it in its archives, a fate which had befallen other notable papers in the past. To Bose, who all his life had listened to Britishers lecture against the evils of the Indian caste system, the vote seemed to evidence the existence of a not dissimilar system within British science itself. At the institution's laboratories, Bose was consoled by Lord Rayleigh, who told him that he too had been subjected to ceaseless attacks from chemists because, as a physicist, he had had the temerity to predict that a hitherto unsuspected new element would be found in air, a prediction shortly to be verified by his discovery, with the help of Sir William Ramsay, of argon.

The controversy with the physiologists elicited the interest of Bose's former teacher Professor Sidney Howard Vines, the well-known botanist and vegetable physiologist at Oxford, who called on Bose and asked if he could witness Bose's experiments. Vines brought with him T. K. Howes, who had succeeded T. H. Huxley at the British Museum's Department of Botany at South Kensington. When the men saw Bose's plant respond to stimulus, Howes exclaimed: "Huxley would have given years of his life to see this experiment." As secretary of the Linnean Society, he told Bose that, since his paper had been refused for publication by the Royal Society, not only would the Linnean accept it but also he would invite Bose to repeat all his experiments before the physiologists, particularly his opponents.*

As a result of this new presentation to the Linnean Society, on February 21, 1902, Bose was able to write to his friend Tagore: "Victory! I stood there alone, ready for hosts of opponents, but in fifteen minutes the hall was resounding with applause. After the paper, Professor Howes told me that as he saw each experiment, he tried to get out of it by thinking of a loophole of explanation, but my next experiment closed that hole." The president of the Linnean Society wrote Bose a few days later: "It seems to me that your experiments make it clear beyond doubt that all parts of plants—not merely those which are known to be motile—are irritable, and manifest their irritability by an electrical response to stimulation. This is an important step in advance, and will, I hope, be the starting point for further researches to elucidate what is the nature of the molecular condition which constitutes irritability, and the nature of the molecular change induced by a stimulus. This would doubtless lead to some important generalities as to the properties of matter, not only living matter, but non-living matter as well."

Since ordinary plants and their different organs exhibited electrical response indicative of excitation under mechanical and other stimuli, it puzzled Bose that they gave no sign of this excitement by *visible movement.* Unlike the mimosa leaf, which, if irritated, abruptly collapses, owing to a contraction of its cushion-shaped base, or pulvinus, other plants seem, at least to the eye, placidly unconcerned when scraped, burned, or otherwise interfered with. Back home in Calcutta, it suddenly hit Bose that the contraction in the mimosa was magnified by its long leaf stalk. To similarly magnify a suspected contraction in other plants,

*The Linnean Society, named after Carl von Linné or Linnaeus (1707–1778), the great Swedish botanist whose *Genera Plantorum* is considered the starting point of modern systematic botany, was organized at the end of the eighteenth century when Sir J. E. Smith, its first president, acquired Linnaeus' botanical library from his widow.

he designed a special optical lever with which he was able to demonstrate visually that *all the characteristics of the responses exhibited by animal tissues were also found in those of plants.*

Bose communicated the results of these new and extended investigations in December, 1903, in a series of seven papers to the Royal Society, which immediately planned their publication the following year in its "Philosophical Transactions," a series reserved for only the most significant and momentous scientific findings. However, as the papers were being readied for the printer, underhanded intrigues and prejudicial insinuations, which had almost suppressed his Linnean Society offering, began anew and, with Bose unable to refute them from far-off India, won the day.

Convinced by Bose's opponents that his theories should not be officially printed, and without waiting for his detailed records, the society changed its august mind and once again filed Bose's papers in its archives. To Bose this vacillation by the society only justified his decision, taken two years before, no longer to rely wholly upon the acceptance of others before presenting his astonishing discoveries to the world. "Although," as he put it, "I thought I was much too lazy to write books, I was forced into it." To guarantee that the substance of the lectures he had given in London, Paris, and Berlin should receive the widest possible circulation, Bose completed a book-length account of all his experimentation up to the middle of 1902, which was published the same year under the title *Response in the Living and Non-Living.*

Herbert Spencer, the great British synthetic philosopher, very much alive to the important scientific advances of his time, despite his entry at eighty-three into the last year of his life, personally acknowledged Bose's volume with the regret that it was too late for him to incorporate its data into his own massive *Principles of Biology.* Two years later, Professor Waller, one of Bose's most adamant opponents, quietly inserted into his new book, without even mentioning Bose's name, the Bengali's assertion that "any vegetable protoplasm gives electrical response."

Bose then began to concentrate on determining how *mechanical* movements in plants might be similar to those in animals and humans.

Since he knew that in plants there was respiration without gills or lungs, digestion without a stomach, and movements without muscles, it seemed plausible to Bose that there could be the same kind of excitation as in higher animals but without a complicated nervous system.

Bose concluded that the only way to find out about the "unseen changes which take place in plants" and tell if they were "excited or depressed" would be to measure visually their responses to what he called "definite testing blows" or shocks. "In order to succeed in this," he wrote, "we have to discover some compulsive force which will make the plant give an answering signal. Secondly, we have to supply the means for an automatic conversion of these signals into an intelligent script. And, last of all, we have ourselves to learn the nature of these hieroglyphics." In this single statement Bose mapped out for himself a course for the next two decades.

He first began by improving his optical lever into an optical pulse recorder. Consisting of a pair of drums over which revolved a continuous paper band driven by clockwork, this device picked up movements in the plant which were translated through a movable lever attached to a set of mirrors which reflected a beam of light onto the paper. The excursion of the shifting spot of light, followed by means of a sliding inkwell with an ink sponge protruding from it, made visible for the first time movements in plant organs which had thus far remained hidden to the scientific world.

With the aid of this instrument, Bose was able to show how the skins of lizards, tortoises, and frogs as well as those of grapes, tomatoes, and other fruits and vegetables behaved similarly. He found that the vegetal digestive organs in insectivorous plants, from the tentacle of a sundew to the hair-lined flap of a pitcher plant, were analogous to animal stomachs. He discovered close parallels between the response to light in leaves and in the retinas of animal eyes. With his magnifier he proved that plants become as fatigued by continuous stimulation as animal muscles, whether they were hypersensitive mimosas or undemonstrative radishes.

Working with the *Desmodium gyrans*, a species whose continuously oscillating leaves recall the motion of semaphore flags and led to its

common appellation, telegraph plant, Bose found that the poison which could stop its automatic ceaseless pulsation would also stop an animal heart and that the antidote for this poison could bring both organisms back to life.

Bose demonstrated the characteristics of a nerve system in mimosa, a plant whose leaflets are symmetrically arranged on each leaf with several leaves stemming from more or less the same point, the whole leaf system borne on small branchlets or petioles issuing from the main stem.

When Bose electrically shocked the stem or touched it with a hot wire, the base of the nearest petiole collapsed within seconds, to be followed, after another interval, by the folding of the leaves at its end. Connecting a galvanometer to the petiole, Bose recorded an electrical disturbance between these two points of reaction. If he touched the tip of a leaf with a hot object, first the leaflets closed and then the base segment drooped.

Bose interpreted these actions as due to electrical excitation, which, in turn, produced mechanical responses; this was also what happened in the animal nerve-muscle unit, where the nerve carried the electric impulse and the muscle contracted in response. Bose later proved that identical results could be produced in both plant and animal systems by cold, anesthesia, or the passage of a weak current.

Bose showed that in mimosa there exists the same kind of "reflex arc" which causes us to withdraw our fingers instantly from a hot stove before pain can be felt. When Bose touched the tip of one leaf on a three-leaf petiole he saw that the leaflets of the disturbed leaf gradually closed, starting from the tip; then the petiole collapsed; lastly, the other two leaves closed from the base upward.

In *Desmodium gyrans*, or the telegraph plant, Bose found that if the cut end of a detached leaflet was dipped in water in a bent glass tube it recovered from the shock of its amputation and began to pulsate anew. Was this not like an excised animal heart which can be kept beating in Ringer's solution? Just as the heart stops beating when blood pressure is lowered and starts again when pressure is raised, Bose found the same was true for the pulsation of the *Desmodium* when the sap pressure was increased or decreased.

Bose experimented with heat and cold to ascertain the optimal conditions under which plant movement was best elicited. One day he found that when all motion stopped in his plant, it suddenly shuddered in a way reminiscent of the death spasm in animals. To determine exactly the critical temperature at which death occurred, he invented a morograph, or death recorder. While many plants met their end at sixty degrees Centigrade, individual plants exhibited variations depending on their previous histories and ages. If their power of resistance was artificially depressed by fatigue, or poison, the death spasm would take place with temperatures as low as twenty-three degrees Centigrade. At death, the plant threw off a huge electrical force. Five hundred green peas could develop five hundred volts, said Bose, enough to fulminate a cook but for the fact that peas are seldom connected in series.

Though it had been thought that plants liked unlimited quantities of carbon dioxide, Bose found that too much of this gas could suffocate them, but that they could then be revived, just like animals, with oxygen. Like human beings, plants became intoxicated when given shots of whiskey or gin, swayed like any barroom drunkard, passed out, and eventually revived, with definite signs of a hangover. These findings together with hundreds of other data were published in two massive volumes in 1906 and 1907.

Plant Response as a Means of Physiological Investigation ran to 781 pages and detailed 315 separate experiments. These went against an entrenched notion, which Bose thus explained: "From the plausible analogy of the firing off of a gun by pulling a trigger, or the action of a combustion engine, it has been customary to suppose that all response to stimulus must be of the nature of an explosive chemical change, accompanied by an inevitable rundown of energy." Bose's experiments, on the contrary, showed him that in plants their movement, the ascent of their sap, and their growth were due to energy absorbed from their surroundings, which they could hold latent or store for future use.

These revolutionary ideas, and especially the finding that plants had nerves, were received with veiled hostility among botanists. The *Botanical Gazette* commended Bose for a path-breaking achievement, but held that his book was "not without errors into which the author has fallen by reason of some unfamiliarity with his materials."

Even as the botanists grumbled, Bose sent to the printer a second, equally massive, volume, *Comparative Electro-Physiology*, setting forth 321 additional experiments; its findings also clashed with current teaching and doctrine. Instead of emphasizing the accepted wide range of specific differences between the reactions of various plant and animal tissues, Bose consistently pointed to a real continuity between them. The nerve, universally held to be typically nonmotile, he showed capable of indisputable movement, which could more delicately be ascertained by mechanical than by electrical means. Whereas plants were considered to lack all power of conducting true excitation, Bose showed they were in fact possessed of this power.

Even more heretically, Bose held that the isolated vegetal nerve is indistinguishable from animal nerve: "So complete, indeed, has that similarity between the responses of plant and animal, of which this is an instance, been found," wrote Bose, "that the discovery of a given responsive characteristic in one case has proved a sure guide to its observation in the other, and that the explanation of a phenomenon, under the simpler conditions of the plant, has been found fully sufficient for its elucidation under the more complex circumstances of the animal."

Going even further, Bose maintained that when electromotive intensity was above or below a certain range the law of polar effects of currents, established by Pflüger, was overturned; in addition, a nervous impulse, supposed to lie beyond any conceivable power of visual scrutiny, attended by a change of form, was entirely capable of direct observation.

The authoritative scientific magazine *Nature*, left gasping by both volumes, wrote of the first: "In fact, the whole book abounds in interesting matter skillfully woven together and would be recommended as of great value if it did not continually arouse our incredulity." Of the second, *Nature* was equally ambivalent in its attitude. "The student of plant physiology," said the reviewer, "who has some acquaintance with the main classical ideas of his subject, will feel at first extreme bewilderment as he peruses this book. It proceeds so smoothly and logically, and yet it does not start from any place in the existing 'corpus' of knowledge, and never attaches itself with any firm adherence. This effect of detachment is heightened by the complete absence of precise reference to the work of other investigators." There were, of course, no other investigators; and the reviewer, limited by the compartmentalized science of his day, had no way of knowing he was dealing with a genius half a century ahead of his time.

In a short statement Bose summed up his philosophy: "This vast abode of nature is built in many wings, each with its own portal. The physicist, the chemist and the biologist come in by different doors, each one his own department of knowledge, and each comes to think that this is his special domain unconnected with that of any other. Hence has arisen our present division of phenomena into the worlds of inorganic, vegetal and sentient. This philosophical attitude of mind may be denied. We must remember that all inquiries have as their goal the attainment of knowledge in its entirety."

One of the blocks to the acceptance by plant physiologists of Bose's revolutionary findings was their inability to construct the delicate instruments he had devised. Yet the mounting opposition to his basic thesis that responses in plants are similar to those due to the nervous system of animals convinced Bose that he should develop an even more refined set of instruments for automatic stimulation and recording of response. He therefore designed a resonant recorder, capable of measuring time up to 1/1000 of a second, to make rapid movement in plants apparent, and an oscillating recorder to reveal the slowest movement in plants.

With the assistance of his new recorder Bose got results on the nervous impulse so convincing that this time they were published in the Royal Society's *Philosophical Transactions.* In the same year Bose published his third massive volume of experimentation, *Researches in Irritability of Plants;* 376 pages; 180 experiments.

In 1914, Bose left for Europe on a fourth scientific mission, this time carrying not only his various instruments but specimens of *Mimosa pudica* and *Desmodium gyrans* to illustrate his lectures. In England he demonstrated before audiences at Oxford and Cambridge how a plant touched on one side would shiver and react on the other. He addressed evening meetings of both the Royal Institution and the Royal Society of Medicine, where Sir Lauder Brunton, who had made experiments on

insectivorous plants for Charles Darwin in 1875, remarked that all the subsequent physiological experimentation he had seen since then was "crude in comparison with yours in which you show what a marvellous resemblance there is between the reactions of plants and animals."

The vegetarian and antivivisectionist George Bernard Shaw, having witnessed in Bose's laboratory, through one of Bose's magnifiers, a cabbage leaf going through violent paroxysms as it was scalded to death, dedicated his own collected works to Bose, inscribing them: "From the least to the greatest living biologist." A repentant animal physiologist who had cast the single vote preventing publication of plant research by the Royal Society came up to Bose to confess his misdeed and said, "I could not believe that such things were possible and thought your oriental imagination had led you astray. Now, I fully confess that you have been right all along." Bose, letting bygones be bygones, never divulged his name.

Bose's research was for the first time vividly recorded for the public in the British publication *Nation:*

> In a room near Maida Vale there is an unfortunate carrot strapped to the table of an unlicensed vivisector. Wires pass through two glass tubes full of a white substance; they are like two legs, whose feet are buried in the flesh of the carrot. When the vegetable is pinched with a pair of forceps, it winces. It is so strapped that its electric shudder of pain pulls the long arm of a very delicate level which actuates a tiny mirror. This casts a beam of light on the frieze at the other end of the room, and thus enormously exaggerates the tremor of the carrot. A pinch near the right-hand tube sends the beam seven or eight feet to the right, and a stab near the other wire sends it far to the left. Thus can science reveal the feelings of even so stolid a vegetable as the carrot.

The acclaim which came in the British Isles was repeated in Vienna, where it was the consensus of eminent German and Austrian scientists that "Calcutta was far ahead of us in these new lines of investigation."

Back in India, where the governor of Bengal had arranged for a huge meeting, headed by the sheriff of Calcutta to greet him, Bose spoke of the pursuit, under extreme difficulty, of his investigation of the extraordinary slowness of growth in plants. To conceive of this it is only necessary to state that if the annual growth of a tree is liberally estimated to be five feet, it would take one thousand years to cover a mile.

In 1917, at a huge meeting of students held to honor the knighthood bestowed upon Bose, the chairman remarked that he should be looked upon not as a mere discoverer of scientific truths, but as a Yuga Pravartak, or one who has brought about a new epoch of synthesis in scientific development. This compliment was to Bose small music compared to the opening of his own Institute for Research on the thirtieth of November, on the occasion of his fifty-ninth birthday.

During his speech at the ceremony, Bose, who had declined to patent the device which could have made him, instead of Marconi, the inventor of wireless telegraphy, and had consistently resisted the blandishments of industrial representatives to turn his ideas into profits, stated that it was his particular desire that any discoveries made at his new institute would become public property and that no patents would ever be taken out on them. "Not in matter, but in thought, not in possessions, but in ideas, are to be found the seeds of immortality," Bose told the assembled crowd. "Not through material acquisitions, but in generous diffusion of ideas can the true empire of humanity be established. Thus, the spirit of our national culture demands that we should forever be free from the desire of utilizing knowledge for personal gain."

A year after the foundation of the institute, Bose convened a meeting, sponsored by the governor of Bengal, to announce that, after eight years of struggle, he had finally been able to devise a brand-new instrument, the crescograph. Through the use of two levers, this extraordinary invention not only produced a ten-thousand-fold magnification of movement, far beyond the powers of the strongest microscope, but could automatically record the rate of growth of plants and their changes in a period as short as a minute.

With this instrument Bose showed the remarkable fact that in countless plants, growth proceeds in rhythmic pulses, each pulse exhibiting a rapid uplift and then a slower partial recoil of about a fourth the distance gained. The pulses in Calcutta averaged about three per minute. By watching the progress of the movement on the chart of his new invention, Bose found that growth in some plants could be retarded and even

halted by merely touching them, and that in others rough handling stimulated growth, especially if they were sluggish and morose.

To determine a method which would allow him *instantly* to show the acceleration or retardation of a plant's growth in response to a stimulant, Bose now devised what he called a "balanced crescograph," which would allow the plant to be lowered *at the same rate* at which it was growing upward, thus reducing the marking of its growth on the chart to a horizontal line and allowing any changes in *the rate* to express themselves as curves. The method was so extremely sensitive that Bose was able to detect variation of the rate of growth as hyper-minimal as 1/1500 millionths of an inch per second.

In America, *Scientific American*, referring to the significance of Bose's findings for agriculture, wrote: "What is the tale of Aladdin and his wonderful lamp compared to the possibilities of Dr. Bose's Crescograph? In less than a quarter of an hour the action of fertilizers, food, electric currents and various stimulants can be fully determined."

Bose also elucidated the mysteries of tropistic movements in plants, or their tendency to move in response to an external stimulus. At the time of his research, botanists could no more explain these tropisms than could Molière's medical student who passed his exam by answering the question "Why does opium make one sleep?" with the tautology "Because it has a dormitive virtue."

The roots of plants are called "geotropic," because they burrow into the soil. Because their shoots flee the earth they are said to be imbued with "negative geotropism." To heighten this nonsense, branches are said to start out laterally from the shoot by "diageotropism." Leaves turn to light because they are "heliotropic" or "phototropic." If, disobeying this rule, they turn away from light, then they are "negatively phototropic." Roots questing water are described as "hydrotropic," and those bending against the flow of a stream "rheotropic." The tendril's touch is known as its "thigmotropism."

As the botanist Sir Patrick Geddes wrote: "Intellectual activities have their verbalisms, their confusions and misdirections and these may also accumulate into what are practically diseases. Every science, of course, needs its technical terminology but all have suffered from the verbosity of nomenclatures and, notoriously, botany most of all. Thus—apart from the systematic names for each and every species and order which are of course indispensable—there are some fifteen or twenty thousand technical terms in the botanical dictionaries of which many have survived into modern textbooks to the perplexity of the student." In an essay, commenting on the strange power of big words like "heliotropism," Bose said that they usually acted like some malevolent magic to kill curiosity.

Though it was beginning to be finally accepted that plants did possess conducting tissue analogous to animal nerve, it was now urged by plant specialists that the sensibility of plants was, if it did in fact exist, of a very low order. Bose demonstrated that this was not the case.

He showed the tropism exhibited by tendrils to be the result of two fundamental reactions: a direct stimulus inducing contraction and an indirect stimulus causing expansion. In the curvature of the plant organ, the convex side was electrically positive, the concave side negative. Since the human organ most readily available and most sensitive to the perception of electric current is the tip of the tongue, Bose decided to match its detective ability against that of the sensitive leaflet of the *Biophytum* plant. Hooking up a tongue and a leaflet, he passed a current through both organs, gradually increasing the amperage. When the current reached an intensity of 1.5 micro-amperes, or 1 1/2 millionths of the standard electrical unit of current, the leaflet shimmered in response but the overrated tongue had nothing to relate about the current until the intensity had been increased threefold.

With the same instrumentation, Bose showed that plants of all kinds are sensitive. He found "a stoutish tree will give its response in a slow and lordly fashion whereas a thin one attains the acme of its excitement in an incredibly short time."

During Bose's trip to London and Europe in 1919 and 1920, the distinguished scientist Professor John Arthur Thomson wrote in the *New Statesman:* "It is in accordance with the genius of India that the investigator should press further towards unity than we have yet hinted at, should seek to correlate responses and memory expression in the living with their analogs in organic matter, and should see in anticipation the lines of Physics and Physiology and of Psychology converging and

meeting. These are questionings of a prince of experimenters whom we are proud to welcome in our midst today."

The usually reserved *Times* wrote: "While we in England were still steeped in the rude empiricism of barbaric life, the subtle Easterner had swept the universe into a synthesis and had seen the *one* in all its changing manifestations." But even those bold statements and the announcement that Bose was to be made a fellow of the Royal Society, in May, 1920, could not stem the all-too-familiar intimations of the doubters and pedants. Bose's old adversary Professor Waller, upsetting the general atmosphere of cordiality and recognition, wrote to the *Times* to question the reliability of Bose's magnetic crescograph and to ask for a demonstration of it in a physiological laboratory before experts. When the demonstration, which took place at London University on April 23, 1920, was a complete success, Lord Rayleigh joined with several colleagues in a letter to the *Times* stating: "We are satisfied that the growth of plant tissues is correctly recorded by this instrument and at magnification of one million to more than ten million times."

Bose wrote to the *Times* on May 5:

> Criticism which transgresses the limit of fairness must inevitably hinder the progress of knowledge. My special investigations have by their nature presented extraordinary difficulties. I regret to say that during a period of twenty years, these difficulties have been greatly aggravated by misrepresentation and worse. The obstacles deliberately placed in my path I can now ignore and forget. If the result of my work, by upsetting any particular theory, has aroused the hostility here and there of an individual, I can take comfort in the warm welcome which has been extended to me by the great body of scientific men in this country.

During still another trip to Europe in 1923, the year that saw the publication of Bose's detailed 227-page work *The Physiology of the Ascent of Sap,* the French philosopher Henri Bergson said, after hearing Bose lecture at the Sorbonne: "The dumb plants had by Bose's marvelous inventions been rendered the most eloquent witnesses of their hitherto unexpressed life story. Nature has at last been forced to yield her most jealously guarded secrets." More Gallicly humorous, *Le Matin* stated: "After this discovery we begin to have misgivings, when we strike a woman with a blossom, which of them suffers more, the woman or the flower?"

In 1924 and 1926 there appeared two more volumes of experiments totaling more than five hundred pages: *The Physiology of Photosynthesis* and *The Nervous Mechanism of Plants.* In 1926 Bose was nominated a member of the League of Nations Committee on Intercultural Cooperation, along with a physicist, Albert Einstein, a mathematician, H. A. Lorentz, and a Greek literary scholar, Gilbert Murray. The assignment had the advantage of taking Bose to Europe annually. Still the Indian Government had to be jolted into awareness of the importance of Bose's work. In 1926 Sir Charles Sherrington, president of the Royal Society, Lord Rayleigh, Sir Oliver Lodge, and Julian Huxley all signed a memorial to the Viceroy of India pleading for the expansion of the institute.

Back in Europe in 1927, the year which saw the appearance of his *Plant Autographs and Their Revelations,* Bose was presented by Romain Rolland with a signed copy of his new novel, *Jean Christophe,* inscribed "To the Revealer of a New World." Later, comparing Bose to Siegfried, who had learned the language of birds, Rolland said: "In the European scientist the steeling of the mind to the interpretation of nature has often been accompanied by a withering of the feeling for beauty. Darwin bitterly lamented the fact that his research in biology had completely atrophied his appreciation of poetry. With Bose it is otherwise."

In 1928, the same year that Bose brought out his last book, the 429-page *Motor Mechanisms of Plants,* one of the greatest plant physiologists of modern times, Professor Hans Molisch of Vienna, decided, after hearing Bose lecture in the Austrian capital, to go to India and work with the Bengali. Before leaving the subcontinent he wrote to *Nature:* "I saw the plant writing down its rate of assimilation of gaseous food. I also observed the speed of the impulse of the excitement in plants being recorded by the resonant recorder. All these are more wonderful than fairytales."

All his life Bose had stressed to a scientific community steeped in a mechanistic and materialistic outlook, and increasingly divided and subdivided into specialized cubbyholes, the idea that all of nature pulsed

with life and that each of the interrelated entities in the natural kingdom might reveal untold secrets could man but learn how to communicate with them. In the lecture hall of his institute, under a bronze, silver, and gold relief of the Hindu sun god rising in his chariot for his daily cosmic fight against the powers of darkness—which Bose had first seen depicted in an ancient cave fresco at Ajanta—Bose, now in retirement, summed up his scientific philosophy.

> In my investigations on the action of forces on matter, I was amazed to find boundary lines vanishing and to discover points of contact emerging between the Living and the non-Living. My first work in the region of invisible lights made me realize how in the midst of luminous ocean we stood almost blind. Just as in following light from visible to invisible our range of investigation transcends our physical sight, so also the problem of the great mystery of Life and Death is brought a little nearer solution, when, in the realm of the Living, we pass from the Voiced to the Unvoiced.
>
> Is there any possible relation between our own life and that of the plant world? The question is not one of speculation but of actual demonstration by some method that is unimpeachable. This means that we should abandon all our preconceptions, most of which are afterward found to be absolutely groundless and contrary to facts. The final appeal must be made to the plant itself and no evidence should be accepted unless it bears the plant's own signature.

CHAPTER 7

The Metamorphosis of Plants

Why botany, a potentially fascinating subject dealing with plants, living and extinct, their uses, classification, anatomy, physiology, geographical distribution, should have been from the beginning reduced to a dull taxonomy, an endless Latin dirge, in which progress is measured more by the number of corpses cataloged than by the number of blossoms cherished, is perhaps the greatest mystery in the study of plant life.

While young botanists still struggle today through the jungles of Central Africa and along the Amazon in search of polysyllabic victims to add to the 350,000 already on the books, what makes plants live, or why, does not appear to be the purview of the science, nor has it been since the fourth century B.C. when Theophrastus, the Lesbian disciple of Aristotle, first cataloged a couple of hundred species in his nine books *On the History of Plants* and six *On the Causes of Plants.* The Christian era merely raised the rolls to four hundred medicinal plants with the publication of *De Materia Medica* by a Greek physician to the Roman army, Dioscorides, shortly after the Crucifixion, an event which put the quietus on the subject for another thousand years. Throughout the Dark Ages, the books of Theophrastus and Dioscorides remained the standard texts in botany. Even though the Renaissance brought aesthetics into the field, with lovely woodcuts in large herbals such as those of Hieronymus Bock, it could not rip botany from the rigorous grip of the taxonomist.

By 1583 a Florentine, Andreas Caesalpinus, had classified 1,520 plants into fifteen classes, distinguished by seed and fruit. He was followed by the Frenchman Joseph Pitton de Tournefort, who described some 8,000 species of plants in twenty-two classes, chiefly according to the form of corolla—the colored petals of the flower. This brought sex into the picture. Although Herodotus had reported almost half a millennium before Christ that the Babylonians distinguished two sorts of palms, and would sprinkle the pollen from one onto the flower of the other in order to secure the production of fruit, it was not till the end of the seventeenth century that it was realized that plants were sexual creatures with a flourishing sex life of their own.

The first botanist to demonstrate that flowering plants have sex and that pollen is necessary for fertilization and seed formation was a German, Rudolf Jakob Camerarius, a professor of medicine and director of the botanical gardens at Tübingen, who published his *De Sexu Plantorum Epistula* in 1694. The idea that there could be a sexual difference in plants caused general astonishment, and Camerarius' theory was fiercely combated by the current establishment. It was considered "the wildest and most singular invention that ever evolved from a poet's mind." A heated controversy lasted almost a generation before it was finally established that plants had sexual organs and could therefore be elevated to a higher sphere of creation.

Even so, that plants have female organs in the form of vulva, vagina, uterus, and ovaries, serving precisely the same functions as they do in woman, as well as distinct male organs in the form of penis, glans, and testes, designed to sprinkle the air with billions of spermatozoa, were facts quickly covered by the eighteenth-century establishment with an almost impenetrable veil of Latin nomenclature, which stigmatized the labiate vulva, and mis-styled the vagina; the former being called "stigma," the latter "style." Penis and glans were equally disfigured into "filament" and "anther."

Whereas plants had been going through countless millennia of improvement to their sexual organs, often in the face of staggering climatic changes, and had invented the most ingenious methods for fecundating each other and for spreading their fertile seed, students of botany, who might have delighted in the sexuality of plants, were frustrated by such terms as "stamens" for the male and "pistils" for the female organs. Schoolchildren might have been fascinated to learn that each corn kernel on a cob in summer is a separate ovule, that each strand on the pubic corn silk tufted around the cob is an individual vagina ready to suck up the pollen sperm brought to it on the wind, that it may wriggle the entire length of the stylized vagina to impregnate each kernel on the cob, that every single seed produced on a plant is the result of a separate independent impregnation. Instead of struggling with archaic nomenclature, teenagers might be interested to learn that each pollen grain impregnates but one womb, which contains but one seed, that a capsule of tobacco contains, on an average, 2,500 seeds, which require 2,500 impregnations, all of which must be effected within a period of 24 hours in a space less than one-sixteenth of an inch in diameter. Instead of using the wonders of nature to stimulate the budding minds of their pupils, Victorian teachers misused the birds and the bees to denature their own sexuality.

How many universities even now draw the parallel between the hermaphroditic nature of plants, which bear both penis and vagina in the same body, with the "ancient wisdom" which relates that man is descended from an androgynous predecessor? The ingenuity of some plants in avoiding self-fertilization is uncanny. Some kinds of palm trees even bear staminate flowers one year and pistillate the next. Whereas

in grasses and cereals cross-fertilization is insured by the action of the wind, most other plants are cross-fertilized by birds and insects. Like animals and women, flowers exude a powerful and seductive odor when ready for mating. This causes a multitude of bees, birds, and butterflies to join in a Saturnalian rite of fecundation. Flowers that remain unfertilized emit a strong fragrance for as many as eight days or until the flower withers and falls; yet once impregnated, the flower ceases to exude its fragrance, usually in less than half an hour. As in humans, sexual frustration can gradually turn fragrance into fetor. Similarly, when a plant is ready for impregnation, there is an evolution of heat in the female organ. This was first noted by the celebrated French botanist Adolphe Théodore Brongniart in examining a flower of the *Colocasia odorata,* a tropical plant grown in greenhouses for the beauty of its foliage. This plant, at the time of flowering, presents an increase of temperature that Brongniart compared to an attack of fever, repeating the phenomenon for six days, daily from three to six in the afternoon. At the proper time for impregnation Brongniart found that a small thermometer fastened to the female organ marked a temperature eleven degrees Centigrade higher than any other part of the plant.

The pollen of most plants has a highly inflammable character; when thrown on a red-hot surface it will ignite as quickly as gunpowder. Artificial lightning was formerly produced on the theatrical stage by throwing the pollen grains of the *Lycopodium* or club mosses onto a hot shovel. In many plants the pollen diffuses an odor bearing the most striking resemblance to the seminal emission of animals and man. Pollen, which performs the same function in almost precisely the same manner as does the semen of animals and men, enters the folds of the plant vulva and traverses the whole length of the vagina, until it enters the ovary and comes in contact with the ovule. Pollen tubes elongate themselves by a most remarkable process. As with animals and humans, the sexuality of certain plants is guided by taste. The spermatozoa of certain mosses carried in the morning dew in search of females, is guided by its taste for malic acid toward the delicate cups at the bottom of which lie moss eggs to be fertilized. The spermatozoa of ferns, on the other hand, liking sugar, find their females in pools of sweetened water.

Camerarius' discovery of sex in plants set the stage for the generator of systematic botany, Carl von Linné, who dubbed the corolla petals "curtains of the nuptial bed." A Swede, who latinized his name to Linnaeus from a favorite linden tree while studying for the priesthood, he divided the plant world into species principally on the basis of variations in the male sexual organ or pollen-bearing stamens of each plant. With his penchant for looking, Linnaeus recognized some six thousand different species of plants. His system, referred to as the "sexual system," was considered "a great stimulus to students of botany." But his monumental method of latinized classification turned out to be as sterile as that of any voyeur who only looks at bodies. Still in use today under the unwieldy title of "binomial nomenclature," the system grants to each plant a Latin name for species and genus, to which is added the name of the person responsible for first naming it; thus the garden pea you eat with chops is the *Pisum sativum Linnaeum.*

This mania for registration was but a hangover of scholasticism. As Raoul Francé, true lover of plants, described Linné's efforts, "Wherever he went the laughing brook died, the glory of the flowers withered, the grace and joy of the meadows was transformed into withered corpses whose crushed and discolored bodies were described in a thousand minute Latin terms. The blooming fields and the storied woods disappeared during a botanical hour into a dusty herbarium, into a dreary catalogue of Greek and Latin labels. It became the hour for the practice of tiresome dialectic, filled with discussions about the number of stamens, the shape of leaves, all of which we learnt only to forget. When the work was over we stood disenchanted and estranged from nature."

To break away from this taxonomania, to put life and love and sex back into the plant world, took real poetic genius. In September of 1786, eight years after the death of Linnaeus, a tall, handsome man of thirty-seven, extremely attractive to women, who had been spending his holidays at Karlsbad taking the waters and strolling with the ladies in the woods on long botanical expeditions, suddenly rebelled against the whole system. "Secretly and stealthily" he abandoned mistress and friends to go south toward the Alps. Incognito, with only his servant aware that they were heading for *das Land wo die Citronen bluehen,*

the traveler, in real life privy councilor and director of mines for the Duchy of Saxe-Weimar, was delighted at the beauty and variety of the southern vegetation beyond the Brenner Pass. This secret trip to Italy, the culmination of years of longing, was to constitute a climax in the life of Germany's greatest poet, Johann Wolfgang von Goethe.

On his way to Venice he stopped to visit the botanical gardens of the University of Padua. Strolling among the luxuriant verdure, most of which grew only in hothouses in his native Germany, Goethe was overcome with a sudden poetic vision; it was to give him insight into the very nature of plants. It was also to give him a place in the history of science as the precursor of Darwin's theory of organic development, an achievement as little appreciated by his compeers as it was extolled by a later generation. The great biologist Ernst Haeckel considered Goethe to stand with Jean Lamarck "at the head of all the great philosophers of nature who first established a theory of organic development, and who are the illustrious fellow workers of Darwin." For years Goethe had been distressed by the limitations involved in a merely analytical and intellectual approach to the plant world, typified by the cataloging mind of the eighteenth century, and of a theory of physics, then triumphant, which submitted the world to blind laws of mechanics, to a *"jeu de rouages et de ressorts sans vie."*

While still at the university in Leipzig, Goethe had rebelled against an arbitrary division of knowledge into faculties which cut up science into rival disciplines. In Goethe's nostrils university science had the stench of a corpse whose limbs have rotted apart. Disgusted at the petty contradictions of university savants, the young poet, whose early verses glowed with a passionate delight in nature, sought knowledge elsewhere, avidly studying galvanism and mesmerism and pursuing the electrical experiments of Winkler. Already as a child he had been fascinated by the phenomena of electricity and magnetism, struck by the extraordinary phenomenon of polarity. Cured in his late teens of a dangerous throat infection by a Rosicrucian doctor, Johann Friedrich Metz, Goethe was suddenly overwhelmed by the urge to apprehend the tremendous secret displayed all around him in constant creation and annihilation; he was thus led to books on mysticism and alchemy in pursuit of the secret forces of nature. There he discovered Paracelsus, Jakob Boehme, Giordano Bruno, Spinoza, and Gottfried Arnold.

To Goethe's delight he found magic and alchemy "quite other than obscure superstitious practices with the object of creating illusion or malefice." It was then, according to Christian Lepinte, author of *Goethe et l'occultisme,* that Goethe began "to aspire with all his strength to shatter the framework of a mechanized universe, to find the living science capable of revealing to him the ultimate secret of nature." From Philippus Aureolus Theophrastus Bombastus von Hohenheim, or Paracelsus, Goethe learned that the occult, because it deals with living reality and not dead catalogs, might come closer to the truth than science, and that the sage unveiling the secrets of nature was not necessarily profaning a forbidden sanctuary but might be walking in the footsteps of divinity, a person privileged to look deeply into the mystery of souls and of cosmic forces.

Above all, Goethe learned that the treasures of nature are not discovered by one who is not in sympathy with nature. He realized that the normal techniques of botany could not get near to the living being of a plant as an organism in a cycle of growth. Some other form of looking was needed which could unite itself with the life of the plant. To obtain a clearer picture of a plant, Goethe would tranquilize himself at night before going to sleep by visualizing the entire cycle of a plant's development through its various stages from seed to seed. In the splendid ducal gardens at Weimar, in the Gartenhaus quarters given to him by the Duke, Goethe developed an acute interest in living plants, an interest which was sharpened by his friendship with the sole local apothecary, Wilhelm Heinrich Sebastian Buchholz, who kept a garden of medicinal herbs and plants of special interest and with whom Goethe built up a private botanical garden.

In the grander botanical gardens of Padua, where Paracelsus had preceded him, Goethe was most impressed by a high, broad wall of fiery red bells, *Bignonia radicans,* that glowed enchantingly. He was also attracted by a palm because he was able to discern in its fanlike quality a complete development from the simple lance-shaped leaves near the ground, through successive separations, up to a spatulate sheaf where a branchlet of blossoms emerged, strangely unrelated to the preceding

growth. From the observation of this complex series of transitional forms Goethe obtained the inspiration for what was to become his doctrine of the *metamorphosis of plants.* In a flash he realized what had been accumulating in his mind through long years of association with plants: the fan palm showed clear, living proof that *all* the lateral outgrowths of the plant were simply variations of a single structure: the leaf.* Goethe saw that propagation and prolification of one organ into another was simply a process of metamorphosis. He saw that each organ though outwardly changed from a similarity to a dissimilarity had a virtual inner identity.

At Goethe's request the Padua gardener cut from the fan palm an entire sequence of modifications which Goethe carried away with him in several pasteboard containers, where they lasted several years. As for the palm tree, it still stands in the Padua botanical gardens despite numerous intervening wars and revolutions.

With his new way of looking at plants Goethe came to the conclusion that nature, by bringing forth one part through another, could achieve the most diversified forms through modification of a single organ. "The variation of plant forms, whose unique course I had long been following, now awakened in me more and more the idea that the plant forms round about us are not predetermined, but are happily mobile and flexible, enabling them to adapt to the many conditions throughout the world, which influence them, and to be formed and re-formed with them."

Goethe also recognized that the process of development and refinement of form in plants worked through a threefold cycle of expansion and contraction. The expansion of foliage was followed by a contraction into calyx and bracts; there followed a splendid expansion into the petals of the corolla and a contraction into the meeting point of stamen and stigma; finally there came a swelling into fruit followed by a contraction into seed. This six-step cycle completed, the essential plant was ready to start all over again.

Ernst Lehrs' thoughtful evaluation of Goethe in *Man or Matter* says

*Sir George Trevelyan in a chapter on Goethe's plant metamorphosis in his forthcoming book on architecture, points out that by "leaf" Goethe did not mean the stem leaf, which is itself a manifestation of the basic organ. Some other word, says Trevelyan, is needed, such as "phyllome," to imply the archetypal ideal organ which underlies every organ of the plant and is able to transfer one part into another.

that another natural principle is implicit in this cycle for which Goethe did not coin a specific term, "although he shows through other utterances that he was well aware of it, and of its universal significance for all life." Lehrs calls this principle that of renunciation.

> In the life of the plant this principle shows itself most conspicuously where the green leaf is heightened into the flower. While progressing from leaf to flower the plant undergoes a decisive ebb in its vitality. Compared with the leaf, the flower is a dying organ. This dying, however, is of a kind we may aptly call a "dying into being." Life in its mere vegetative form is here seen withdrawing in order that a higher manifestation of the spirit may take place. The same principle can be seen at work in the insect kingdom when the caterpillar's tremendous vitality passes over into the short-lived beauty of the butterfly. In the human being it is responsible for that metamorphosis or organic process which occurs on the path from the metabolic to the nervous system, and which we came to recognize as the precondition for the appearance of consciousness within the organism.

Lehrs marvels at the powerful forces which must be at work in the plant organism at the point of transition from its green to its colored parts. They enforce, says Lehrs, a complete halt upon the juices that rise up right into the calyx, so that these bring nothing of their life-bearing activity into the formation of the flower, but undergo a complete transmutation, not gradually, but with a sudden leap.

> After achieving its masterpiece in the flower, the plant once more goes through a process of withdrawal, this time into the tiny organs of fertilization. After fertilization, the fruit begins to swell: once more the plant produces an organ with a more or less conspicuous spatial extension. This is followed by a final and extreme contraction in the forming of the seed inside the fruit. In the seed the plant gives up all outer appearance to such a degree that nothing seems to remain but a small, insignificant speck of organized matter. Yet this tiny, inconspicuous thing bears in it the power of bringing forth a whole new plant.

Lehrs points out that in its three successive rhythms of expansion and contraction the plant reveals the basic rule of its existence.

> During each expansion, the active principle of the plant presses forth into visible *appearance;* during each contraction it withdraws from outer embodiment into what we may describe as a more formless pure state of *being.* We thus find the spiritual principle of the plant engaged in a kind of breathing rhythm, now appearing, now disappearing, now assuming power over matter; now withdrawing from it again.

Goethe saw in the changeableness of all the external characteristics of plants nothing but appearance; he drew the conclusion that the nature of the plant was not to be found in these characteristics, but had to be sought at a deeper level. The thought became more and more alive in him that it might be possible to develop all plants from a single one. This small conceit was destined to transform the science of botany, indeed the whole concept of the world: with it came the idea of *evolution.* Metamorphosis was to become the key to the whole alphabet of nature. But, whereas Darwin was to assume that external influences, like mechanical causes, work upon the nature of an organism and modify it accordingly, to Goethe the single alterations were various expressions of the archetypal organism *(Urorganismus),* which possesses within itself the capacity to take on manifold forms, and which at a particular time takes on that form which is best suited to the conditions of the external environing world. Goethe's *Urorganismus* is a sort of Platonic idea in the eye of the created mind.

Aristotle's philosophy teaches that, besides original matter, another principle is necessary to complete the triune nature of every particle, and this is form: an invisible, but still, in an ontological sense of the word, a substantial being, really distinct from matter proper. Thus, as the theosophist Helena Blavatsky interprets Aristotle, in an animal or a plant, besides the bones, the flesh, the nerves, the brains, and the blood, in the former, and besides the pulpy matter, tissues, fibers, and juice in the latter, there must be a substantial form, which Aristotle named, in the horse, the horse's *soul;* which Proclus identified as the *demon* of every mineral, plant, or animal; and which was later categorized by medieval philosophers as the *elementary spirits* of the four kingdoms.

Trevelyan explains the kernel of Goethe's philosophy as lying in a metaphysical concept of nature.

> The godhead is at work in the living, not in the dead; it is present in everything in the process of development and transformation, not in what has already taken shape and rigidified. Thus, reason in its strivings towards the divine is concerned with putting to use what has already developed and grown torpid.

Seeing that every part of the plant is a metamorphosis of the archetypal "leaf" organ, Goethe came to the conception of an *archetypal* plant, or *Ur-pflanze*, a supersensible force capable of developing into myriad different forms. This, says Trevelyan, is no single plant, but a force that holds the potentiality of every plant form within it.

> All plants are thus seen as specific manifestations of the archetypal plant which controls the entire plant kingdom and gives the value to nature's artistry in creating forms. It is in ceaseless play within the world of plant form, capable of moving backwards and forwards, up and down, in and out, through the scale of forms.

Summing up his discovery, Goethe asked, "If all plants were not modeled on one pattern, how could I recognize that they are plants?" Filled with delight, Goethe declared he could now invent plant forms, even if they had never been realized on earth before.

From Naples Goethe wrote to his friend and fellow poet in Weimar, Johann Gottfried von Herder: "I must tell you confidentially that I am very close to the secret of the creation of plants, and that it is the simplest thing one could imagine. The archetypal plant will be the strangest creature in the world, which nature herself ought to envy me. With this model and the key to it, one can invent plants endlessly which must be consistent—that is, if they did not exist, yet they could exist, and not some artistic or poetic shadows and appearances but possessing inner truth and inevitability. The same law can be applied to everything living." Goethe now pursued the idea "with joy and ecstasy, lovingly immersing myself in it in Naples and Sicily," applying the idea to every plant he saw, writing reports to Herder on what took place "with as much enthusiasm as was manifested over the finding of the lost silver piece in the gospel parable."

For two years Goethe observed, collected, studied phenomena in detail, made many sketches and accurate drawings. "I pursued my botanical studies, into which I was guided, driven, forced—and then held captive by my interest." Back in Germany after two years in Italy, Goethe found that the new vision of life he had acquired was incomprehensible to his fellow countrymen.

> From Italy, rich in forms, I was plunged back into formless Germany, exchanging a sunny sky for a gloomy one. My friends, instead of comforting me and drawing me back to them, drove me to despair. My delight in things remote and almost unknown to them, my sorrow and grief over what I had lost, seemed to offend them. I received no sympathy, no one understood my language. I could not adjust myself to this distressing situation, so great was the loss to which my exterior senses must become reconciled. But gradually my spirit returned and sought to preserve itself intact.

Goethe set his thoughts on paper in a first essay, "On the Metamorphosis of Plants," in which he traced "the manifold specific phenomena in the magnificent garden of the universe back to one simple general principle," and stressed nature's method of "producing in accord with definite laws, a living structure that is a model of everything artistic." The essay, which was to generate the science of morphology in plants, was written in an unusual style, different from contemporary scientific writings in that it did not pursue each idea to its full conclusion but, in a cryptic manner, left room for interpretation. "Well satisfied with my brochure," says Goethe, "I was flattered to believe myself auspiciously launched on a career in science. But the same thing happened to me that I had experienced in purely literary work; once more, at the very outset, I was repulsed."

Goethe's regular publisher refused the manuscript, telling him he was a literary man, not a scientist. Goethe found it hard to understand why the publisher would not print the brochure when, "merely by risking six sheets of paper at the very most he might have retained for himself a prolific, reliable, easily satisfied author, who was just getting a fresh start." When the brochure was printed elsewhere Goethe was further surprised to find it completely ignored by botanist and public alike.

> The public [said Goethe] demand that every man remain in his own field. Nowhere would anyone grant that science and poetry can be united. People forgot that science had developed from poetry and they failed to take into consideration that a swing of the pendulum might beneficently reunite the two, at a higher level and to mutual advantage.

Goethe then made the mistake of giving away copies of the brochure to friends outside his immediate circle. These friends, said he, were by no means tactful in their comments.

> No one dared to accommodate himself to my method of expressing myself. It is most tormenting not to be understood when one feels sure himself, after a great stress and strain, that one understands both one's self and one's subject. It drove one to insanity to hear repeated again and again a mistake from which one has himself just escaped by a hair's breadth, and nothing is more painful than to have the things that should unite us with informed and intelligent men give rise instead to unbridgeable separation.

To his newly acquired friend and fellow poet Johann Christoph Friedrich von Schiller, Goethe gave a spirited explanation of his theory of the metamorphosis of plants, with graphic pen sketches of a symbolic plant. "He listened and looked with great interest, with unerring comprehension, but when I had ended he shook his head, saying: 'That is not an experience, that is an idea.'" Goethe was taken aback and a little irritated. Controlling himself he said: "How splendid that I have ideas without knowing it, and can see them before my eyes." From the argument Goethe was left with the philosophic concept that ideas must be clearly independent of space and time, whereas experience is restricted to space and time. "The simultaneous and successive are therefore intimately bound together in an idea, whereas they are always separated in experience."

It was eighteen years after the Congress of Vienna before references to the metamorphosis of plants began to appear in botanical texts and other writings, and thirty years before it was fully accepted by botanists. When the essay became known in Switzerland and France people were astonished to find that a poet "normally occupied with moral phenomena associated with feeling and power and imagination, could have achieved such an important discovery."

Late in life Goethe added another basic idea to the science of botany. With his perception carefully attuned to nature he realized—a generation before Darwin was to approach the same subject—that vegetation had a tendency to grow in two distinct ways: vertically and spirally. With

his poet's intuition Goethe labeled the vertical tendency, with its sustaining principle, male; the spiral tendency, which conceals itself during the development of the plant but predominates during blossoming and fruiting, he labeled female. "When we see," said Goethe, "that the vertical system is definitely male and the spiral definitely female, we will be able to conceive of all vegetation as androgynous from the root up. In the course of the transformation of growth the two systems are separated, and take opposite courses to be reunited on a higher level."

Goethe held a lofty and comprehensive view of the significance of the male and female principles as spiritual opposites in the cosmos. Lehrs elaborated on it: "In order that spiritual continuity may be maintained within the coming and going multitude of nature's creations, the physical stream must suffer discontinuity at certain intervals. In the case of the plant this discontinuity is achieved by the breaking asunder of the male and female growth-principles. When they have reunited, the type begins to abandon either the entire old plant or at least part of it, according to whether the species is an annual or a perennial one, in order to concentrate on the tiny seed, setting, as it were, its living seal on it."

To Goethe the fact that the action of the root of a plant is directed earthward toward moisture and darkness, whereas the stem or trunk strives skyward in the opposite direction toward the light and the air, was a truly magical phenomenon. To explain it Goethe postulated a force opposite, or polar, to Newton's gravity, to which he gave the name "levity." "Newton," says Lehrs, "explained to you—or at least was once supposed to explain, why an apple fell; but he never thought of explaining the exact correlative but infinitely more difficult question, how the apple got up there." The concept led Goethe to a picture of the earth as being surrounded and penetrated by a field of force in every respect the opposite of the earth's gravitational field.

"As the gravity field decreases in strength," says Lehrs, "with increasing distance from the center of the field, that is, in the outward direction, so does the levity-field decrease in strength with increasing distance from its periphery, or in the inward direction. . . . This is why things 'fall' under the influence of gravity and 'rise' under the influence of levity." Lehrs adds that if there were no field working outward toward the cosmic periphery, the entire material content of the earthly realm would be reduced by gravitation to a spaceless point, just as under the sole influence of the peripheral field of levity it would dissipate into the universe. "Just as in volcanic activity heavy matter is suddenly and swiftly driven heavenwards under the influence of levity, so in a storm does light matter stream earthwards under the influence of gravity."

Goethe, taking his inspiration from the Rosicrucian Aurea Catena of 1781, presumed to be authored by Herwerd von Forchenbrun, saw the whole universe as being moved by opposite polar forces which manifest as light and dark, or plus and minus in electricity, or oxidation and reduction in chemistry.

In his old age Goethe conceived the earth to be an organism animated by the same rhythm of inspiration and evaporation as a plant or an animal. He compared the earth and her hydrosphere, in which he included the humid atmosphere and its clouds, to a great living being perpetually inhaling and exhaling. He said:

> If she inhales, she draws the hydrosphere to her, so that, coming near her surface, it is condensed to clouds and rain. This state I call water-affirmative [*Wasser-Bejahung*]. Should it continue for an indefinite period, the earth would be drowned. This the earth does not allow, but exhales again, and sends the watery vapours upwards, where they are dissipated through the whole space of the higher atmosphere. These become so rarefied that not only does the sun penetrate them with its brilliance, but the eternal darkness of infinite space is seen through them as a fresh blue. This state of the atmosphere I call water-negative [*Wasser-Verneinung*]. For, just as under the contrary influence, not only does water come profusely from above, but also the moisture of the earth cannot be dried and dissipated—so, on the contrary, in this state not only does no moisture come from above, but the damp of the earth itself flies upwards; so that, if this should continue for an indefinite period, the earth, even if the sun did not shine, would be in danger of drying up.

The actual phenomenon of light Goethe considered to be inscrutable, but disagreed with Newton's concept that light waves were light itself and that light was composed of various colors. Goethe considered light waves to be the physical manifestation of eternal light. He saw light and dark to be polar opposites, with a series of colors formed by their interaction: darkness was not complete passive absence of light: it was

something active, something that opposed itself to light and interplayed with it. He imagined light and dark as being related like the north and south poles of a magnet. If darkness were absolute void, said Goethe, there would be no perception looking into the dark. The importance Goethe attached to his theory of color is clear from his statement late in life that "I do not attach importance to my work as a poet, but I do claim to be alone in my time in apprehending the true nature of color."

When Goethe died on March 22, 1832, twenty-seven years before Darwin was to proclaim his principle of organic evolution, he was considered Germany's greatest poet, with a universal mind capable of compassing every domain of human activity and knowledge. But as a scientist he was considered a layman.

Though a genus of plants, the Goethea, was named for him, as was a mineral, goethite, it was as a courtesy to a great man more than to a scientist. In due course Goethe was credited with having coined the word "morphology" and of having formulated the concept of botanical morphology which persists to this day. He was credited with the discovery of the volcanic origin of mountains, with establishing the first system of weather stations, with being interested in connecting the Gulf of Mexico with the Pacific Ocean, and with wanting to build steamships and flying machines; but the scope of Goethe's formulation of the metamorphosis of plants had to await the advent of Darwin to be fully appreciated, and even then it was largely misunderstood.

As Rudolf Steiner was to write, almost a hundred years later,

> It was from observations similar to those of Goethe that Darwin proceeded when he asserted his doubt as to the constancy of the external forms of genera and species. But the conclusions which the two thinkers reached were entirely unlike. Whereas Darwin considered that the whole nature of the organism was, in fact, comprised in these characteristics, and came to the conclusion, therefore, that there is nothing constant in the life of the plant, Goethe went deeper and drew the inference that, since those characteristics are not constant, what is constant must be sought in something else which lies beneath changeable externalities.

CHAPTER 8

Plants Will Grow to Please You

Goethe's poetic notion that a spiritual essence lies behind the material form of plants was put on a firmer basis by a medical doctor and a professor of physics at the University of Leipzig. Credited with over forty papers on such subjects as the measurement of electrical currents and the perceptions of colors, Gustav Theodor Fechner came to his profound understanding of plants in a totally unexpected way. In 1839 he began to stare at the sun in the hope of discovering the nature of afterimages, those strange pictures which seem to persist on the retina of the eye even after the cessation of normal visual stimulus.

A few days later, Fechner was horrified to realize that he was going blind. Exhausted from overwork, and unable in his new affliction to face his friends and colleagues, he retired to a darkened room with a mask over his face, to live in solitude praying for recovery.

One spring morning three years later, sensing that his sight had been restored, he emerged into the light of day. Joyously walking along the Mulde River he instantly recognized that flowers and trees along its banks were what he called be-souled. "As I stood by the water and watched a flower, it was as though I saw its soul lift itself from the bloom and, drifting through the mist, become clearer until the spiritual form hung clearly above it. Perhaps it wanted to stand on the roof of its budding house in order better to enjoy the sun. Believing itself invisible, it was quite surprised when a little child appeared."

While still in semi-seclusion Fechner began setting down a series of similar remarkable impressions. The result was *Nanna, or the Soul-Life of Plants,* published in Leipzig in 1848, which though scathingly rejected by his fellow academicians, became so popular that it was still being printed in Germany three-quarters of a century later.

In his introduction, Fechner explained that he happened on the title by accident. At first he thought of calling his new book *Flora,* after the Roman goddess of flowers, or *Hamadryas,* after the wood nymphs which the Hellenes recognized as living only as long as the trees of which they were the spirit. But he rejected the first as too botanical, the second as too classically stiff and antiquarian. One day, while reading Teutonic mythology, Fechner learned that Baldur, god of light, had, like Actaeon peeping at Diana, secretly gazed upon the naked form of the flower princess Nanna as she bathed in a stream. When her natural loveliness was enhanced by the energy over which Baldur ruled, his heart, said the legend, was pierced, and the marriage of Light and Flowers became a foregone conclusion.

Fechner's awakening to the soul life of plants turned him from professing physics to professing philosophy, of which branch of knowledge he was given a chair at Leipzig the same year that *Nanna* appeared. However, even before his realization that plants had undreamed-of sensitivity, Fechner had concerned himself with cosmic problems in his *Little Book of Life After Death,* posthumously published in Dresden in

1936, and in *Comparative Anatomy of the Angels,* a work which he considered so risqué that he wrote it under the pseudonym of Dr. Mises.

In the *Little Book* Fechner put forward the idea that human life was lived in three stages: one of continuous sleep from conception to birth; one of half wakefulness, which humans called terrestrial life; and one of fuller alertness, which began only after death. In *Comparative Anatomy* he traced the path of evolution from monocellular organisms through man on to angelic higher beings spherical in form and capable of seeing universal gravitation as ordinary humans perceive light, of communicating not acoustically but through luminous symbols.

Fechner introduced *Nanna* with the concept that believing whether plants have a soul or not changes one's whole insight into nature. If man admitted to an omnipresent, all-knowing, and almighty god who bestowed animation on all things, then nothing in the world could be excluded from this munificence, neither plant nor stone nor crystal nor wave. Why would universal spirit, he asked, sit less firmly in nature than in human beings, and not be as much in command of nature's power as it is of human bodies?

Anticipating Bose's work, Fechner further reasoned that if plants have life and soul, they must have some sort of nervous system, hidden perhaps in their strange spiral fibers. Going beyond the limitation of today's mechanistic physiology, Fechner referred to "spiritual nerves" in the universe, one expression of which was the interconnection of celestial bodies, not with "long ropes," but with a unified web of light, gravity, and forces as yet unknown. The soul, said Fechner, receives sensations, in a manner analogous to that of a spider which is alerted to outside influences by its web. It seemed reasonable to Fechner to accept the idea that plants have nerves, their purported absence being due to man's ignorance rather than to any innate vegetal deficiency.

According to Fechner, the psyche of plants is no more linked to their nervous system than is the soul of man to a human body. Both are diffused throughout, yet separated from all the organs which they direct. "None of my limbs anticipates anything for itself," wrote Fechner, "only I, the spirit of my whole, sense everything that happens to me."

Fechner created a new branch of learning called *psychophysics,* which

abolished the artificial separation between mind and body and held the two entities to be only different sides of one reality, the mind appearing subjectively, the body objectively, as a circle is either concave or convex depending on whether the observer stands inside it or outside. The confusion resulted, said Fechner, because it was difficult to hold both points of view simultaneously. To Fechner all things express in different ways the same *anima mundi,* or cosmic soul, which came into existence with the universe, is its conscience, and will die when and if the universe dies. Basic to his animate philosophy was the axiom that all life is *one* and simply takes up different shapes in order to divert itself. The highest good and supreme end of all action is the maximum pleasure not of the individual but of all, said Fechner, and on this he based all his rules for morals.

Since spirit to Fechner was a deistic universal, it was useless to refer to souls as wholly individual, whether vegetal or human. Nonetheless souls provided the only criteria for forming a conception of other souls and making themselves known to them by outward physical signs. To the undoubted irritation of today's prevalent school of behaviorist, "carrot-and-stick" psychology, Fechner also maintained that in its soul alone was the true freedom of any creature.

Because a plant is rooted, it necessarily has less freedom of movement than an animal, Fechner declared, though by moving its branches, leaves, and tendrils as it sees fit it behaves much like an animal which opens its claws upon capture or runs away when frightened.

More than a century before experiments in the Soviet Union apparently convinced the Russians that plants can regulate their own needs with the help of man-designed instrumentation, Fechner asked, "Why should we believe that a plant is not any less aware of hunger and thirst than an animal? The animal searches for food with its whole body, the plant with portions of it, guided not with nose, eyes or ears but with other senses." It seemed to Fechner that "plant people," calmly living their lives in the spots of their rooting, might well wonder why human bipeds keep rushing about. "In addition to souls which run and shriek and devour, might there not be souls which bloom in stillness, exhale fragrance and satisfy their thirst with dew and their impulses by their burgeoning?" Could not flowers, Fechner asked, communicate with each other by the very perfumes they exude, becoming aware of each other's presence by a means more delightful than the verbiage and breath of humans, which is seldom delicate or fragrant except, by coincidence, in lovers?

"From *inside* comes the voice," wrote Fechner, "and from inside comes the scent. Just as one can tell human beings in the dark from the tone of their voices, so in the dark, every flower can be recognized by its scent. Each carries the soul of its progenitor." Flowers having no fragrance he likened to animals which live alone in the wilds, and those with perfume to gregarious beasts. In the end, posited this German sage, was it not one of the ultimate purposes of human bodies to serve vegetal life, surrounding it by emitting carbon dioxide for the plants to breathe, and manuring them with human bodies after death? Did not flowers and trees finally consume man and, by combining his remains together with raw earth, water, air, and sunlight, transform and transmute human bodies into the most glorious forms and colors?

Fechner's "animism," for which he was so wrathfully castigated by his contemporaries, led him to issue, two years after *Nanna*, a book on atomic theory, in which, long before the birth of particle physics, he argued that atoms were centers of pure energy and the lowest elements in a spiritual hierarchy. The following year he brought out *Zendavesta*, its title inspired by the sacred writings of the ancient Zoroastrians, who claimed that their great religious leader Zarathustra had taught his people how to breed the food plants that still today form our chief source of nourishment. The original *Zendavesta* might be considered the first textbook on agriculture. Fechner's work was characterized by the younger American philosopher William James as a "wonderful book by a wonderful genius." Its fascinating and complex philosophy contained such concepts as that of "mental energy," which appealed strongly to Sigmund Freud and without which the edifice of psychoanalysis might never have been built.

Though Fechner heroically attempted to put forward what his contemporaries, and many present-day philosophers, would call "an idealistic view of reality," he ceaselessly tried to reconcile it with the methodology of modern science, in which he was trained.

Perhaps this was why the Leipzig physician and physicist, characterized as one of the most versatile thinkers of the nineteenth century, was so excellent an observer of the details of the vegetable world surrounding him. In *Nanna* he described the sex organs of plants—which in humans St. Paul considered so uncomely—as marvels of beauty, lyricizing on the manner in which plants lure insects to wriggle into their genitalia to drink the hidden nectar and thus shake fertilizing pollen from the anthers of some distant blossom onto the stigma of their petals. Fechner marveled at how plants could devise the most sophisticated systems to spread their species, how the puffball waits to be trodden upon in order to produce a cloud of minute spores which are carried a great distance by the wind, how the maple casts off propeller seeds that spin away with a passing breeze, how fruit trees seduce birds, beasts, and man into distributing their seeds afar, neatly packaged in nourishing manure, how viviparous water lilies and ferns reproduce tiny but perfect plants on the surface of their leaves.

Fechner also expatiated on plant roots, the sensitive tips of which enable plants to maintain a sense of direction, and on the climbing tendrils of plants which, searching for purchase, repeat perfect circles in the air.

Though Fechner's work was not taken seriously in his own time, one Englishman, whose life ran parallel to Fechner's, had the daring to recognize that some mysterious force in plants had the characteristics of sentience or intelligence. After publishing his earthshaking *Origin of Species* in 1859, Charles Robert Darwin devoted the greater part of his remaining twenty-three years not only to an elaboration on his theory of evolution but to a meticulous study of the behavior of plants.

In his 575-page *The Power of Movement in Plants*, published just before his death, Darwin developed in a more scientific way than Fechner the idea that the habit of moving at certain times of day was the common inheritance of both plants and animals. The most striking part of this similarity, he wrote, was "the localization of their sensitiveness, and the transmission of an influence from the excited part to another which consequently moves."

Though this seemed to imply that Fechner might have been correct in stating that plants, like animals, had nervous systems, Darwin stopped short of making this assertion because he could find no such system. Nevertheless, he could not get out of his mind that plants must have sentient ability. In the very last sentence of his massive volume, referring to the properties of a plant's radicle—that part of its embryo which develops into the primary root—he stated boldly: "It is hardly an exaggeration to say that the tip of the radicle acts like the brain of one of the lower animals: the brain being seated within the anterior end of the body, receiving impressions from the sense organs, and directing the several movements."

In an earlier book, *The Fertilization of Orchids,* published in 1862, one of the most masterful and complete studies on a single species of plant life ever to appear, Darwin set forth in highly technical language the way insects caused the fertilization of those unusual flowers, which he had learned of by sitting on the grass for hours and patiently watching the process.

In more than a dozen years of experiments conducted on fifty-seven species of plants Darwin found that products of cross-pollination resulted in more numerous, larger, heavier, more vigorous and more fertile offspring, even in species that are normally self-pollinating, and he put his finger on the secret of the production of such copious amounts of pollen. Though the odds were millions to one against it, if the pollen of an immobile plant could mix with a faraway relative, its offspring were likely to attain what came to be known as "hybrid vigor." Of this Darwin wrote that "the advantages of cross-fertilization do not follow from some mysterious virtue in the mere union of two distinct individuals, but from such individuals having been subjected during previous generations to different conditions, or to their having varied in a manner commonly called spontaneous, so that in either case their sexual elements have been in some degree differentiated."

For all his academic preciseness, the thrust of Darwin's theory of evolution and of the survival of the fittest indicated that something more than chance was in play. That this something might accommodate to the wish of man was the next extraordinary development.

In 1892, ten years after Darwin's death and five years after Fechner's, a fifty-two-page nurseryman's catalog, *New Creations in Fruits and Flowers,* published in Santa Rosa, California, created a sensation in the United States. Unlike similar booklets, which had thus far included not more than half a dozen novelties among the hundreds advertised, this catalog contained not a single plant known to man.

Among its horticultural marvels were a hardwood giant Paradox walnut, which, growing as fast as a spongy pulpwood, could form a hedge tall enough to screen a house within a few years; a giant daisy, named for Mount Shasta, with mammoth snow-white petals; an apple, sweet on one side and sour on the other; and a cross between a strawberry and a raspberry which, though it did not fruit, seemed as strange to followers of the theory of natural selection as would the mating of a chicken with an owl.

When the catalog finally made its way six thousand miles to the Netherlands, it caught the eye of an Amsterdam professor, Hugo De Vries, in the process of rediscovering the modern science of genetics—originated in the mid-nineteenth century by the Austrian monk Gregor Johann Mendel, but buried during his lifetime in the shelves of his monastery library. De Vries, later to be celebrated for carrying forward Darwin's life work with his own theory of mutation, was flabbergasted by the catalog and the apparent ability of one man to bring into the world botanical specimens undreamed of by nature. To satisfy his curiosity, De Vries set off across the world to visit the catalog's publisher, who turned out to be a New England transplant to California, Luther Burbank, whose feats with plants led to the new transitive verb *to burbank,** and his reputation as the "Wizard of Horticulture" was to infuriate botanists unable to understand the magic of his methods.

When De Vries came to Santa Rosa and saw growing in the "wizard's" front yard a fourteen-year-old Paradox walnut larger than the Persian variety four times its age and a monkey-puzzle tree which could stun passers-by by dropping twenty-pound nuts on their heads, he was dumbstruck that in the little cottage where Burbank worked there was

* *Webster's New International Dictionary,* 2d ed., lists: "Burbank, *v.t.* To modify and improve (plants or animals) esp. by selective breeding. Also to cross or graft (a plant). Hence, figuratively, to improve (anything, as a process or institution) by a selecting of good features and rejecting of bad, or by adding good features.

neither library nor laboratory and that Burbank's work notes were kept on tearings from brown-paper bags or the backs of letters and envelopes.

Throughout the evening the bewildered De Vries, who had expected files of carefully recorded data which might reveal Burbank's secrets, questioned the plant breeder, only to be told that his art was basically "a matter of concentration and the rapid elimination of non-essentials." As for his laboratory, Burbank told De Vries: "I keep it in my head."

The Dutch scientist was no more perplexed than were hundreds of his American confrères who, lacking any rational explanation for Burbank's methodology, often branded the wizard a charlatan. Burbank's own evaluation of the botanical fraternity did little to appease their collective ire. In 1901 Burbank told the San Francisco Floral Congress:

> The chief work of the botanists of yesterday was the study and classification of dried, shriveled plant mummies whose souls had fled. They thought their classified species were more fixed and unchangeable than anything in heaven or earth that we can now imagine. We have learned that they are as plastic in our hands as clay in the hands of the potter or color on the artists' canvas and can readily be molded into more beautiful forms and colors than any painter or sculptor can ever hope to bring forth.

Unlike the narrower minds which such simple and truthful statements drove to frenzy, De Vries, accepting Burbank as a natural-born genius, wrote of his work that "its value for the doctrine of evolution compels our highest admiration."

As his biographers almost inadvertently make clear, Burbank was and remains an enigma. Born in 1849 in the rural Massachusetts village of Lunenburg, the lasting impressions from his schooling came from his reading of Henry David Thoreau and of the other great naturalists Alexander von Humboldt and Louis Agassiz. But even these were overshadowed when he devoured, shortly after its publication in 1868, Charles Darwin's massive two-volume *The Variation of Animals and Plants Under Domestication.* Burbank was deeply impressed by its theme that organisms, when removed from their natural conditions, vary.

While still in Massachusetts, Burbank one day happened upon a seed ball in his patch of potatoes—a vegetable which almost never sets seed

and is therefore propagated from the buds, or "eyes," of its tuber. Because he knew that potato seeds, if they could be found, would not grow tubers true to type, and instead would produce a curious batch of mongrels, he excitedly thought that one of them might develop into a potato miracle. One of the twenty-three seeds in the ball gave rise to an offspring that managed to double the average yield. Smooth, plump, an excellent baker, the new potato, unlike its red-skinned progenitor, was creamy-white.

Burbank received $150 from a Marblehead seedman for his discovery and the compliment that it was the best potato the seedman had ever eaten. Christened the "Burbank," it was later widely planted by growers in the San Joaquin River delta town of Stockton, California, who gratefully presented to Burbank its solid gold miniature replica. Today it dominates the U.S. potato market. Three days after the original sale—following the terse advice he later gave to a New England farmer who asked him what he should raise on some newly acquired acreage, "Enough money to go to California"—Burbank was on a cross-continental train.

Shortly after Burbank's arrival in Santa Rosa, Darwin's *The Effects of Cross and Self Fertilisation in the Vegetable Kingdom* came out, and Burbank was particularly struck by a challenging introductory statement: "As plants are adapted by such diversified and effective means for cross-fertilization, it might have been inferred from this fact alone that they derived some great advantage from the process." To Burbank, this sentence seemed both a blueprint and a command. If Darwin had drawn plans, he would carry them out.

Burbank's first chance for fame came in the spring of 1882 when a variety of plums known as prunes were coming into their own in hundreds of California orchards as a new money-making fruit, easily dried and thus easily shipped and slow to spoil. In March a canny banker in the neighboring town of Petaluma, fearful lest he miss the bonanza, asked Burbank if he could deliver twenty thousand young prune trees for a two-hundred-acre planting by December. Everyone else, said the worried banker, had told him this was impossible. Burbank knew that if the man had given him two years nothing would have been simpler than to sprout plum trees from seed, bud them with prunes in the late summer, and after cutting off the original plum tops, watch them develop into prune seedlings the year following. How, he asked himself, could he turn the same trick in eight months?

It then struck Burbank that almonds, a member of the genus *Prunus*, would sprout much faster than the hard stones of plums. After buying a sackful of the oval-shaped nuts, Burbank forced them to sprout in warm water, copying a method he had used with corn in Massachusetts, which allowed him to beat other farmers to the market by more than a week. Even so, the little seedlings were not ready for budding until June, and time was running short. With a cash advance from the banker, Burbank hired all available nursery help in the region. They worked around the clock; when the job was finished, Burbank prayed that his tiny seedlings would grow into trees as tall as the average woman in the four months remaining before the contract called for delivery. His luck held; before Christmas he was able to deliver 19,500 trees to the overjoyed banker. Other nurserymen were left gasping at the feat, which not only produced a $6,000 windfall for Burbank but taught him that mass production was one of the keys to prodding out of nature secrets she was normally unwilling to give up.

Thus began Burbank's pomological revolution, which led to the development of new prunes and plums—including one, the Climax, which tasted like a pineapple, and another which tasted like a pear—that today still account for over half of California's giant crop; the ever-popular Burbank July Elberta peach, a luscious Burbank Flaming Gold nectarine, a bush-type chestnut, which bore a crop six months after its seed was put in the ground, a white blackberry the color of an icicle, and two quinces that were so good that most nurseries still stock no other.

In developing new fruit, Burbank was so adept and fast that he could race through thousands of cross-pollinations while orthodox plant specialists in laboratories were pedantically poring over sheaves of notes involving only a few dozen. It was no wonder that the schoolmen increasingly accused him of trickery, mainly of buying his "new creations" abroad. For Burbank, convinced that plants, like people, would behave differently when away from home, would order, from as far away as Japan and New Zealand, experimental varieties to cross with home-

grown standbys. Burbank introduced over a thousand new plants, which, if evenly spaced over his working career, would have amounted to a never-before-seen specimen every three weeks. Despite the backbiting cavils from envious and narrow-minded scientists, this miracle making was heralded by professional experts big enough to recognize genius when they saw it, even if it passed their understanding.

Liberty Hyde Bailey, the universally recognized dean of American botany, who had earlier told a world horticultural congress that "man could not do much to produce variations in plants," came from Cornell University to see what Burbank was doing to create such a furor. He left Santa Rosa stupefied and wrote the same year in an issue of *World's Work* magazine:

> Luther Burbank is a breeder of plants by profession, and in this business he stands almost alone in this country. So many and so striking have been the new plants that he has given to the world that he has been called the "Wizard of Horticulture." This sobriquet has prejudiced a good many people against his work. Luther Burbank is not a wizard. He is an honest, straight-forward, careful, inquisitive and persistent man. He believes that causes produce results. He has no other magic than that of patient inquiry, abiding enthusiasm, an unprejudiced mind, and a remarkably acute judgement of the merits and capabilities of plants.

This was a delight to Burbank, who smarted from the ugly rumors circulated about his work in the halls of academe. He told a packed lecture hall at Stanford University that "Orthodoxy is ankylosis—nobody at home: ring up the undertaker for further information!" Professor H. J. Webber, a geneticist in charge of plant breeding at the U.S. Department of Agriculture, maintained that Burbank had single-handedly saved the world nearly a quarter of a century in plant-breeding time. David Fairchild, who spent years exploring the world for new plants which might prove commercially useful in the United States, though baffled by Burbank's methods, summed up his impressions of his visit to Santa Rosa in a letter to a friend: "There are those who say Burbank is not scientific. It is true only in the sense that he has tried to do so much, and has been so fascinated by the desire to create that he has not always noted and labeled the footsteps which he has taken."

Just watching Burbank at work took the breath away from countless observers. On his experimental farm in nearby Sebastopol, where forty thousand Japanese plums or a quarter of a million flowering bulbs could be seen growing at the same time, Burbank would walk down a row of thousands of plants—whether tiny seedlings just breaking ground or chest-high flowers nearing maturity—and without breaking his stride pick out those likely to succeed. One wide-eyed county farm adviser described this in his own words: "He'd go along a row of gladioli, yanking out the ones he didn't want as fast as he could pull them up. He seemed to have an instinct that told him if a tiny plant would grow up to bear the kind of fruit or flowers he wanted. I couldn't see any difference between them, even if I stooped and looked closely, but Burbank did no more than glance at them."

Burbank's catalogs described his results in such a way that readers could imagine he had thousands of workers and several genies helping him: "Six new gladioli, the best of a million seedlings." "The growing of 10,000 hybrid clematis plants for several years to get a final six good ones." "Discarding 18,000 calla lilies in order to get one plant." "My Royal Walnut can outgrow ordinary walnuts eight to one and promises to revolutionize the furniture business and also perhaps the cord-wood industry."

When, on the 18th day of April, 1906, the same earthquake which all but devastated San Francisco reduced Santa Rosa to a mass of flaming splinters and rubble, the overwhelmed citizens were further stunned that not a pane of glass in Burbank's huge greenhouse not far from the center of town was even cracked.

Burbank was less amazed than his fellow townsmen, though careful not to broach the subject directly in public, surmising that his communing with the forces of nature and the cosmos and his success with plants might well have protected his greenhouse.

His indirect allusions to the personalization of his plants are illustrated by an article he wrote in 1906 for *Century Magazine:*

> The most stubborn living thing in this world, the most difficult to swerve [he asserted] is a plant once fixed in certain habits. Remember that this plant has preserved its individuality all through the ages; perhaps it is one which can be traced backward through eons of time in the very rocks themselves. Do you suppose, after all these ages of repetition, the plant does not become possessed of a will, if you so choose to call it, of unparalleled tenacity?

To Manly P. Hall, founder and president of the Philosophical Research Society of Los Angeles and a student of comparative religion, mythology, and esoterica, Burbank revealed that when he wanted his plants to develop in some particular and peculiar way not common to their kind he would get down on his knees and talk to them. Burbank also mentioned that plants have over twenty sensory perceptions but, because they are different from ours, we cannot recognize them. "He was not sure," wrote Hall, "that the shrubs and flowers understood his words, but he was convinced that by some telepathy, they could comprehend his meaning."

Hall later confirmed what Burbank told the famous yogi, Paramahansa Yogananda, about his development of the spineless cactus, a years-long procedure during which Burbank at first had to pull thousands of cactus thorns from his hands with pliers, though in the end the cacti grew without thorns. "While I was conducting my experiments with cacti," said Burbank, "I often talked to the plants to create a vibration of love. 'You have nothing to fear,' I would tell them. 'You don't need your defensive thorns. I will protect you.'" Burbank's power of love, reported Hall, "greater than any other, was a subtle kind of nourishment that made everything grow better and bear fruit more abundantly. Burbank explained to me that in all his experimentation he took plants into his confidence, asked them to help, and assured them that he held their small lives in deepest regard and affection."

Helen Keller, deaf and blind, after a visit to Burbank, wrote in *Outlook for the Blind:* "He has the rarest of gifts, the receptive spirit of a child. When plants talk to him, he listens. Only a wise child can understand the language of flowers and trees." Her observation was particularly apt since all his life Burbank loved children. In his essay "Training of the Human Plant," later published as a book, he anticipated the more humane attitudes of a later day and shocked authoritarian parents by saying, "It is more important for a child to have a good nervous system than to try to 'force' it along the line of book knowledge at the expense of its spontaneity, its play. A child should learn through a medium of pleasure, not of pain. Most of the things that are really useful in later life come to the children through play and through association with nature."

Burbank, like other geniuses, realized that his successes came from having conserved the exuberance of a small boy and his wonder for everything around him. He told one of his biographers: "I'm almost seventy-seven, and I can still go over a gate or run a foot race or kick the chandelier. That's because my body is no older than my mind—and my mind is adolescent. It has never grown up and I hope it never will."

It was this quality which so puzzled the dour scientists who looked askance at his power of creation and bedeviled audiences who expected him to be explicit as to how he produced so many horticultural wonders. Most of them were as disappointed as the members of the American Pomological Society, gathered to hear Burbank tell "all" during a lecture entitled "How to Produce New Fruits and Flowers," who sat agape as they heard him say:

> In pursuing the study of any of the universal and everlasting laws of nature, whether relating to the life, growth, structure and movements of a giant planet, the tiniest plant or of the psychological movements of the human brain, some conditions are necessary before we can become one of nature's interpreters or the creator of any valuable work for the world. Preconceived notions, dogmas and all personal prejudice and bias must be laid aside. Listen patiently, quietly and reverently to the lessons, one by one, which Mother Nature has to teach, shedding light on that which was before a mystery, so that all who will, may see and know. She conveys her truths only to those who are passive and receptive. Accepting these truths as suggested, wherever they may lead, then we have the whole universe in harmony with us. At last man has found a solid foundation for science, having discovered that he is part of a universe which is eternally unstable in form, eternally immutable in substance.

Had he known of Fechner, Burbank would have agreed with him "that it is a dark and cold world we sit in if we will not open the inward eyes of the spirit to the inward flame of nature."

CHAPTER 9

Wizard of Tuskegee

That plants were able to reveal their hidden secrets upon request was accepted as normal and natural by a remarkable genius born just before the Civil War, the agricultural chemist George Washington Carver, who overcame the handicap of his slave descent to be heralded in his own lifetime as the "Black Leonardo."

During a stunningly creative career, with methods as incomprehensible to his fellow scientists as were those of his professional forebears the alchemists, Carver turned the lowly peanut, considered useful only as hog food, and the unknown sweet potato into hundreds of separate products, ranging from cosmetics and axle grease to printer's ink and coffee.

From the time he was able to get about by himself in the countryside young Carver began to display an uncanny knowledge of all growing things. Local farmers in Diamond Grove, a tiny community in the foothills of the Ozarks in southwestern Missouri, remembered the weak-looking boy roving for hours through their holdings, examining plants and bringing back certain varieties with which he could miraculously heal sick animals. On his own, the child planted a private garden in a remote and unused bit of bottomland. With the remnants of coldframes and other stray material he built a secret greenhouse in the woods. Asked what he was forever doing all by himself so far from the farmyard, Carver replied firmly if enigmatically, "I go to my garden hospital and take care of hundreds of sick plants."

Farmers' wives from all over the countryside began bringing him their ailing house plants, begging him to make them bloom. Gently caring for them in his own way, Carver often sang to them in the same squeaky voice which characterized him in manhood, put them in tin cans with special soil of his own concoction, tenderly covered them at night, and took them out to "play in the sun" during the day. When he returned the plants to their owners, and repeatedly was asked how he could work his miracles, Carver only said softly: "All flowers talk to me and so do hundreds of little living things in the woods. I learn what I know by watching and loving everything."

Enrolling in Simpson College in Indianola, Iowa, Carver supported himself through his skill as a laundryman by doing shirts for students, then transferred to the Iowa State College of Agriculture. There among his most lasting impressions was the statement of his best-loved teacher, Henry Cantwell Wallace, editor of the popular *Wallace's Farmer*, that "nations endure only as long as their topsoil." Carrying a heavy load of course work and employed by churches as an entirely self-taught organist, Carver found time to take Wallace's six-year-old grandson on long walks into the woods to talk with plants and fairies, little suspecting that the hand he was holding would be that of a Secretary of Agriculture, and later, two years before Carver's own death, Vice President of the United States.

By 1896, Carver had his master's degree and was invited to join the

faculty. However, when the founder and president of the Normal and Industrial Institute, Booker T. Washington, who had heard of Carver's brilliance, asked him to come to Tuskegee, Alabama, and run the institute's agricultural department, Carver decided, like Sir Jagadis Chandra Bose, that he could not let the prospect of a comfortable and well-paying post on the Iowa State faculty dissuade him from serving his own people. So he accepted.

Carver had not been back in the South more than a few weeks when he discerned that the main problem facing the flat land spreading out in hundreds of square miles around him was its slow poisoning through monotonous planting year in year out of a single crop, cotton, which for generations had been sucking fertility out of the soil. To counteract the despoliation by thousands of sharecroppers, he decided to set up an experimental station. There he had a private laboratory, christened "God's Little Workshop," in which he would sit for hours communing with plants and into which he never allowed a single book to penetrate.

For his students at Tuskegee he made his lectures as simple and yet as thoroughgoing as possible. When the chancellor of the University of Georgia, W. B. Hill, came to Tuskegee to see for himself if it was true that a Negro professor was as brilliant as rumor had reported, he declared that Carver's presentation on the problem of Southern agriculture was "the best lecture that it has ever been my privilege to attend." Carver's students were greatly impressed that each morning he would rise at four o'clock to walk in the woods before the start of the working day and bring back countless plants with which to illustrate his lectures. Explaining this habit to friends, Carver said, "Nature is the greatest teacher and I learn from her best when others are asleep. In the still dark hours before sunrise God tells me of the plans I am to fulfill."

For more than a decade Carver worked daily on experimental plots of soil trying to discover exactly how to change Alabama's enthrallment by "ol' debbil cotton." On one nineteen-acre plot he put no commercial fertilizer, benefiting it instead with nothing but old dead leaves from the forest, rich muck from the swamps, and barnyard manure. The plot furnished such bountiful harvests of rotated crops that Carver came to the conclusion that "in Alabama the very fertilizers which existed in almost unlimited supply were allowed to go to waste in favor of commercially sold products."

As a horticulturalist, Carver had noticed that the peanut was incredibly self-sufficient and could grow well in poor soil. As a chemist, he discovered that it equaled sirloin steaks in protein and potatoes in carbohydrates. Late one evening while pondering the problem in his workshop Carver stared at a peanut plant and asked, "Why did the Lord make you?" In a flash, he received the briefest of answers: "You have three things to go by: compatibility, temperature, and pressure."

With this slim advice Carver locked himself in his laboratory. There, throughout a sleepless week, he began breaking down the peanut into its chemical components and exposing them by trial and error to different conditions of temperature and pressure. To his satisfaction he found that one-third of the little nut was made up of seven different varieties of oil. Working round the clock, he analyzed and synthesized, took apart and recombined, broke down and built up the chemically differentiable parts of the peanut until at last he had two dozen bottles, each containing a brand-new product.

Leaving his laboratory, he convoked a meeting of farmers and agricultural specialists and showed them what he had been able to do in seven days and seven nights. He begged his audience to plow under the soil-destroying cotton and plant peanuts in its stead, assuring them that it would produce a cash crop far more valuable than its sole existing use as food for pigs might indicate.

The audience was doubtful, the more so when Carver, asked to explain his methods, replied that he never groped for them but that they came to him in flashes of inspiration while walking in the woods. To allay their doubts he began to issue bulletins, one of which stated incredibly that rich, nutritious, and highly palatable butter could be made from the peanut, and that whereas it took one hundred pounds of dairy milk to make ten pounds of butter, a hundred pounds of peanuts could produce thirty-five pounds of peanut butter. Other bulletins showed how a cornucopia of products could also be extracted from the sweet potato, a tropical vine of which most Americans had never heard, that throve in the South's cotton-debased soil. When World War I broke out, and the

shortage of dyestuffs presented itself as a serious national problem, Carver rambled at daybreak through the mist and dew, inquiring of his plant friends which of them could alleviate the deficit. From the leaves, roots, stems, and fruits of twenty-eight volunteers he coaxed 536 separate dyes, which could be used to color wool, cotton, linen, silk, and even leather, producing 49 of them from the scuppernong grape alone.

At last his labors attracted national attention. When it was bruited that at Tuskegee Institute they were saving two hundred pounds of wheat per day by mixing two parts of ordinary flour with a new flour derived from sweet potatoes, a flock of dieticians and food writers interested in cooperating with the wartime drive to economize on wheat came to investigate. They were served delicious breads made from the mixed flours, along with a sumptuous lunch of five courses each made from peanuts or sweet potatoes, or, like Carver's "mock chicken," from the two combined. The only other vegetables on the table were sheep sorrel, pepper grass, wild chicory, and dandelions, served as a salad to illustrate Carver's assertion that plants growing in nature were far better than those from which the natural vitality had been removed in cultivation. The food experts, who realized that Carver's contributions might go a long way to helping the war effort, rushed to telephone their papers, and Carver, who had become known to scientists the year before when he was elected a fellow of Great Britain's famous Royal Society, now appeared in the headlines.

Invited to Washington, Carver dazzled government officials with dozens of products, including a starch valuable to the textile industry which later became a component in the glue of billions of U.S. postage stamps.

Next it came to Carver that peanut oil could help the atrophied muscles of polio victims. Results were so astonishing that he had to set aside one day each month to treat patients who came to his laboratory on stretchers, crutches, or canes. This feat remained as unheralded in medicine as the application of castor-oil packs, recommended about the same time by the "sleeping prophet," Edgar Cayce, with which doctors of an intrepidly investigative frame of mind are only today beginning to achieve startling, and wholly inexplicable cures.

By 1930, the peanut's one-time worthlessness had been converted, through Carver's clairvoyance, into a quarter of a billion dollars for Southern farmers, and had created a huge industry. Peanut oil alone was valued at $60 million a year and peanut butter was establishing itself as one of the favorite foods of even the poorest American child. Not satisfied with his achievements, Carver went on to make paper from a local Southern pine tree which ultimately helped to spur lumberers to cover millions of Southern acres with productive forests where only scrub woods had existed.

In the midst of the depression, Carver was again invited to Washington to testify before the powerful Ways and Means Committee of the U.S. Senate, which was considering the Smoot-Hawley tariff bill designed to protect struggling American manufacturers. Dressed in his usual, seemingly eternally durable, two-dollar black suit, with an ever-present flower in its buttonhole and a home-made necktie, Carver, upon his arrival at Union Station, was rebuffed by a waiting porter who, when Carver asked him to help him with his bags and direct him to Congress, replied: "Sorry, Pop, I ain't got time for you now. I'm expecting an important colored scientist coming from Alabama." Patiently Carver hefted his own bags to a taxi which took him to Capitol Hill.

Though the committee had accorded him no more than ten minutes to testify, when he began his presentations and took from his bag face powders, petroleum substitutes, shampoos, creosote, vinegar, wood-stains, and other samples of the countless creations concocted in his laboratories, the Vice President of the United States, testy "Cactus Jack" Garner from Texas, overruled protocol and told Carver he could have as much time as he liked because his demonstration was the best that he had ever seen presented to a Senate committee.

In half a lifetime of research Carver, though he created fortunes for thousands, rarely took out a patent on any of his ideas. When practical-minded industrialists and politicians reminded him of the money he might have made had he only afforded himself this protection, he replied simply: "God did not charge me or you for making peanuts. Why should I profit from their products?" Like Bose, Carver believed that the fruit of his mind, however valuable, should be granted free of charge to mankind.

Thomas A. Edison told his associates that "Carver is worth a fortune" and backed up his statement by offering to employ the black chemist at an astronomically high salary. Carver turned down the offer. Henry Ford, who thought Carver "the greatest scientist living," tried to get him to come to his River Rouge establishment, with an equal lack of success.

Because of the strangely unaccountable source from which his magic with plant products sprang, his methods continued to be as wholly inscrutable as Burbank's to scientists and to the general public. Visitors finding Carver puttering at his workbench amid a confusing clutter of molds, soils, plants, and insects were baffled by the utter and, to many of them, meaningless simplicity of his replies to their persistent pleas for him to reveal his secrets.

To one puzzled interlocutor he said: "The secrets are in the plants. To elicit them you have to love them enough."

"But why do so few people have your power?" the man persisted. "Who besides you can do these things?"

"Everyone can," said Carver, "if only they believe it." Tapping a large Bible on a table, he added, "The secrets are all here. In God's promises. These promises are real, as real as, and more infinitely solid and substantial than, this table which the materialist so thoroughly believes in."

In a celebrated public lecture, Carver related how he had been able to call forth from the low mountains of Alabama hundreds of natural colors from clays and other earths, including a rare pigment of deep blue which amazed Egyptologists, who saw rediscovered in it the blue color found in the tomb of Tutankhamen, as bright and fresh after so many centuries as it was when it had been first applied.

When Carver was eighty or thereabouts—his exact date of birth never having been established since no records were kept for slave children—he addressed a meeting of chemists in New York as World War II was erupting in Europe.

"The ideal chemist of the future," said Carver, "will not be satisfied with humdrum day-to-day analysis, but is one who dares to think and work with an independence not permissible heretofore, unfolding before our eyes a veritable mystic maze of new and useful products from material almost or quite beneath our feet and now considered of little or no value."

Not long before Carver's death a visitor to his laboratory saw him reach out his long sensitive fingers to a little flower on his workbench. "When I touch that flower," he said rapturously, "I am touching infinity. It existed long before there were human beings on this earth and will continue to exist for millions of years to come. Through the flower, I talk to the Infinite, which is only a silent force. This is not a physical contact. It is not in the earthquake, wind or fire. It is in the invisible world. It is that still small voice that calls up the fairies."

He suddenly stopped and after a moment of reflection smiled at his visitor. "Many people know this instinctively," he said, "and none better than Tennyson when he wrote:

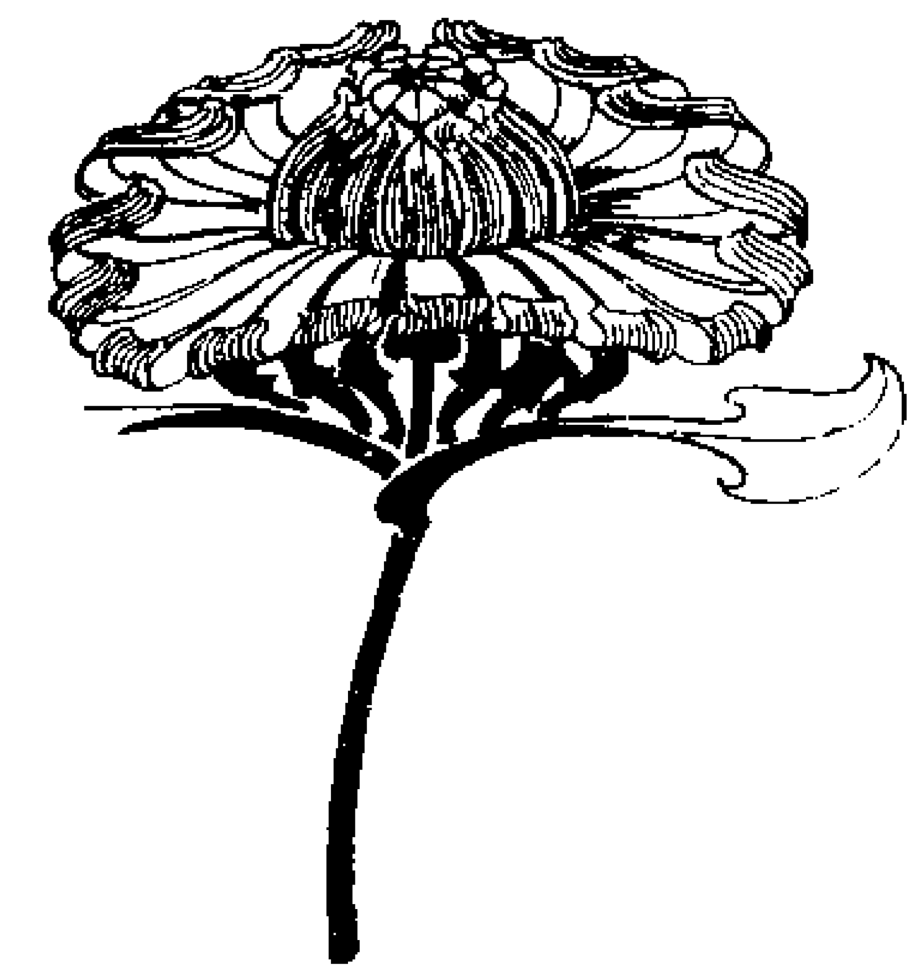
> "Flower in the crannied wall,
> I pluck you out of the crannies,
> I hold you here, root and all, in my hand,
> Little flower—but *if* I could understand
> What you are, root and all, and all in all,
> I should know what God and man is."

PART III

TUNED TO THE MUSIC OF THE SPHERES

CHAPTER 10

The Harmonic Life of Plants



The strangest experiment Charles Darwin ever performed on a plant was to sit before his *Mimosa pudica,* or touch-me-not, and play to it his bassoon in close enough proximity to see if he could stimulate its pinnae, or feathery leaflets, into movement. The experiment failed but was exotic enough to stimulate the renowned German plant physiologist Wilhelm Pfeffer, author of the classic *Handbuch der Pflanzenphysiologie,* into attempting, also unsuccessfully, to provoke stamens of *Cynararea,* a small genus of erect herbs, into response by means of sound.

In 1950 when Professor Julian Huxley, the biologist grandson of Thomas Henry Huxley and brother of novelist Aldous, was visiting Dr.

T. C. Singh, head of the department of botany at Annamalai University south of the Tamil-speaking city of Madras, he found his host studying through a microscope the live streaming of protoplasm in the cells of *Hydrilla verticillata,* an aquatic plant of Asian origin with long transparent leaves. Aware of both Darwin's and Pfeffer's experiments, Huxley was struck by the idea that the magnification might be sufficient for his host to see if the streaming process could be affected by sound.

Because the streaming of protoplasm in vegetation begins to speed up after sunrise, Singh placed an electrically operated tuning fork six feet from a *Hydrilla,* and microscopically observed that the fork's note, broadcast for half an hour just before 6 A.M., caused the protoplasm to stream at a speed normally attained only much later in the day.

Singh next asked his young assistant, Stella Ponniah, an accomplished dancer and violinist, if she would play notes on her instrument while standing near a *Hydrilla.* When the girl stroked her strings at a certain pitch, the protoplasm's streaming was again accelerated.

Because the *raga,* a traditional form of South Indian devotional song, has a tonal system which can produce a deep religious feeling and specific emotions in a listener, Singh decided to try its tones on the *Hydrilla.*

Lord Krishna, the eighth and principal avatar and incarnation of the Hindu deity Vishnu, was reputed to have promoted with music enthralling growth and bewitching verdure in Vrindavan, a city on the banks of the Jamuna River in north-central India long famous for its saint-musicians. Much later a courtier of the famous Moghul emperor Akbar is reported to have been able to perform such miracles with his songs as to bring on rain, light oil lamps, vernalize plants and induce them to blossom simply by intoning *ragas* at them. This appealing idea is confirmed in Tamil literature, which refers to the eyes, or buds, of sugar cane growing vigorously in response to the mellifluous buzzing of speckled beetles and to the profuse oozing of sugary nectar from the golden flowers of *Cassia fistula* when serenaded with heart-melting melodies.

Knowing this ancient lore, Singh asked his assistant to play the South Indian tune *"Maya-malava-gaula raga"* to mimosas. After a fortnight, to Singh's intense excitement, he discovered that the number of stomata

per unit area in the experimental plants was 66 percent higher, the epidermal walls were thicker, the palisade cells were longer and broader than in control plants, sometimes by as much as 50 percent.

Encouraged to further experimentation, Singh requested Gouri Kumari, a lecturer at Annamalai's Music College, to play a *raga* known as the *"Kara-hara-priya"* to some balsam plants. Kumari, a virtuoso, played for twenty-five minutes each day, on a fretted lutelike instrument usually fitted with seven strings, the *veena* traditionally associated with Saraswati, goddess of wisdom. During the fifth week, the experimental balsams began to shoot ahead of their unserenaded neighbors and, at the end of December, had produced an average of 72 percent more leaves than the control plants, and had grown 20 percent higher.

Singh then experimented on a vast number of species, such as common asters, petunias, cosmos, and white spider lilies, along with such economic plants as onions, sesame, radishes, sweet potatoes, and tapioca.

Each of these species Singh entertained for several weeks just before sunrise with more than half a dozen separate *ragas,* one per experiment, played on the flute, violin, harmonium, and *veena;* the music lasted a half hour daily, scaled at a high pitch, with frequencies between one hundred and six hundred cycles per second. From all this experimentation Singh was able to state, in the magazine of the Bihar Agricultural College at Sabour, that he had "proven beyond any shadow of doubt that harmonic sound waves affect the growth, flowering, fruiting, and seed-yields of plants."

As a result of his success, Singh began wondering whether sound, properly prescribed, could spur field crops to greater yields. From 1960 to 1963 he piped the *"Charukesi raga"* on a gramophone via a loudspeaker to six varieties of early, medium, and late paddy rice growing in the fields of seven villages located in the state of Madras and in Pondicherry on the Bay of Bengal, and got harvests ranging consistently from 25 to 60 percent higher than the regional average. He also was able musically to provoke peanuts and chewing tobacco into producing nearly 50 percent more than normal. Singh further reported that merely by dancing the *"Bharata-Natyam,"* India's most ancient dance style, without musical accompaniment and executed by girls without trinkets on their ankles, the growth of Michaelmas daisies, marigolds, and petunias was very much accelerated, causing them to flower as much as a fortnight earlier than controls, presumably because of the rhythm of the footwork transmitted through the earth.

Replying to a question which he thought would "naturally bristle up" in the minds of his readers, as to exactly what caused the effect on plants, Singh explained that in his laboratories he could visually demonstrate that the fundamental metabolic processes of plants in relation to transpiration and carbon assimilation under the excitation of musical sound or rhythmic beat were very much accelerated and increased over 200 percent compared to controls. "The stimulated plants," wrote Singh, "are energized to synthesize greater quantities of food during a given period of time, which naturally leads to greater yields." Singh also reported that his method of musical stimulation has even increased the chromosome count of certain species of water plants and the nicotine content of tobacco leaves.

Though the Indians of the subcontinent, both ancient and modern, appear to have been the first to produce a significant effect on plants with music or sound, they are by no means the only ones. In the Milwaukee, Wisconsin, suburb of Wauwatosa, a florist, Arthur Locker, began piping music into his greenhouses in the late 1950s. The difference he observed in flower production before and after the broadcasts was sufficiently marked to convince Locker that music powerfully contributed to horticulture. "My plants grew straighter, germinated quicker, bloomed more abundantly," he said. "The colors of the flowers were more striking to the eye, and the blooms lasted longer than usual."

At about the same time a Canadian engineer and gentleman farmer, Eugene Canby, of Wainfleet, Ontario, broadcast the violin sonatas of Johann Sebastian Bach to a test plot of wheat and produced a crop not only 66 percent greater than average but with larger and heavier seeds. Since the wheat growing in those areas of the plot where the soil was inferior did just as well as those growing in the richest earth, it seemed to Canby that Bach's musical genius was as good as or better than nutrients.

In 1960 in the agricultural community of Normal, Illinois, a botanist

and agricultural researcher, George E. Smith, learned of Singh's experiments while chatting with the farm editor of his local newspaper. The following spring, Smith, somewhat skeptically, planted corn and soybeans in flats and divided them between two identical greenhouses, both kept precisely at the same level of temperature and humidity. In one of the greenhouses he installed a small record player, its speaker directed toward the experimental plants, and played George Gershwin's "Rhapsody in Blue" twenty-four hours a day. According to Smith's report to his employer, Mangelsdorf and Bros., Inc., wholesale field seed suppliers in St. Louis, Missouri, the Gershwin-inspired seedlings sprouted earlier than those given the silent treatment, and their stems were thicker, tougher, and greener.

Smith, still skeptical, was not satisfied with his subjective observations. Removing ten corn and ten soybean plants from each of the greenhouses, he carefully cut them at ground level and immediately weighed them on apothecary scales. To his surprise the ten corn plants which had been enjoying Gershwin's music weighed 40 grams and those deprived of it only 28 grams; the corresponding soybean plants' weights were 31 and 25 grams respectively.

The following year Smith continuously broadcast music to a small plot of Embro 44XE hybrid corn from the day of its planting to harvest time. The plot produced 137 bushels to the acre as against only 117 bushels for an untreated plot of similar corn growing under the same conditions. Smith noted that the musically entertained corn also grew more rapidly and uniformly and silked earlier. The larger yield per acre was due not to an increase per plant but to a greater survival of plants in the plot. To make sure that his tests were not due to chance, Smith laid out four corn plots in 1962 planted not only with the same Embro 44XE but also with another highly prolific hybrid, Embro Departure. The first plot was treated to the previous year's music, the second left silent, and the third and fourth offered only ear-splitting continuous notes, one with a high pitch of 1,800 cycles a second, the other with a low pitch of 450. At harvest time the Departure plants stimulated with music produced 186 bushels per acre as against only 171 for the silent plot. But those exposed to the high note outdid themselves to achieve nearly 198 bushels; those subjected to the low note topped 200. Gains for the Embro 44XE were less pronounced, though Smith had no idea why.

Pressed by his neighbors from several counties around to explain his results, Smith speculated that sound energy might increase molecular activity in the corn, and added that thermometers placed in the plots indicated that soil temperature was inexplicably two degrees higher directly in front of the loudspeaker. Smith was perplexed that the edges of the leaves of those corn plants growing in the slightly heated earth appeared a little burned, but thought this might be due to excessive exposure to musical vibrations. There were many unresolved mysteries, said Smith, one of whose Kansas friends had told him that high-frequency waves had been used successfully to control insects in stored wheat and that the same wheat planted later germinated faster than untreated grain.

The frequencies on the so-called sonic spectrum, unlike those on the so-called electromagnetic spectrum, relate to vibrations in matter, the medium in which they travel, and result from the rate of its compression and expansion. Thus a sound wave can pass through air, water, and other fluids, an iron bar, a table top, a human being, or a plant. Because human ears can pick up only those frequencies from 16 to about 20,000 cycles per second, they are known as "audio," or "sonic," frequencies. Below them are inaudible subsonic frequencies, some of which result from pressure applied slowly, such as that produced with a hydraulic jack, which become so slow they are measured not in cycles per second but in seconds per cycle. Above them are ultrasonic frequencies also inaudible to the human ear but affecting man's being in a variety of ways which are not fully known. Extremely high frequencies on this spectrum, ranging from hundreds to thousands of millions of cycles per second, can be perceived as heat on the skin and are therefore termed "thermal," though because they too cannot be audially detected could just as well be considered ultrasonic.

After his experimentation was given publicity all over North America, Smith received a letter from Peter Belton of the research branch of Canada's Department of Agriculture, who informed him that he had broadcast ultrasonic waves to control the European corn-borer moth,

whose larvae extensively damage growing corn. "At first we tested the hearing ability of this moth," wrote Belton. "It was obvious that moths could hear sounds at about 50,000 cycles. These high-pitched sounds are much like those made by bats, the moth's natural enemy. We planted two plots of corn, each ten feet by twenty, and divided them with sheets of plastic eight feet tall, capable of stopping this sound frequency. Then we broadcast the bat-like sound across two of the half-plots from dusk till dawn throughout the period the moths lay their eggs." Belton informed Smith that nearly 50 percent of his ripe corn ears were damaged by larvae in the silent plots but only 5 percent suffered injury in the plots where the moths had supposedly suspected bats might be lurking. A careful count also revealed 60 percent fewer larvae in the sound plots, and the corn was three inches taller.

In the mid-1960s the varied efforts of Singh and Smith aroused the curiosity of two researchers at Canada's University of Ottawa, Mary Measures and Pearl Weinberger. Like L. George Lawrence, they were conversant with discoveries by Russians, Canadians, and Americans that ultrasonic frequencies markedly affect the germination and growth of barley, sunflower, spruce, Jack pine, Siberian pea tree, and other seeds and seedlings. The experiments indicated, albeit inexplicably, that enzyme activity and respiration rates in plants and their seeds increased when they were stimulated by ultrasonic frequencies. However, the very frequencies which stimulated some plant species inhibited others. Measures and Weinberger wondered whether specific *audible* frequencies in the sonic range would be as effective as music in enhancing the growth of wheat.

In a series of experiments lasting more than four years, the two biologists exposed the grains and seedlings of spring Marquis and winter Rideau wheat to high-frequency vibrations. They found that, depending on how long the wheat seeds had been vernalized, the plants responded best to a frequency of 5,000 cycles a second.

Baffled by their results, the two researchers could not explain why audible sound had resulted in accelerated growth so striking that it seemed to promise to double wheat harvests. The effect could not have been produced by breaking chemical bonds in the seeds, they wrote in the *Canadian Journal of Botany*, since, to do this, one billion times as much energy as was added by the sound frequencies would be required. Instead, they suggested that sound waves might produce a resonant effect in the plant cells, enabling the energy to accumulate and affect the plant's metabolism. In the July, 1968, issue of *Prevention* magazine J. I. Rodale reported that Weinberger "is coming to believe that basic farm equipment of the future will include an oscillator for production of sound waves and a speaker."

Asked to confirm whether her experiments might result in application of sound to wheat seed planted in extended acreage, Dr. Weinberger stated in 1973 that large-scale tests were going forward in Canada, the United States, and Europe to determine the practicability of their idea.

Weinberger's observations are echoed by four scientists at the University of North Carolina at Greensboro, who have discovered that experimental "pink" noise, which, at 20 to 20,000 cycles per second and 100 decibels, sounds to the ear about the same as the noise received 100 feet away from a 727 jet plane about to take off, caused turnips to sprout much faster than those left silently in the ground. Professor Gaylord T. Hageseth, a physicist and leader of the research team, says that his findings have stirred up interest at the U.S. Department of Agriculture, which is studying the team's proposals to awaken seeds planted in hot regions such as California's San Joaquin Valley, where temperatures ranging above 100 degrees Fahrenheit induce dormancy in lettuce seeds. If awakened by sound irradiation, lettuce might produce two crops per season instead of one, say Hageseth and his colleagues, who also suggest that sound waves could be used to make weeds germinate before a field is planted. The weeds could then be plowed under to allow a crop to grow in a weed-free field.

Since broadcasting airport-level noise all over the countryside is hardly appealing, the North Carolina team has been working, like Measures and Weinberger, to find particular wavelengths or combinations to produce the desired effects at lower decibel levels. By the beginning of 1973 they had discovered that the germination rate in turnips seemed to speed up when the turnips were exposed to a frequency of 4,000 cycles per second.

An interesting and eventually very controversial series of experiments on the effects of music on plants began in 1968 when Dorothy Retallack, a professional organist and mezzo soprano, who gave concerts at Denver's Beacon Supper Club from 1947 to 1952, felt herself at loose ends when her eight children went off to college. Not to be the sole member of the family without a degree, Mrs. Retallack surprised her hard-working physician husband with the announcement of her own enrollment for a degree in music at Temple Buell College. Required to come up with a laboratory experiment in biology, Mrs. Retallack vaguely recalled reading an article about George Smith's playing disc jockey to his cornfields.

Following Smith's lead, Mrs. Retallack teamed with a fellow student, whose family provided an empty room at home and furnished two groups of plants, which included philodendron, corn, radishes, geraniums, and African violets. The neophyte experimenters suspended Gro-Lux lights over one group and played the taped musical notes B and D struck on the piano every second, alternating five minutes of those wearisomely repetitive sounds with five minutes of silence. The tape played continuously twelve hours a day. During the first week, the African violets, drooping at the start of the experiment, revived and began to flower. For ten days all the plants in the sound group seemed to thrive; but at the end of two weeks the geranium leaves began to yellow. By the end of the third week all the plants, some of which had been actually leaning away from the source of the sound as if blown by a strong wind, had died, with the unaccountable exception of the African violets, which somehow remained outwardly unaffected. The control group, allowed to grow in peace, flourished.

When she reported these results to her biology professor, Francis F. Broman, and asked if she could do a more elaborately controlled experiment for credit in his course, he reluctantly consented. "The idea made me groan a little," said Broman afterward, "but it was novel and I decided to okay it, even though most of the other students laughed out loud." Broman made available to Dorothy Retallack three new Biotronic Mark III Environmental Chambers fifty-six feet long, twenty-six feet high, and eighteen feet deep, recently purchased by his department, similar in shape but much larger than home fish aquariums, which allowed for precise control of light, temperature, and humidity.

Allotting one chamber for a control group, Mrs. Retallack used the same plants, with the exception of the violets, as in the first experiment, setting them in identical soil and affording them equal amounts of water on schedule. Trying to pinpoint the musical note most conducive to survival, each day she tried an F note, played unremittingly for eight hours in one chamber and three hours intermittently in another. In the first chamber her plants were stone dead within two weeks. In the second chamber, the plants were much healthier than controls left in silence.

Mrs. Retallack and Professor Broman were nonplused by these results; for they had no idea what could be causing the disparate reactions, and could not help wondering whether the plants had succumbed to fatigue or boredom or had simply been "driven out of their minds." The clear-cut experiments aroused a spate of controversy in the biology department, with both students and professors either dismissing the whole effort as spurious, or intrigued by the inexplicable outcome. Two students, following Mrs. Retallack's lead, ran an eight-week experiment on summer squashes, broadcasting music from two Denver radio stations into their chambers, one specializing in heavily accented rock, the other in classical music.

The cucurbits were hardly indifferent to the two musical forms: those exposed to Haydn, Beethoven, Brahms, Schubert, and other eighteenth- and nineteenth-century European scores grew *toward* the transistor radio, one of them even twining itself lovingly around it. The other squashes grew away from the rock broadcasts and even tried to climb the slippery walls of their glass cage.

Impressed with her friends' success, Mrs. Retallack ran a series of similar trials early in 1969 with corn, squash, petunias, zinnias, and marigolds; she noticed the same effect. The rock music caused some of the plants first to grow either abnormally tall and put out excessively small leaves, or remain stunted. Within a fortnight all the marigolds had died, but only six feet away identical marigolds, enjoying the classical strains, were flowering. More interestingly, Mrs. Retallack found that even during the first week the rock-stimulated plants were using much

more water than the classically entertained vegetation, but apparently enjoying it less, since examination of the roots on the eighteenth day revealed that soil growth was sparse in the first group, averaging only about an inch, whereas in the second it was thick, tangled, and about four times as long.

At this point, various critics sourly suggested that the experiments were invalid because such variables as sixty-cycle hum, the "white sound" heard from a radio tuned to a frequency not occupied by a radio transmitter, or the announcers' voices emitted by the radio sets had not been taken into account. To satisfy these cavils, Mrs. Retallack taped rock music from records. She selected the extremely percussive rock renditions of Led Zeppelin, Vanilla Fudge, and Jimi Hendrix. When plants leaned away from this cacophony, Mrs. Retallack rotated all the pots 180 degrees, only to see the plants lean in the opposite direction. This convinced the majority of critics that the plants were definitely reacting to the sounds of rock music.

Trying to determine what it was about rock that so jarred her plants, Mrs. Retallack guessed that it might be the percussive component in the music and started yet another experiment in the fall. Selecting the familiar Spanish tune "La Paloma," she played one version of it performed on steel drums to one chamber of plants and another version played on strings to a second. The percussion caused a lean ten degrees *away* from the vertical in Mrs. Retallack's plants, but nothing compared to the rock. The plants listening to the fiddles leaned fifteen degrees *toward* the source of the music. An eighteen-day repeat of the same experiment using twenty-five plants per chamber including squash from seed and flowering and leaf-type plants from greenhouses produced largely similar results.

Now Mrs. Retallack wondered how the effects of what she called "intellectual mathematically sophisticated music of both East and West" would appeal to plants. As program director for the American Guild of Organists, she chose choral preludes from Johann Sebastian Bach's *Orgelbüchlein* and the classical strains of the *sitar,* a less-complicated Hindustani version of the south Indian *veena,* played by Ravi Shankar, the Bengali Brahmin.

The plants gave positive evidence of liking Bach, since they leaned an unprecedented thirty-five degrees *toward* the preludes. But even this affirmation was far exceeded by their reaction to Shankar: in their straining to reach the source of the classical Indian music they bent more than halfway to the horizontal, at angles in excess of sixty degrees, the nearest one almost embracing the speaker.

In order not to be swayed by her own special taste for the classical music of both hemispheres Mrs. Retallack, at the behest of hundreds of young people, followed Bach and Shankar with trials of folk and "country-western" music. Her plants seemed to produce no more reaction than those in the silent chamber. Perplexed, Mrs. Retallack could only ask: "Were the plants in complete harmony with this kind of earthy music or didn't they care one way or the other?"

Jazz caused her a real surprise. When her plants heard recordings as varied as Duke Ellington's "Soul Call" and two discs by Louis Armstrong, 55 percent of the plants leaned fifteen to twenty degrees *toward* the speaker, and growth was more abundant than in the silent chamber. Mrs. Retallack also determined that these different musical styles markedly affected the evaporation rate of distilled water inside the chambers. From full beakers, fourteen to seventeen milliliters evaporated over a given time period in the silent chambers, twenty to twenty-five milliliters vaporized under the influence of Bach, Shankar, and jazz; but, with rock, the disappearance was fifty-five to fifty-nine milliliters.

When the office of public information at Temple Buell got wind that Mrs. Retallack was the first grandmother ever to be graduated from its college, it informed Olga Curtis, a reporter on the Denver *Post,* about her extraordinary doings with plants. Mrs. Retallack set up a brand-new experiment for Curtis in which she compared the effects of rock with that of string quartets by such twentieth-century composers as Schoenberg, Webern, and Berg. The point of choosing the largely twelve-tone music of these neo-classicists was to see whether its dissonances, like those of rock, would also cause the plants to cringe. They did not. Root examination showed that the specimens in the rock chamber were scrawny, whereas those subjected to the avant-garde music were comparable to control plants.

On June 21, 1970, the *Post*'s weekend supplement *Empire Magazine*

came out with a color-illustrated four-page spread entitled "Music That Kills Plants," which won for Curtis an annual award by the National Federation of Press Women. Syndicated by Metro Sunday Newspapers, the piece appeared all over the United States, spawning a new generation of articles with such titles as "Bach or Rock: Ask Your Flowers," "Mother Is Knitting Earmuffs for Our Petunias," and more alarmingly, "It Shouldn't Happen to Teenagers." Tying rock music to the proliferation of drugs among American youth, one writer for the popular right-wing *Christian Crusade Weekly* sanctimoniously wrote: "The Scripture admonishes the sluggard to go to the ant! Perhaps the druggard should go to the plant!"

From an avalanche of mail Mrs. Retallack learned that her experiments had elicited the interest of hundreds of readers, including a passel of professors who asked for her published scientific works. Spurred by the unsolicited interest, Retallack, together with Professor Broman, prepared a nine-page scientific paper, "Response of Growing Plants to a Manipulation of Their Sonic Environment," and sent it in to *Bio-Science Magazine,* published by the American Institute of Biological Sciences. They received a turndown, in the form of a review by Dr. Robert S. Leisner, stating that though one could draw a "highly tentative" conclusion that sound affects plant growth, the Retallack-Broman conclusions were hardly novel in light of the earlier work of Weinberger and Measures in Ottawa.

Meanwhile, Mrs. Retallack was called by CBS television and asked to set up a Rock-versus-Shankar experiment for filming with time-lapse cameras. Almost sick with nervousness lest her charges not deliver their message for the CBS technicians, Mrs. Retallack was relieved when the plants performed as if they knew they were scheduled for a nationwide broadcast. Aired on Walter Cronkite's newscast on October 16, 1970, the program added another enormous pile to her correspondence, which included a number of reports which researchers around the country wanted to share with her.

From them Dorothy Retallack learned that two North Carolina State University professors, L. H. Royster, of the Department of Mechanical and Aerospace Engineering, and B. H. Huang, of the Department of

Biological Engineering, had teamed with C. B. Woodlief, a researcher at Fiber Industries in the town of Shelby, to perform an experiment written up in the *Journal of the Acoustical Society of America* as "Effect of Random Noise on Plant Growth." The threesome, who realized that the effects of proliferating noise pollution on animals and man had been studied but that similar effects on plant systems had been overlooked, put twelve male sterile tobacco plants into an environmental control chamber with constant soil and temperature conditions. From a Bruel and Kraer random-noise generator they harried the plants with noise frequencies ranging from 31.5 to 20,000 cycles per second and concluded that growth rate in each plant decreased 40 percent.

Another correspondent was Dr. George Milstein, of Long Island City, New York, a retired dental surgeon turned teacher of horticulture at the New York Botanical Garden. After some of his patients had presented him with exotic plants the names of which no florist could be sure of, Milstein had dipped into botanical sources, become fascinated with the vegetal world, and begun growing exotic and colorful Bromeliads, an extended plant family which includes specimens as diverse as the pineapple and Spanish moss.

Learning of the Canadian research on wheat, he decided to see how sonics would affect other plants. Selecting a wide variety of house plants and two bananas, he subjected them to sonic vibrations delivered directly through the air or transduced through the soil of their pots or through their stems. Assisted by an NBC sound engineer, Milstein found that a continuous low hum at 3,000 cycles per second accelerated the growth of most of his subjects and even caused some of them to bloom six full months ahead of their normal schedule.

When Pip Records, a division of Pickwick International, Inc., asked him to make a record of stimulatory sounds for plants, it insisted that the record also contain music. Milstein accordingly embedded the stimulating hum in the record's musical selections. In an insert in the disc's jacket, "Growing Plants Successfully in the Home," Milstein, after giving precise information on the best kind of light, humidity, ventilation, temperature, watering, fertilizer, and pots, stated that just as all plant growth and flower development are stimulated by light

vibrations, so it is logical to assume that the vibrations of sound energy can also exert a beneficial influence on horticulture. Milstein recommended that for best results the record be played daily.

When the record attracted attention in the United States and other countries, Milstein was pestered in the mail and over the telephone by hundreds of persons who wanted to know what kind of music best suited plants, and whether his research accorded with that of Dorothy Retallack and tied in with that of Cleve Backster. Milstein blew up. Mrs. Retallack's experiments, he says, have nothing to do with science, since "plants can't hear." Appalled at what he calls the total fakery of comparing plants to people, and disgusted at the "dishonesty" on the part of those promoting the record, he says he is tired of the repeated allegations that he used *music* to enhance plant growth.

Asked to comment on Cleve Backster's work, the dentist turned horticulturist said: "Backster must be, at best, self-deluded since no one who has studied botany or physiology could ever agree that plants, whose tissues differ completely from those of animals and man, have minds or emotions and can be frightened by a mental threat."

As secretary of the Society of American Magicians, Milstein, who performed magic to work his way through college, said he had investigated hundreds of so-called "psychic phenomena" and never found a case in which the person claiming a given psychic power could perform under test conditions. "At least Backster isn't collecting money the way some other charlatans are," said Milstein, "but I don't want any part of his research because everything he says he has discovered can be disproved."

Milstein's dogmatic statement was paralleled by those of various professors at Temple Buell. The *New York Times*, which published a feature article on Mrs. Retallack's work on February 21, 1971, stated that the academicians seemed to "cringe and die" quite as much as Dorothy Retallack's acid-rock-exposed plants when it was suggested to them that Backster could be serious. "They find the whole thing an excruciating embarrassment," the *Times* stated, then quoted one of the college's own biologists as saying, "We have been ridiculed professionally." Dr. Cleon Ross, a plant physiologist at Colorado State University, though he reluctantly agreed to discuss the subject of the effect of sonic energy on plants with the *Times* reporter, Anthony Ripley, when asked to comment on Backster's discovery that plants respond to human thought, only blurted out: "Pure garbage!"

At Utah State University, Dr. Frank B. Salisbury of the Plant Science Department was a bit kinder. "I don't know what to make of it all," protested the professor about the effect of music on plants. "It's been going on since 1950. There was a report at the 1954 International Botanical Congress by a man from India who played violins to plants. I hate to just out-and-out say it's all baloney, but there's been an awful lot of pseudo-science in this field for years. Most of this stuff just doesn't have the right kind of experimentation. Until that comes along I don't believe any of it."

Her own unequivocal results caused Mrs. Retallack to wonder whether the nationwide craze for acid rock among the younger generation might not be deleterious to their development. Her doubts about the effects of rock increased when she read an article in the Napa, California, *Register* stating that two doctors had reported to the California Medical Association that of forty-three musicians playing amplified hard-rock music forty-one had suffered permanent hearing loss.

Some of Denver's rock buffs also seemed deeply impressed by Mrs. Retallack's experiments. One long-haired musician, peering into the rock-suffused biotronic chamber, said to her: "If rock is doing *that* to plants, man, I wonder what it's doing to me?" Mrs. Retallack wants to continue her experiments in order to collect enough scientific data to give the young musician a reasoned answer. One test she envisions will involve playing musical tapes backward to see if they produce effects similar to or different from the same tapes played in the normal direction.

When she began writing a short book on her experiments, *The Sound of Music and Plants*, published in early 1973, Mrs. Retallack was inspired with a line from Oscar Hammerstein she had sung years before as the star of *The Sound of Music* in Denver's summer opera: "The hills are alive with the sound of music, with songs they have sung for a thousand years."

Delving in libraries to find material with which to give a philosophical underpinning to her experimental work, she came across a declaration in the *Book of the Secrets of Enoch* that everything in the universe, from the herbs of the field to the stars of the heavens, had its individual spirit or angel, and noted that Hermes Trismegistus was reputed to have stated that plants had lives, minds, and souls, even as did animals, men, and higher beings. Hermes, named "thrice greatest" by the Greeks and from whose name the word "hermetic" is derived, was regarded as the originator of Egyptian art, science, magic, alchemy, and religion.

That musical sound lies within the very hearts of atoms is the contention of a professor of chemistry, now retired after a long career at Johns Hopkins University, Donald Hatch Andrews. In his book, *The Symphony of Life*, Andrews invites readers to join him on an imaginary journey inside a magnified calcium atom taken from the bone beneath the tip of his forefinger. Inside the atom, says Andrews, there are shrill tones dozens of octaves above the highest tones of a violin, the music of the atomic nucleus, the tiny particle at the center of the atom. If one listens closely, he continues, one is aware that this music is far more complex than familiar church music. There are many dissonant chords like those found in the music of today's modern composers.

The whole purpose of dissonant music, according to Cyril Meir Scott, the English composer and theosophist, was to break up thought forms, which, settling over whole countries and people, turn them stagnant with lethargy or rampant with madness. It is an occult musical fact, says Scott, that discord—used in its moral sense—can alone be destroyed by discord, the reason for this being that the vibrations of intrinsically beautiful music are too rarefied to touch the comparatively coarse vibrations of all that pertains to a much lower plane.

So far, no researcher with the exception of Hans Kayser, the German author of *Harmonia Plantarum* and other mathematically learned books on the relation of sound intervals to the growth of plants, seems to have become interested in the octaval correspondences between the shapes of plants and musical notes. Kayser observed that if one projects all tones within the space of one octave—in the same manner that the astronomer and astrologer Johannes Kepler worked out in his *Harmonice Mundi* for the solar planetary system—and sketches their angles in a specific way, one obtains the prototype of leaf form. The interval of the octave, the basis for music making and indeed all sensation, thus contains within itself the form of the leaf.

Not only does this observation lend new "psychological" support to Goethe's metamorphosis of plants, which derive their development from the leaf form, but it casts new light on the ingenious classificatory system developed by Linnaeus. When one considers, says Kayser, that a passion flower contains two ratios, a *five*-part petal and stamen arrangement and a *three*-part pistil, even if one rejects a logically reasoning intelligence, one must admit that in the soul of plants are certain form-carrying prototypes—in the passion flower's case musical thirds and fifths—which work, as in music, to shape the blossom forms as intervals. It is from this point of view that Linnaeus' system acquires a "psychic" rehabilitation, concludes Kayser, for, with his "sexual" classification scheme, the famous Swedish botanist hit on the psychic nerve of plants.

What humans are able to perceive consciously with their limited senses is but a minute fraction of what vibrationally affects them. The so-called scentless daisy may be as sweet-smelling as the rose—if people had the olfactory ability to detect the particles the daisy throws off. Efforts to prove that a given sonic vibration will affect plants or man may, far from resolving the interaction of music and life, be only unraveling a wondrously resonating tapestry of influences into its separate, unrelated threads.

CHAPTER 11

Plants and Electromagnetism

Just as plants respond to the wavelengths of music, so also are they continually being affected by wavelengths of the electromagnetic spectrum, from earth, moon, planets, cosmos and from a proliferation of man-made devices; only it remains to be established exactly which are beneficial and which are harmful.

One evening in the late 1720s a French writer and astronomer, Jean-Jacques Dertous de Mairan, was watering a series of pet *Mimosa pudica* in his Paris drawing room when he noticed to his surprise that the disappearance of the sun appeared to be causing the sensitive plants to fold their leaves just as they did when touched by his hand. A true searcher, esteemed by his contemporary Voltaire, Mairan did not instantly conclude that his plants were "simply going to sleep" as darkness fell. Instead he waited for the sun to rise again and put two of the mimosas in a pitch-dark closet. At noon he noticed that their leaves remained wide open; but at sunset they shut just as promptly as the ones on the drawing-room table. The plants, concluded Mairan, must be able to "sense" the sun without "seeing" it.

As to the cause of this effect, Mairan—whose scientific investigations ranged from the rotational movement of the moon and the physical properties of the aurora borealis to the reason for light in phosphors and the peculiarities of the number 9—could offer no solution. In his report to the French Academy he lamely suggested that his plants must be under the influence of an unknown factor in the universe, and that because hospitalized patients seemed to get extremely weak at certain times they too might be subject to the same force.

Some two and a half centuries later, Dr. John Ott, who runs the Environmental Health and Light Research Institute at Sarasota, Florida, was struck by Mairan's observations, which he was able to confirm, and wondered if this "unknown energy" could penetrate a massive amount of earth, the only shield known to be able to block so-called "cosmic radiation."

Ott took six mimosa plants down a mine shaft at noon to a point 650 feet beneath the earth's surface. Unlike those in the dark of Mairan's closet, Ott's subterranean specimens immediately closed their leaves without waiting for sunset; they did so even when incandescent bulbs were lit all around them. Except for the fact that he related the phenomenon to electromagnetism, of which little was known in Mairan's time, Ott was as much in the dark about the cause of it as had been his eighteenth-century French predecessor.

Mairan's contemporaries had known about electricity only what the Hellenes had passed on to them concerning the properties of amber, or *electron,* as they called it, which when vigorously rubbed attracted a feather or a piece of straw. Before Aristotle, it had been known that lodestone, a black ferrous oxide, could also exert an equally inexplicable attraction on iron filings. Since this material was found in liberal quantities in a region of Asia Minor called Magnesia, it was dubbed *magnes lithos,* or magnesian stone, a term shortened to *magnes* in Latin and to *magnet* in English.

First to link electricity and magnetism was the sixteenth-century savant William Gilbert, whose medical skill and philosophical erudition won him appointment as personal physician to Queen Elizabeth I. Announcing that the planet itself was a globular magnet, Gilbert attributed to the lodestone a "soul," since it was "part and choice offspring of its animate mother, the earth." Gilbert also discovered that materials other than amber could be caused to attract light objects if friction was applied to them. He designated them "electrics" and coined the term "electric force."

For centuries the attractive forces in amber and lodestone were thought to be "penetrating etheric fluids" (whatever *they* might be), emitted by the substances. Even fifty years after Mairan's experiments, Joseph Priestley, known principally as the discoverer of oxygen, wrote in his popular textbook on electricity:

> The earth and all the bodies we are acquainted with, without exception, are supposed to contain a certain quantity of an exceedingly elastic and subtle fluid which philosophers have agreed to term electric. The moment any body becomes possessed of more or less than its natural quantity, very remarkable effects arise from it. The body is said to be electrified and is capable of exhibiting appearances which are ascribed to the power of electricity.

By the twentieth century real knowledge about magnetism had progressed very little. As Professor Silvanus Thompson stated in his Robert Boyle lecture just before World War I, "Those occult qualities of magnetism which for centuries have excited the admiration of mankind are still *occult,* not in the sense only that they need to be investigated by experiment, but that their ultimate cause still remains unexplained." In a text published right after World War II by Chicago's Museum of Science and Industry, it is stated that human beings still do not know why the earth is a magnet, how magnetic materials can be mechanically affected by other magnets at a distance from them, why electric currents have magnetic fields about them, or even why tiny atoms of matter, small as they are, occupy such empty but prodigious volumes of energy-packed space.

In the three and one half centuries since Gilbert's famous work *De Magnete* was published, many theories have been proposed to explain the origin of geomagnetism but none is satisfactory.

The same can be said for contemporary physics, which has substituted for the idea of an "etheric fluid" a spectrum of undulating radiations called "electromagnetic radiations," ranging from enormous macropulsations, lasting several hundred thousand years each, with wavelengths millions of miles long, to super-rapid energy pulses alternating 10,000,000,000,000,000,000,000 times a second, with wavelengths measuring an infinitesimal ten billionths of a centimeter. The first type are associated with such phenomena as the reversal of the earth's magnetic field, the second with the collision of atoms, usually those of helium and hydrogen, moving at incredibly high speeds and converted to radiant energy termed "cosmic rays." In between lie countless bands of energy waves, including gamma rays, originating in the nuclei of atoms; X-rays, originating in their shells; a collection of frequencies which because they can be perceived with the eye are called light; those used in radio, TV, radar, and a growing multitude of applications from space research to electronic cooking.

The electromagnetic waves differ from sound waves in that they can travel not only through matter but through "nothing," racing at a speed of 186 million miles per second through vast regions of the cosmos which previously was thought to contain a medium called "ether" but is now held to be almost a perfect vacuum. But no one has yet explained exactly how they travel. As one eniment physicist complained to the authors, "We just don't know the mechanism for the damn thing."

In 1747, Jean Antoine Nollet, a French abbot and physics tutor to the dauphin, was informed by a German physicist in Wittenberg that water, which normally issued drop by drop from a capillary tube, would run out in a constant stream if the tube was electrified. After repeating the German's experiments and adding some of his own, Nollet, as he later put it, "began to believe that this electrical virtue employed in a certain manner might have some remarkable effect on organized bodies

which can be looked upon, in some way, as hydraulic machines prepared by nature itself." Nollet put several plants in metallic pots next to a conductor and was intrigued to note that the rate of their transpiration increased. In a long series of experiments, Nollet carefully weighed not only daffodils but sparrows, pigeons, and cats and found they lost weight faster if electrified.

Wondering how electrical phenomena might influence seeds, Nollet planted several dozen mustard grains in two tin containers and electrified one of them from 7 to 10 A.M. and from 3 to 8 P.M. seven days running. At the end of the week, every grain in the electrified container had sprouted and grown to an average height of 15 to 16 French *lignes;* the *ligne* is an old French measure, the twelfth part of an inch, or about 2.25 millimeters. Of the nonelectrified seeds the three which had broken ground were only 2 to 3 *lignes* tall. Though he had no idea why, Nollet could only suggest in his book-long report to the French Academy that electricity somehow had profound effects on the growth functions of life forms.

Nollet's conclusion was formulated a few years before the announcement rocked Europe that Benjamin Franklin had been able to collect a charge of electricity from lightning by flying a kite during stormy weather outside Philadelphia. When the bolt struck a metal point on the kite's frame, it had run down the kite's wet string into a Leyden bottle, a device developed in 1746 at the University of Leyden, whereby electricity could be stored in water and discharged in a single sudden burst. Theretofore, only static electricity obtained with an electrostatic generator had been storable in a Leyden jar.

As Franklin was now collecting electricity from clouds, the brilliant astronomer Pierre Charles Lemonnier, who was admitted to the French Academy at twenty-one and later acclaimed for his discovery of the obliquity of the ecliptic, determined that a permanent state of electrical activity exists in the earth's atmosphere even on a clear and sunny day, but exactly how the omnipresent charges interact with plants remained veiled in mystery.

The next efforts to adapt atmospheric electricity to the fructification of plants came in Italy. In 1770 a Professor Gardini stretched a number of wires above a productive monastery garden in Turin. Within a short time, many of the plants began to wither and die. When the monks dismantled the wires, the garden revived. Gardini hypothesized that either the plants had been deprived of a natural supply of electricity necessary to their growth or that they had received an overdose. When Gardini heard from France that the brothers Joseph-Michel and Jacques-Etienne Montgolfier had sent aloft an enormous balloon filled with heated air to carry two passengers on a ten-kilometer, twenty-five-minute trip over Paris, he recommended that this new invention be practically applied to horticulture by attaching a long wire to it along which electricity could be conducted from great heights into fields and gardens below.

These French and Italian reports caused little stir among the scientific pundits of the day, who, even then, were beginning to pay more attention to the effects of electricity on inert, rather than on living, bodies. Nor were they impressed when yet another clergyman, Abbé Bertholon, came out in 1783 with a full-scale treatise, *De l'Electricité des Végétaux.* A professor of experimental physics at French and Spanish universities, Bertholon gave strong support to Nollet's idea that by altering the viscosity, or flow resistance, of fluids in living organisms electricity could change their growth functions. He cited the report of an Italian physicist, Giuseppe Toaldo, that in a row of jasmine bushes the two which were next to a lightning conductor grew thirty feet tall whereas all the others attained only four feet.

Bertholon, who was considered something of a sorcerer, had a gardener stand on a slab of insulating material and sprinkle vegetables from an electrified watering can. He reported that his salads grew to an extraordinary size. He also invented what he called an "electrovegetometer" to collect atmospheric electricity by means of an antenna, and pass it through plants growing in a field. "This instrument," he wrote, "is applicable to all kinds of vegetal production, everywhere, in all weather; and its utility and efficacity cannot be ignored or doubted except by timid souls who are not inspired by discoveries and who will never push back the barriers of the sciences but will remain eternally within the narrow confines of a cowardly pusillanimity which, to palliate it, is too

often given the name of prudence." In his conclusion, the abbot boldly suggested that one day the best fertilizer for plants would come in electrical form "free from the sky."

The exciting notion that living things interacted and indeed were imbued with electricity advanced a giant step in November, 1780, when the wife of a Bolognese scientist, Luigi Galvani, accidentally discovered that a machine used to generate static electricity caused the severed leg of a frog to jump spasmodically. When his attention was called to it, Galvani was surprised and instantly wondered whether electricity was not in fact a manifestation of life. Deciding on Christmas Day that it was, he wrote in his workbook: "The electrical fluid should be considered a means to excite nervo-muscular force."

For the next six years Galvani worked on the effects on muscular motion of electricity until he happened accidentally to discover that his frogs' legs would twitch just as well without the application of an electric charge if the copper wires they hung from were blown by the wind against an iron railing. Realizing that the electricity in the three-part circuit had to be coming from the legs or the metals, Galvani, who believed it to be a living rather than a dead force, decided it was associated with the animal tissue and ascribed the reaction to a vital fluid or energy in the frogs' bodies which he termed "animal electricity."

Galvani's findings at first received warm support from his compatriot Alessandro Volta, a physicist at the University of Pavia in the Duchy of Milan. But when Volta repeated Galvani's experiments and found he could elicit the electrical effect only when two different metals were used, he wrote to Abbot Tommaselli that it was obvious that the electricity came, not from the frog's legs, but from "the simple application of two metals of different quality." Concentrating on the electrical properties of metals, Volta was led in 1800 to the invention of a pile of alternating zinc and copper discs with a piece of wet paper sandwiched between each two layers. Instantly chargeable, it could be used to produce electric current at will, not only once, like the Leyden jar, but thousands of times, and thus for the first time researchers were freed from their dependence on static or natural electricity. This first ancestor of our electric storage cell disclosed an artificial dynamic or kinetic electricity, which all but obliterated Galvani's notion of a special vital energy in living tissues.

Though at first Volta had accepted Galvani's findings, he later wrote: "If we deprive animal organs of any electrical activity of their own and abandon this attractive idea which Galvani's beautiful experiments suggested, these organs can be regarded simply as electrometers of a new kind and of a marvelous sensitivity." Despite Galvani's prophetic assertion, just before his death, that one day the analysis of all the necessary physiological aspects of his experiments "would provide better knowledge of the nature of the life forces, their different duration, according to variations in sex, age, temperament, illnesses, and even the very constitution of the atmosphere," scientists neglected his theories and denied them in practice.

A few years earlier, unknown to Galvani, the Hungarian Jesuit Maximilian Hell had revived Gilbert's idea of "soul-like" characteristics in the lodestone being transmitted to ferrous metals; and with this idea had invented a singular arrangement of magnetized steel plates to cure his own persistent rheumatism. His friend the Viennese physician Franz Anton Mesmer, who picked up an interest in magnetism by reading Paracelsus, was impressed with Hell's subsequent cures of a variety of afflictions in others, and embarked on a long series of experiments to check them. In so doing Mesmer became convinced that living matter had a property susceptible to being acted upon by "earthly and celestial magnetic forces," which in 1779 he called "animal magnetism" and to which he devoted a doctoral thesis entitled "The Influence of the Planets on the Human Body." Learning that a Swiss priest, J. J. Gassner, was healing patients by touch, Mesmer successfully adopted Gassner's technique and proclaimed that some people, himself included, were better endowed with the "magnetic" force than others.

Though it seemed that these startling discoveries of bioelectrical and biomagnetic energy might open the door to a new age of research which could unite physics with medicine and physiology, the door was again slammed shut for more than a century. Mesmer's success in treating cases, where others had failed, provoked his Viennese medical colleagues to jealousy. Attributing his cures to witchcraft and the devil, they organized a commission to investigate his claims. When the commission reported unfavorably, Mesmer was expelled from the medical faculty and told to give up his practice.

Moving in 1778 to Paris, where he found "people more enlightened and less indifferent to new discoveries," he made a powerful convert to his new methods of Charles D'Eslon, first physician to the court of the brother of Louis XVI, who introduced Mesmer to influential circles. It was not long before the French physicians grew as angry and jealous as had their Austrian counterparts. Their clamor forced the king to appoint a royal commission to investigate Mesmer's claims, despite the fact that D'Eslon at a meeting of the medical faculty of the University of Paris had championed Mesmer's scientific contribution as "one of the most important of our age." When the commission, whose members included the director of the French Academy of Sciences—which in 1772 had solemnly ruled that meteorites did not exist—and whose chairman was the American ambassador, Benjamin Franklin, returned a verdict that "animal magnetism is nonexistent and can have no salubrious effect," Mesmer's great popularity, held up to public ridicule, began to wane. Retiring to Switzerland, he completed, one year before his death in 1815, his most important work: *Mesmerism or the System of Reciprocal Influences; or The Theory and Practice of Animal Magnetism.*

In 1820, Hans Christian Oersted, a Danish scientist, found that a compass needle placed near a current-carrying wire always turned so that the needle became perpendicular to the wire. When the current was reversed, the compass needle pointed in the opposite direction. The fact that a force could act on the compass needle indicated that a magnetic field existed in the space around the wire. This led to one of the most profitable discoveries in the history of science when Michael Faraday in England and Joseph Henry in the United States independently realized the opposite phenomenon was equally valid, that a magnetic field could induce an electric current if the wire were moved through it. Thus the "generator" was invented, and with it a whole new world of electrical appliances.

Today, books on what man can *do* with electricity fill seventeen 100-foot shelves of stacks in the Library of Congress, but what electricity *is* and why it functions are as much a mystery as they were in Priestley's day. Modern scientists still have no idea of the composition of electromagnetic waves. They simply use them for radio, radar, television and toasters.

Because of such a lopsided concentration on the mechanical properties of electromagnetism, only a corporal's guard of individuals has paid attention over the years to how and why electromagnetism might affect living things. A notable exception was Baron Karl von Reichenbach, a German scientist from Tübingen who in 1845 had discovered wood-tar products, including creosote, used for the preservation of above-ground fencing and underwater pilings. He became aware that specially gifted persons whom he termed "sensitives" could actually see a strange energy emanating from all living things and even from the ends of bar magnets; this energy he called *Odyle* or *Od.* But, though his works were translated into English by a distinguished medical doctor, William Gregory, appointed professor of chemistry at the University of Edinburgh in 1844, as *Researches into the Forces of Magnetism, Electricity, Heat and Light in Relation to the Force of Life,* his attempts to prove its existence to his physicist contemporaries in England and on the continent were rejected out of hand.

Reichenbach indicated the reason why his "odic force" was spurned when he wrote: "Whenever I began to touch on the subject, I felt at once that I was harping on a string of an unpleasant tone. They coupled Od and sensitivity in their minds with so-called 'animal magnetism' and 'Mesmerism' and with that all sympathy was at an end." The coupling was entirely unjustified, in that Reichenbach had clearly stated that though the mysterious odic force might resemble animal magnetism and was associated with it, it also could exist quite independently.

Years later, Wilhelm Reich contended that "the energy with which the ancient Greeks and the moderns since Gilbert were dealing was a basically different energy from that with which the physicists are dealing since Volta and Faraday, one obtained by the movement of wires in magnetic fields; different not only with regard to the principle of its production, but *fundamentally* different."

Reich believed that the ancient Greeks, with the principle of friction,

had discovered the mysterious energy to which he gave the name "orgone," so similar to Reichenbach's Od and to the ether of the ancients. Reich claimed that orgone is the medium in which light moves, and the medium for electromagnetic and gravitational activity, that it fills all space, though in different degrees and concentration, and is even present in vacuums. He considered it the basic link between inorganic and organic matter. By the 1960s, shortly after Reich's death, the evidence for the electrical basis of organisms was becoming overwhelming. As D. S. Halacy, a writer on orthodox science, praided it simply: "The flow of electrons is basic to practically all life processes."

The difficulties encountered in the period between Reichenbach and Reich stemmed partly from the vogue in science for taking things apart, rather than studying them as functioning wholes. Simultaneously the gulf widened between workers in what came to be known as the "life sciences" and physicists who more and more would believe only what they could see or instrumentally measure. In between, chemistry concentrated on increasingly varied and smaller separate entities, which in their artificial recombination offered a cornucopia of fascinating new products.

The first artificial synthesis in the laboratory of an organic substance, urea, in 1828, seemed to destroy the idea that there was a special "vital" aspect in living things. The discovery of cells, the purported biological counterparts of the atoms of classical Greek philosophy, suggested that plants, animals, and man himself were merely different associations of these building blocks or chemical aggregates. In this new climate, few took initiative to delve deeper into the effects of electromagnetism on life. Nevertheless, individualistic mavericks occasionally brought forward an idea on how plants might respond to external cosmic forces and thus kept the findings of Nollet and Bertholon from expiring.

Across the Atlantic in North America, William Ross, testing claims of the Marquis of Anglesey that seeds sprouted faster when electrified, planted cucumbers in a mixture of black manganese oxide, table salt, and clean sand, watered with dilute sulphuric acid. When he applied an electric current to the mixture, the seeds sprouted well ahead of those in a similar but nonelectrified mixture. A year later, in 1845, the first issue of the London *Journal of the Horticultural Society* published a long account of the "Influence of Electricity on Vegetation" by an agronomist, Edward Solly, who, like Gardini, suspended wires in the air over garden plots, and, like Ross, tried burying them under the soil. But of Solly's seventy experiments with various grains, vegetables, and flowers, only nineteen were of any benefit, and nearly as many were harmful.

The conflicting results of these researchers made it obvious that the amount, quality, and duration of electrical stimulation was of crucial importance to each form of vegetal life. But since physicists lacked instrumentation to measure its specific effects, and still knew little about how electricity, artificial or atmospheric, actually operated on plants, the experimental field was left to persistently curious horticulturalists or out-and-out cranks. Still, various observations showing that vegetation had an electric quality continued to be recorded.

In 1859 an issue of the London *Gardeners' Chronicle* published a report of light flashes passing from one scarlet verbena to another and noted that the phenomenon could best be seen during crepuscular periods when a thunderstorm approached after a long spell of dry weather. This validated an observation of Goethe's that the flowers of oriental poppies could be seen flashing at dusk.

It was not until the latter part of the century that new vistas were opened in Germany onto the exact nature of the electricity in the air which Lemonnier had discovered. Julius Elster and Hans Geitel, who specialized in the spontaneous emission of radiation from inorganic substances which was coming to be called "radioactivity," began a vast study of atmospheric electricity. This disclosed that the soil of the earth continually emits electrically charged particles into the air. Called *ions* from the neuter present participle of the Greek verb, *ienai*, meaning "to go," these particles were either atoms, groups of atoms, or molecules regarded as having a net positive or negative charge after gaining or losing electrons. Lemonnier's observation that the atmosphere was continually filled with electricity at last had some kind of material explanation.

Since on a clear day in good weather the earth has a negative electrical charge while the atmosphere is positive, electrons stream skyward from

the soil and plants. During storms the polarity is reversed, the earth becoming positive and the base of the cloud layer negative. Because there are at any time an estimated three to four thousand "electrical" storms raging over the surface of the globe, the charges lost by the earth in those areas favored by balmy weather are thus replaced, and a seesawing balance of electrical gradients maintained.

As a result of the ever-present flow of electricity, the voltage, or electric pressure, increases at higher altitudes. Between the head of a six-foot man and the ground he stands on, it is 200 volts; from the top of the Empire State Building to the sidewalks around it, 40,000 volts; in the interval between the lowest layers of the ionosphere and the earth's surface, 360,000 volts. Though this sounds dangerous, not much shocking power can be generated because there is little current flow. The chief difficulty in harnessing this vast reservoir of energy and putting it to work is lack of precise knowledge of exactly how it functions and of the laws which govern its operations.

A new attack on the application of atmospheric electricity to the growth of plants began when a Finnish scientist of eclectic interests, Selim Lemström, made four expeditions to the subpolar regions of Spitsbergen, northern Norway, and Lapland from 1868 to 1884. An expert on polar light and earth magnetism, Lemström theorized that the luxuriant vegetation in those latitudes, which popular opinion ascribed to the lengthened days of their summers, was actually attributable to what he called "that violent electrical manifestation, the aurora borealis."

As it had been known from the time of Franklin that sharp points were especially attractive to atmospheric electricity—an observation which led to the development of the lightning rod—Lemström reasoned that "the sharp points of plants acted like lightning rods to collect atmospheric electricity and facilitate the exchange of charges of the air and the ground." Lemström conducted studies on the rings in cross-sections of fir-tree trunks and found that the annual growth fully correlated with periods of high aurora and sunspot activity, the effects being most pronounced as one traveled north.

When he came home to verify these observations by experimentation, Lemström connected a series of flowers in metal pots to a static generator by an overhead network of wires sixteen inches above them and a pole set into the soil as a ground. Other pots he "left to nature." After eight weeks, the electrified plants showed gains in weight of nearly 50 percent over their electrically deprived neighbors. When he transferred his apparatus into a garden he not only more than doubled the yield of strawberries but found them to be much sweeter; his harvest from barley plants increased by one-third.

In a long series of experiments conducted as far south as Burgundy, Lemström's results varied not only with specific vegetables, fruits, and cereals but also with temperature, moisture, and the natural fertility and manuring of the soil. Lemström reported his success in 1902 in a book *Electro Cultur,* published in Berlin, and the term was included in Liberty Hyde Bailey's *Standard Cyclopedia of Horticulture.*

The English translation of Lemström's book, entitled *Electricity in Agriculture and Horticulture,* which appeared in London two years after the German original, acerbically, yet truthfully, as it turned out, warned in its introduction that, since the whole complicated subject was connected with no less than three separate sciences, physics, botany, and agronomy, it might not seem "particularly attractive" to scientists. This caveat was not needed for one of his readers, Sir Oliver Lodge. After achieving singular distinction in the field of physics, Lodge went on to demonstrate his open-mindedness by joining the London Society for Psychical Research and brought out a dozen books which advanced his conviction that whole worlds lay beyond the physical.

Lodge determined to obviate Lemström's time-consuming difficulties in moving his wire network upward as his plants grew; to allow the movement of people, animals, and farm equipment through his electrified fields, he suspended his grid on insulators attached to high poles. During one growing season Lodge was able to increase the per-acre yield of Canadian Red Fife wheat by 40 percent and was pleased that the bakers who used flour ground from it claimed it produced bread of a far better quality than that made from the wheat they were normally furnished.

After working with Lodge, his collaborator, John Newman, adapted

the system to achieve over 20 percent increase in wheat yields in Evesham, England, and in potatoes dug at Dumfries, Scotland. Newman's strawberries were not only vastly more productive than nonelectrified equivalents but, like Lemström's, were more succulent and sweet; his sugar beets tested out as having greater than normal sugar content. Of passing interest, Newman published his report, not in a botanical journal, but in the fifth edition of the *Standard Handbook for Electrical Engineers,* brought out by McGraw-Hill in New York. Ever since, it has been more the engineering fraternity than the plant men who have assiduously pursued electrocultural efforts.

CHAPTER 12

Force Fields, Humans and Plants

Because their profession calls upon them for practical solutions to problems no matter how difficult they appear at first glance, engineers, unlike researchers in pure science, are less concerned with *why* or *how* something works than with *whether* it will work. This attitude frees them from the shackles of theory, which in the history of science has often caused pedants to disregard the brilliant new findings of geniuses because there was no theoretical basis to support them.

When an ingenious Hungarian refugee, Joseph Molitorisz, who escaped from his Soviet-occupied homeland and took an engineering degree, came across Abbé Nollet's ideas about electro-osmosis, he started thinking about how the Frenchman's efforts could be applied to agricultural problems. It seemed strange to Molitorisz that a redwood can raise its sap more than three hundred feet whereas the best man-designed suction pump can pull water up less than a tenth of that distance. There was evidently something about trees and electricity that defied laws of hydrodynamics in standard engineering. At an agricultural research station run by the U.S. Government near Riverside, California, Molitorisz decided to adapt what he had learned from Nollet's insights to citrus orchards. In an early experiment, he ran current through citrus seedlings. When the current flowed in one direction, the growth of the tiny trees was speeded up; when the direction was reversed, the seedlings shriveled. Evidently, the electricity somehow abetted the natural flow of electric current present in the plants or, when severed, blocked it. In another experiment, partly inspired by his reading of Abbé Bertholon, Molitorisz applied a fifty-eight-volt current to six branches of an orange tree but left another six branches untouched, only to discover that within eighteen hours sap was freely circulating in the "powered" branches while in the untouched branches there was very little sap flow.

One of the problems of harvesting oranges is the fact that their fruit does not all ripen simultaneously and must be laboriously hand-picked over many days if it is not to rot on the branches. Molitorisz theorized that picking costs might be reduced if he could get a tree to drop its ripe fruit through electrical stimulation. By wiring one orange tree to a source of direct current, he got it to drop its ripe fruit but retain the still-green oranges on its branches. Even with this success he could not get funds for additional experimentation; but Molitorisz, who has also invented an "electrical flower pot" which can keep flowers alive much longer than is normally possible, believes that one day it will be easy to harvest electrically the fruit of an entire citrus orchard and obviate the necessity of raising pickers into the trees.

While Molitorisz was working on the West Coast, another engineer, Dr. Larry E. Murr, of the Materials Research Laboratory at the Pennsylvania State University, became the first to simulate artificially in the laboratory the electrical conditions of short thunderstorms and long periods of rainy weather. After seven years of work in his man-made "mini-climate," he was able to get significant increases in plant growth by carefully regulating the voltage field strength over plants in lucite pots set on an aluminum plate to serve as one electrode, the other supplied by an aluminum wire mesh hung from insulating poles. Other voltages, he found, severely damaged the leaves of plants. Murr reached the conclusion that "whether or not we can augment acreage yield by maintaining artificially devised electric fields over crop areas is still a matter for speculation. The cost of achieving such gains by large-scale outdoor installations might be much more than they are worth. Nevertheless, the possibility exists."

Dr. George Starr White, who published a book entitled *Cosmo-electric Culture,* discovered that metals like iron and tin could facilitate plant growth if bright pieces were dangled from fruit trees. His evidence was corroborated by Randall Groves Hay, an industrial engineer from Jenkintown, New Jersey. Where Hay attached metallic Christmas tree balls to tomato plants, they would bear their fruits earlier than normal. In his own words: "At first, my wife would not let me hang the balls on the plants because she said it would look just too ridiculous. But when fifteen potted tomatoes hung with balls started to ripen in cold, inclement weather long before those of any other grower, she allowed me to continue."

The experiments of James Lee Scribner, an electronic engineer in Greenville, South Carolina, who worked thirty years in radio with electronic bathing of seeds, have resulted in a rival to Jack's beanstalk. Scribner wired an aluminum pot to an ordinary electric outlet. Spread between the electrodes was a wet metallic mix made up of millions of zinc and copper particles, which, when dried, allowed electricity to filter between the electrode strips. A butterbean planted in the pot grew to the amazing height of twenty-two feet, though similar beans normally never exceed two feet. At maturity it produced *two bushels* of delicious beans. Scribner believes that

> it is the electron that is responsible before the photosynthesis can take place, for it is the electron that magnetizes the chlorophyll in the plant cell that makes it possible for the photon to assert itself and become a part of the plant in the form of solar energy. It is also this magnetism that

> draws the molecules of oxygen into the ever expanding chlorophyll cells of the plant, and so we must assume that moisture is in no way integrated into the plant through any absorption process whatsoever, for the integration of moisture is purely an electronic one. The so-called root pressure (moisture droplets) appearing on plant surfaces is not root pressure at all, but an abundance of electrons working with the rather excessive water energy in the bed.

Scribner's findings on seeds had apparently been anticipated in the 1930s, when the Italian Bindo Riccioni developed his own system for electrically treating seeds at the rate of five tons per day by allowing them to flow through parallel plate capacitors at about five meters per second. From the treated seeds Riccioni reported harvests from 2 to 37 percent greater than the national average, depending on soil and weather conditions. His work was interrupted by World War II, and his 127-page book, translated into English only in 1960, does not thus far seem to have stimulated further experimentation in the United States or Western Europe.

In the Soviet Union, however, a commercial processing plant to treat seeds with electrical energy, with a 2-ton-per-hour capacity, was reported in 1963. Results indicated that yields for the green mass of corn jumped 15 to 20 percent over the average, oats and barley 10 to 15 percent, peas 13 percent, and buckwheat 8 to 10 percent. What promise this pilot project might hold to relieve Russia's persistent grain shortages was not mentioned. To an agricultural industry which has relied almost wholly on artificially produced chemicals not only to fertilize its soil but to rid its crops of marauding pests, the electrocultural horizons being opened up afresh by engineers seem either unnecessary or a threat. This explains why almost no money has been made available for more investigation.

A former director of the United States Department of Agriculture's Division of Agricultural Engineering Research, E. G. McKibben, complained as far back as 1962 that this policy was extremely short-sighted. In an address to the American Society of Agricultural Engineers McKibben said: "The importance and the possibilities of the application of electromagnetic energy in its many forms to agriculture are limited only by the creative imagination and physical resources available. Electromagnetic energy is probably the most basic form. It, or something closely related to it, appears to be the basic substance of all energy and all matter and the essential fabric of all plant and animal life." McKibben stressed that as yet undreamed-of developments and accomplishments might be reasonably attained if only much more support was put behind electrocultural efforts; but his plea has thus far fallen on deaf ears.

Even before McKibben made his appeal, brand-new discoveries about the influence of magnetism on vegetation were coming to light. In 1960 L. J. Audus, a professor of botany at London University's Bedford College, while trying to find out exactly how plants respond to gravity, stumbled onto the fact that their roots are sensitive to magnetic fields and published a pioneering paper, "Magnetotropism, a New Plant Growth Response," in *Nature.* Nearly simultaneously, two Russians, A. V. Krylov and G. A. Tarakanova, issued their report in Moscow, showing that tomatoes ripen inexplicably faster nearer the south than the north pole of a magnet.

In Canada, Dr. U. J. Pittman, of the Agricultural Research Station in Lethbridge, Alberta, had observed all across the North American continent that the roots of various domestic and wild cereal grains, as well as those of a number of species of weeds, consistently aligned themselves in a north-south plane parallel to the horizontal force of the earth's magnetic field. He found that the earth's magnetism speeded up the germination of Chinook and Kharkov wheat, Compana barley, Eagle oats, Redwood flax, and common fall rye if the long axes of the seeds and embryo ends were oriented toward the north magnetic pole. "When Granny insisted that her pumpkin seeds be planted pointing north," wrote Pittman in *Crops and Soils Magazine,* "she may have been dead right!"

In the United States, the possibility of large-scale application of the occult force of magnetism to agriculture arose when in Denver, Colorado, still another engineer, Dr. H. Len Cox, chanced to read an article in a 1968 issue of *Aviation Week and Space Technology* which reported that infrared photos taken from NASA satellites seemed to indicate that wheat plants attacked by pests, or otherwise incapacitated,

had an entirely different "electromagnetic signature" from those in a field expected to produce a bumper crop. Intrigued by a phenomenon for which he had no explanation, Cox, a space scientist, after dipping into the electrocultural literature, asked a metallurgist friend whether he knew of any magnetizable substance which could make plants grow faster and more fruitfully.

When the metallurgist suggested that deposits of a useless ferrous ore, magnetite, totaling billions of tons, were easily accessible in nearby Wyoming, Cox brought back a truckload and ground it into powder. After charging it in a magnetic field of undisclosed strength and mixing it with trace minerals, he sifted it into the soil of a garden plot where it could come into contact with the roots of red and white radishes. Though the green tops of the maturing plants seemed no different from similar radishes allowed to grow normally in a neighboring plot, when Cox pulled his "activated" vegetables from the ground, he saw results beyond his wildest expectations. Not only were the activated radishes on an average twice as large as the controls, but the fact that their tap roots were three to four times as long indicated that root stimulation seemed to have produced the increased growth. The remarkable effect on radishes was also obtained for other root vegetables, such as rutabagas, turnips, and carrots, and also for green plants such as beans, lettuce, broccoli, and oyster plant.

When Cox's Electroculture Corporation began selling the new product in ten-pound cans in 1970, users reported not only that they got much larger yields but that the vegetables produced had a far better flavor, corroborating Lemström's report on his strawberries and Sir Oliver Lodge's bakers' comments on their bread. Others reported that irises doubled the number of blossoms on a single stalk no matter whether they were planted with or without fertilizer, and a plastic surgeon told Cox that when he had put the magnetized ore among the roots of one of two ponderosa pine seedlings in his lawn, the little tree had grown in one summer four times as high as its neighbor.

Asked how the "activator" works Cox replied: "It is still a mystery. No one knows how it functions any more than doctors know why aspirin has its effect. Disappointing to nurserymen and city-dwelling plant lovers is the odd fact that the magnetized powder produces no results when shaken into flower pots or greenhouse flats. To work it has to go into the soil of the earth itself." One explanation for this anomaly is that the ferrous oxide—which when magnetized is called lodestone—radiates its power only when in contact with what Gilbert, in his day, called "its animate mother."

Whatever the ultimate solution to the problem, in the two decades following World War I startling new discoveries were coming to light in laboratories suggesting that mysterious radiations in the natural environment might be far more crucial to the well-being of plants and animals than had hitherto been suspected.

In the early 1920s Georges Lakhovsky, a Russian-born engineer living in Paris, had begun a series of books which suggested that the basis of life was not matter but immaterial vibrations associated with it. "Every living thing emits radiations," stressed Lakhovsky, and advanced the revolutionary new theory that cells, the essential organic units of all living things, were electromagnetic radiators capable, like wireless sets, of emitting and absorbing high-frequency waves.

The essence of Lakhovsky's theory was that cells are microscopic oscillating circuits. In electrical parlance such an oscillating circuit requires two basic elements: a capacitor, or source of stored electric charge, and a coil of wire. As the current from the capacitor flows back and forth between one end of the wire and the other, it creates a magnetic field which oscillates at a certain frequency, or so many times per second. If such a circuit is greatly reduced in size, very high frequencies are obtained; Lakhovsky believed this to be what occurs in the microscopically tiny nuclei of living cells. In the small twisted filaments within cellular nuclei Lakhovsky descried the analogs to electrical circuits.

In his *L'Origine de la Vie*, published in 1925, Lakhovsky set forth a number of startling experiments upholding the idea that disease is a matter of disequilibrium in cellular oscillation, that the fight between healthy cells and pathogens, such as bacteria or viruses, is a "war of radiations." If the radiations of the microbes are stronger, cells begin to oscillate aperiodically and became "diseased." When they cease to oscillate, they die. If the cellular radiations gain ascendance, the microbes

are killed. In order that a diseased cell be restored to health, Lakhovsky felt it should be treated by means of a radiation of appropriate frequency.

In 1923, Lakhovsky designed an electrical apparatus emitting very short waves (with lengths of two to ten meters) which he called a "radio-cellulo-oscillator." In the surgical clinic of the famous Salpêtrière hospital in Paris he inoculated geraniums with cancer-producing bacteria. When the plants had developed tumors the size of cherry stones, one of them was exposed to radiation from the oscillator. During the first days the tumor grew rapidly, but after two weeks it suddenly began to shrink and die; after a second two-week period it fell off the afflicted plant. Other geraniums treated over different time periods also shed their cancers under the effect of oscillator radiations.

Lakhovsky saw these cures as supporting his theory. The cancer had been overcome by the *enhancement* of the normal oscillations of healthy cells in the geraniums. This was quite opposite to the approach of the radium specialists, who proposed that the cancer cells be destroyed by external radiation.

In the development of his theory Lakhovsky was faced with the problem of the origin of the energy necessary for the normal production and maintenance of cellular oscillations. It did not seem probable to Lakhovsky that the energy is produced within cells any more than the energy in an electric battery or a steam engine is internally produced. He therefore came to the conclusion that the energy is externally derived from cosmic radiation.

To try to establish the cosmic origin of the energy, Lakhovsky decided to dispense with the device he had dreamed up to produce artificial rays and tap natural energy from space. In January, 1925, he picked one of a series of geraniums previously inoculated with cancer and surrounded it with a circular copper spiral thirty centimeters in diameter, its two unjoined ends fixed in an ebonite support. After several weeks he found that whereas all the control geraniums inoculated with cancer had died and dried up, the plant ringed with the copper spiral was not only radiantly healthy but had grown twice as high as uninoculated controls.

These spectacular results led Lakhovsky into a complex theory as to how the geranium had been able to pick up from the vast field of waves in the external atmosphere the exact frequencies which enabled its cells to oscillate normally and so powerfully that the cancer-afflicted cells were destroyed.

To the multitude of radiations of all frequencies emanating from space and unceasingly traversing the atmosphere Lakhovsky gave the generic name "universion." He concluded that some of them, filtered by the spiral, were brought specifically into action to restore the degenerating cells of the diseased geranium to healthy activity.

The universion, or collectivity of universal radiation, was not, in Lakhovsky's mind, to be associated with the notion of a complete vacuum in space with which physicists had replaced the ether of the nineteenth century. To Lakhovsky the ether was not the negation of all matter but a synthesis of radiation forces, the universal plexus of all cosmic rays. It was a ubiquitous and all-pervading medium, into which disintegrated elements were consigned and transformed into electrical particles. Lakhovsky believed that with the recognition of this new concept the bounds of science could be extended and a basis laid for an attack on the most absorbing problems of life, including telepathy, the transmission of thought, and, by inference, man's communication with plants.

In March of 1927 Lakhovsky wrote a communication, "Influence of Astral Waves on Oscillations of Living Cells," which was presented to the French Academy by his friend the eminent biophysicist and discoverer of diathermy, Professor Jacques Arsène d'Arsonval.

By March of 1928, the geranium with the spiral around it had attained the abnormal height of four and one-half feet and was flourishing even in winter. Sure that by his work on plants he had stumbled on a new therapy of unimaginable importance to medicine, Lakhovsky went on to develop a sophisticated therapeutic device for human beings which he called a "multi-wave oscillator." It was successfully used in French, Swedish, and Italian clinics to cure cancerous growths and lesions brought about by radium burns; goiters; and a variety of diseases regarded as incurable. When Lakhovsky, fleeing the Germans who had occupied Paris and were seeking him out as a prominent anti-Nazi, came

to New York in 1941, the physiotherapy department of a large New York hospital employed his multi-wave oscillator successfully to treat arthritis, chronic bronchitis, congenital hip dislocation, and other ills, and a Brooklyn urologist and surgeon, though he would not reveal his name, stated that he had used it on hundreds of patients to arrest bodily disturbances unamenable to other treatment. When Lakhovsky died in 1943, his astonishing findings, which laid the basis for radiobiology, were left unpursued by the medical profession, and today use of the multi-wave oscillator for medical treatment is officially banned by U.S. health authorities.

While Lakhovsky was working in Paris, at the Texas State University a team headed by Professor E. J. Lund devised a way to measure electrical potentials in plants. In a series of experiments lasting more than ten years, Lund showed that plant cells produce electric fields, currents, or impulses which, as Bose had implied, could serve as "nervous systems." Lund further demonstrated that the growth of plants is triggered by these electrical nervous systems rather than by growth hormones, or auxins, as was previously believed, and that the auxins are summoned and even transported by the cell-generated electric fields to the place where growth is known to occur.

In an important but little-known book, *Bioelectric Fields and Growth*, Lund put forward the revolutionary finding that the electric pattern in plant cells changes nearly a half hour before the diffusion of hormones in them can be effective and growth detected.

Meanwhile, the research of the Russian Alexander Gurwitsch, which inspired L. George Lawrence to begin his study of the potentialities of biocommunication, despite its rejection by the U.S. Academy of Sciences, began to get a new lease on life. The distinguished bacteriologist at Cornell University, Professor Otto Rahn, was amazed to find that whenever any of his laboratory workers fell ill they appeared to cause the death of yeast cells with which they were experimenting. A few minutes' exposure to their fingertips even at a distance would kill vigorous cells of this carbohydrate-fermenting fungus. Further investigation showed that a chemical compound excreted from the hands and face of the sick technicians was responsible; but exactly how it acted at a distance was a mystery. Rahn went on to prove that the continually renewed tissue of the cornea of the eye, as well as most wounds and cancer tumors, emit radiation; he set these and other findings down in a book, *Invisible Radiation of Organisms*, which, on the whole, was ignored by his colleagues.

Because most physicists still had no better means of detecting all this new and strange radiation than they did Mesmer's "animal magnetism" or Reichenbach's "odic force," the idea that living tissue could emit or respond to vibrations of energy was greeted with skepticism. The questioning light thrown on discoveries such as Lakhovsky's, Gurwitsch's, and Rahn's was also focused on those of a surgeon, George Washington Crile, founder of the Cleveland Clinic Foundation, who published *The Phenomena of Life: A Radio-Electrical Interpretation* in 1936. The result of a lifetime of research, it offered evidence that the living organism is specifically adapted to the formation, storage, and use of electrical energy, the genesis of which was, according to Crile, ultra-microscopic units or furnaces in protoplasm which Crile called radiogens.

Three years before his book appeared, Crile pointed out in an address to the Congress of the American College of Surgeons that it would be possible for future skilled radio-diagnosticians to detect the presence of disease before it became outwardly apparent. For his efforts Crile was ridiculed by both his medical colleagues and by cellular biologists, who accused him of having no solid grasp of the literature.

The effects of electromagnetic energy on living cells, both healthy and diseased, which most doctors and medical researchers, including cancer specialists, have yet honestly to confront, were finally to be revealed by the magic of time-lapse photography. Because most plants grow very slowly they look as unchanging to the human eye as if petrified. Only by looking away from plants for several hours or, better, for several days, can one notice that they are different from the plastic flowers and shrubs which are supplanting living plants in florist shops across the world.

In 1927, an Illinois teen-ager, staring at the buds on a large apple tree in his front yard, wondering when they would open into flowers, realized that if he could take pictures of them in regular sequence he would be able to watch the buds unfold before his eyes.

Thus began the career of John Nash Ott, whose pioneering interest in time-lapse photography led him to unveil new mysteries in the kingdom of plants.

To experiment with exotic varieties of plants Ott built a small greenhouse, where he found that each variety of plant presented to him as many problems as would a different tribe to an anthropologist. Many of his charges seemed to act like temperamental prima donnas with deep psychological disturbances. As he consulted with university botanists and research scientists on the staffs of large companies, little by little the basic biological causes for his plants' misbehavior became clear: they were extremely sensitive not only to light and temperature but to ultraviolet, TV and X-rays.

Ott's discoveries about light and temperature may lead to the explanation of many botanical mysteries, not the least of which is the tremendous size of plants growing high in the mountains of central Africa.

Over thirty years ago the English author Patrick Synge in his book *Plants with Personality* suggested that though no one had been able to produce a satisfactory theory on the origin of giantism in plants, it perhaps might happen on account of a complement of peculiar environmental conditions, namely, a low but moderately constant temperature, a consistently high humidity, and a strong intensity of ultraviolet light due both to the altitude and to the equatorial location.

In the European Alps vegetation growing high up tends toward dwarfism, but in the Mountains of the Moon, or Ruwenzori as the Africans call them, Synge encountered heathers "as mighty as great trees" and found shell-pink impatiens with flowers two inches across.

On the extinct volcano Mount Elgon, rising fourteen thousand feet on the Kenya-Uganda border, Synge found lobelias, which in England are tiny blue-flowered plants, growing nearly thirty feet tall, "like gigantic blue and green obelisks." He photographed them half covered with snow and with icicles hanging from the tips of their leaves. But when the same plants were brought back to England, they could not survive outdoors even in the mild winters of Surrey.

Synge's idea accorded with the hypothesis of the French chemist Pierre Berthelot, that it is the continuous presence of electricity high in the Alpine ranges that accounts for the luscious growth of plants in very poor soil. If the conditions enumerated by Synge are someday simulated by researchers, perhaps these giant plants will be successfully grown at sea level.

Ott's experiments in time-lapse photography were to lead him to the discovery that different wave lengths of light have a fundamental effect on photosynthesis, the process by which green plants convert light to chemical energy and by means of it synthesize organic compounds from inorganic ones, turning carbon dioxide and water into carbohydrates, with a release of oxygen. To attack this problem, he spent months building equipment which would allow him to take microscopic pictures of the streaming of protoplasm in the cells of Elodea grass while it was stimulated by direct unfiltered natural sunlight. Exposed to the sun's rays, the chlorophyll-containing bodies, called chloroplasts, which are the principal agents of photosynthesis, streamed in an orderly fashion around the edges of the obloid cells. But when the ultraviolet light in the sunlight was filtered out, some of the chloroplasts would drop out of the streaming pattern and huddle, immobile, in the corners. Cutting out the colors from the blue end of the spectrum toward the red increasingly slowed the chloroplast action.

Particularly fascinating to Ott was the fact that, at the day's end, all the chloroplasts slowed down and stopped no matter how intensely they were subjected to artificial light. Only when the sun rose the next day would they resume the normal streaming pattern.

Ott realized that if the basic principles of photochemistry, as they applied to plant photosynthesis, had analogs in the animal world then, as the proponents of color-therapy have long maintained, various frequencies of light might affect the physical well-being of humans by acting on the body chemistry in a way similar to the action of certain drugs on nervous and mental disorders.

In 1964 an article in *Time* magazine spurred Ott to research the effect of TV radiation on plants and humans. The story suggested that symptoms of nervousness, continuous fatigue, headaches, loss of sleep, and vomiting in thirty children under study by two U.S. Air Force physicians were somehow related to the fact that all of these children were watching TV from three to six hours on weekdays and from twelve to twenty

hours on weekends. Though the doctors had concluded that the children were afflicted by prolonged idleness in front of the set, Ott wondered if some sort of radiation might not be at issue, particularly that of X-rays, which lie beyond ultraviolet in the energy spectrum.

To test this idea, Ott covered half of the picture tube of a color TV set with a sixteenth of an inch of lead shielding, normally used to block out X-rays. The other half he covered with heavy black photographic paper capable of stopping visible and ultraviolet light, but allowing other electromagnetic frequencies to penetrate.

Ott placed six pots of bean sprouts in front of each half of the TV tube, a pair at three different levels from top to bottom. As a control, six more pots, each with its three bean sprouts, were placed outdoors, fifty feet from the greenhouse where the TV set was located.

At the end of three weeks, both the lead-shielded beans and those growing outdoors had risen to a height of six inches and appeared healthy and normal. The beans shielded from the TV only by the photographic paper had been distorted by toxic radiations into a vine-type growth. In some cases the roots appeared to have grown incongruously upward out of the soil. If TV radiation could make monsters of bean plants what might it do to children?

Several years later, when Ott was discussing the distortion of the beans with space scientists, he was told that the root growth of his bean plants exposed to radiation resembled that of wheat seedlings in a bio-capsule in outer space, where it was thought to be due to the weightless condition from lack of gravity. Some of the scientists seemed intrigued by his idea that not weightlessness but a general background radiation of an unspecified energy might cause the eccentric root growth.

Since general background radiation coming from the zenith, or the point directly overhead, penetrates through less of the earth's atmosphere and is therefore more powerful than that coming in at any other angle, Ott thinks that roots of plants grow downward to get away from the radiation directly above them.

Similar experiments showed that white rats exposed to the same radiation which caused the wild growth in the beans became increasingly hyperactive and aggressive, then progressively lethargic, to a point where it was necessary to push them to make them move in their cages.

Ott noticed further that after he set up his TV in the greenhouse, rats in an animal-breeding room fifteen feet away produced litters of only one or two babies, as against a norm of eight to twelve, even though two building partitions intervened between the TV set and the pregnant mothers. When the TV set was removed, it took six months for the breeding to return to normal.

Because of increasing difficulty in maintaining discipline in schools, children who are hyperactive or have difficulty concentrating have over recent years been administered so-called behavioral modification drugs or "peace pills." This practice has aroused a storm of controversy among parents, doctors, government officials and even Congressmen. Though it has not been publicly suggested, Ott wonders whether this hyperactivity—and increasingly reported forms of lethargy including prolonged sleep—may be a result of exposure to radiation from TV sets. When Ott offered to repeat his experiments cost-free for technicians at RCA's Bio-Analytical Laboratory, the director of research not only hastily declined but was later quoted as saying, "It is utterly impossible for any TV set today to give off harmful rays."

Ott knew, however, that since the radiation from a TV tube is contained in an extremely narrow band on the electromagnetic spectrum, biological systems sensitive to this narrow spike of energy could be as overstimulated by it as they would be by light focused through a magnifying glass. The only difference is that, whereas the magnifier concentrates the light in one direction, the specific energy emitted from the TV can travel in any direction where it meets no obstruction. "If one-half of a milli-roentgen doesn't appear to be a cause for worry," says Ott, "then it can be pointed out that a pound of gold can also be called one-half of a thousandth of a ton. And it is easy to juggle the decimal point in infinitesimal amounts without realizing the true relationships involved. Eighty degrees Fahrenheit is a comfortable temperature level but one has only to double this figure to reach a point where most forms of life on earth could no longer exist."

Ott's belief that electromagnetic radiation affects plants and animals in many unsuspected ways increased when he was called by Paramount

Pictures in Hollywood to make time-lapse photos of flowers for a new picture, starring Barbra Streisand, based on the Broadway musical hit *On a Clear Day You Can See Forever.* In the story the heroine numbers among her extrasensory abilities that of making flowers grow as she sings to them. The studio wanted Ott to begin work immediately on geraniums, roses, irises, hyacinths, tulips, and daffodils for inclusion in this part of the film.

To duplicate as nearly as possible natural rays of outdoor sunlight, Ott had developed a new full-spectrum fluorescent tube, with added ultraviolet. Because he had a tight deadline, he knew that only if the flowers would grow under the new lights could he hope for success. To his relief, all the flowers grew well. But Ott noticed that the best results came when the flowers were placed under the center, rather than the ends, of the fluorescent tubes. He knew that the tubes worked on the same principle as the cathode guns in TV sets or in X-ray machines, but at much lower voltages, so low in fact that textbooks stated they could not produce harmful radiation. Suspecting the textbooks might be wrong, Ott placed two sets of ten parallel tubes end to end so that there were twenty cathodes in close proximity. When he sprouted the same kind of potted beans used in the TV experiments, he was startled to see that the ones close to the cathodes were stunted whereas those both at the center of the tubes and ten feet away from them appeared normal.

After many more experiments with beans, Ott became certain that they are far more sensitive to trace amounts of radiation than the standard radiation-measuring equipment presently available. This, he thinks, is because whereas the instruments pick up only a single reading of energy the biological systems are exposed to its cumulative effects.

Ott was next confronted with the possibility that light frequencies could affect the development and growth of cancer.

His initial clue that there was a connection between light frequencies and cancer came when a physician in charge of cancer research at one of New York's largest hospitals agreed to ask fifteen human cancer patients to spend as much time as possible outdoors in natural sunlight without their glasses and avoid artificial light sources, including television.

By the end of the summer the doctor told Ott that it was the consensus of all those assisting in the project that fourteen of the patients had shown no further advancement in tumor development.

In the meantime, Ott had aroused the interest of a leading Florida ophthalmologist, who explained to him that a layer of cells in the retina of the eye, with no function in vision, showed abnormal response to tranquilizing drugs and asked if he would run toxicity tests of the drugs by utilizing microscopic time-lapse photography. Ott used a phase-contrast microscope equipped with a complete set of colored filters, which permit the outline and details of cell structure to be clearly seen without killing them with stain as was previously necessary. This technique revealed that exposure to the wavelengths of blue light elicited abnormal pseudopodical activity in the pigment of the retinal cells whereas red light caused the cell walls to rupture. Even more interesting was the fact that when the cells were fed, by adding fresh media to the slide chambers, cell division was not encouraged at constant temperature, but if the temperature was lowered during the feeding accelerated division would take place within sixteen hours.

During their work the researchers also noticed that just before sunset the activity of the pigment granules within the cells would slow down and would return to normal only the next morning. It seemed to Ott that they were behaving just like the chloroplasts in the cells of Elodea grass. Perhaps plants and animals had more similarities in their basic functioning than had hitherto been suspected.

Ott suggests that the responses of chloroplasts and the pigment granules in retinal epithelial cells may be "tuned" to the natural light spectrum of sunlight, under which all life on this earth has evolved. "It would thus appear," he says, "that the basic principles of photosynthesis in plants, where light energy is recognized as a principal growth-regulating factor, might carry over from plant life and be equally important as a growth-regulating factor in animal life through control of the chemical or hormonal activity."

Other studies of cellular behavior have led Ott to conclude that malillumination or malradiation may be as important as malnutrition in the initiation of disease.

At the 1970 meeting of the American Association for the Advancement of Science, Dr. Lewis W. Mayron, in his discussion of Ott's research with bean plants and rats exposed to TV radiation, concluded that "the radiation has a physiological effect both on plants and animals which appears to be chemically mediated." Mayron also commented on Ott's experiments with the effects of fluorescent tubes on beans, stating: "The implications for human health are enormous when one considers the magnitude of the use of fluorescent lighting in stores, offices, factories, schools and homes."

With generous support from the Evelyn Wood Foundation, Ott has carried on studies on what effects TV sets might have on children with behavioral problems. With the cooperation of Mrs. Arnold C. Tackett, principal of a school which devotes itself to such children in Sarasota, Florida, Ott made checks of home TV sets watched by the youngsters and found measurable amounts of X-ray radiation in most of them, especially those which had run for long hours without overhaul. The parents agreed to get the children to spend much more time playing outdoors during the summer vacation and to sit far back from the TV while watching it.

By November of the new school year, Mrs. Tackett was able to report that the behavioral problems of children so treated were markedly diminished.

By the late 1960s the U.S. Congress had passed a Radiation Control Act by a vote of 381 to 0. Florida Representative Paul Ropes, co-author of the act, credited Ott with "getting us all started on the road toward control of radiation from electronic products." Ott credits his plants with showing him the way to the light.

Since the work of Gurwitsch, Rahn, Crile, and the proponents of electroculture all supported the earlier contentions of Galvani and Mesmer that living things have electrical or magnetic properties, it was strange that no one had suggested that they must also have about them the same electromagnetic fields as those accepted in the world of particle physics. This was exactly the theory boldly advanced by two Yale University professors, one a philosopher, F. S. C. Northrop, the other, like Galvani, a medical doctor and anatomist, Harold Saxton Burr.

By asserting that electrical fields are the very organizers of life systems, Northrop and Burr offered chemists a new basis on which to explain how the thousands of separate constituents they had uncovered might be put together. They suggested to the biologists that their long hunt might be over for the "mechanism" which assures that all the cells of the human body, replaced every six months, are properly aligned. This appeared to revitalize the rejected theories of Mesmer's animal magnetism and Galvani's animal electricity and provide a seemingly tangible underpinning for the airy "élan vital" of the French philosopher Henri Bergson, and the "entelechy" of the German biochemist Hans Driesch.

To prove their theory, Burr and his laboratory colleagues constructed a voltmeter of a new design, which drew no current from life forms to be studied and thus could not disrupt the total fields around them. Twenty years of research with this device and its more sophisticated descendants revealed to Burr and several of his associates astonishing things about the vegetal and animal world. Dr. Louis Langman, an obstetrician and gynecologist who worked with Burr's technique, found for example that the precise moment of a woman's ovulation can be measured with great accuracy and that some women ovulate over the entire menstrual cycle, in some cases without menstruation. Though the detection procedure is extremely simple, and in no way counters the rhythm method of birth control of the Catholic Church, it has yet to filter down to millions of women who would like to learn better how, or how not, to have children.

Burr himself determined that malignancies could be detected in certain organs before any clinical signs could be observed, and that the rate of healing in wounds could be reliably measured. The future location of a chick's head could be found and pinpointed in the egg from which it would hatch, without breaking it, during the first day of its incubation.

Turning to the world of plants, Burr measured what he came to call "life-fields" around seeds, and found that profound changes in the voltage patterns were caused by the alteration of a single gene in the parent stock. Even more potentially interesting to plant breeders was his discovery that it is possible to predict how strong and healthy a future plant will be from the electrical diagnosis of the seed which produces it.

Because, of all living things, they seemed the most enduring and the least motile, Burr charted the life fields of trees on the Yale campus and at his laboratory in Old Lyme, Connecticut, over nearly two decades. He found that recordings related not only to the lunar cycle and to sunspots, which flare up at intervals with many years between them, but revealed cycles recurring every three and six months that were beyond his explanation. His conclusions seemed to make less suspect the long-mocked practices of generations of gardeners who claimed that their crops should be planted according to the phases of the moon.

One of Burr's students, Leonard J. Ravitz, Jr., who was to become a psychiatrist, was able to measure depths of hypnosis with the Burr-discovered techniques as far back as 1948. He went on to the not surprising conclusion that all humans are in hypnotic states most of the time, even when wide awake.

The continuous charting of life fields in people indicates a cyclic rise and fall of voltage, the peaks and valleys of which correlate to the periods when they feel good or bad, "up" or "down." By plotting the curves in advance it is possible to predict highs and lows weeks in advance, as the students of bio-rhythms have proposed, going back to the time when they were first theorized by Dr. Wilhelm Fliess, whose letters were so encouraging to Sigmund Freud during the years of Freud's self-analysis.

Burr's life work, as further developed by Ravitz, indicates that the organizing field around the "bodies" of living things *anticipates* the physical events within them and suggests that the mind itself, as Marcel Vogel maintains, can, by modulating the field, affect positively or deleteriously the matter with which it is held to be associated. But these signposts had yet to be read by the leaders of organized medicine, and Burr's work has only recently begun to be seriously considered.

Medical pundits are now in for a further shock due to a startling discovery in 1972 at the Institute of Clinical and Experimental Medicine in Novosibirsk, a burgeoning industrial city of over a million people on the banks of Siberia's mighty river Ob, which strongly supports the findings of Gurwitsch, Rahn and Crile.

S. P. Shchurin and two colleagues from the Institute of Automation and Electrometry have been awarded a special diploma by the USSR

State Committee for Inventions and Discoveries for discovering that cells can "converse" by coding their messages in the form of a special electromagnetic ray.

The experimenters placed identical tissue cultures in two hermetically sealed vessels separated by a wall of glass, then introduced a lethal virus in one of the chambers which killed the colony of cells inside it. The second colony remained wholly unaffected. However, when they replaced the glass divider with a sheet of quartz glass and again introduced killing viruses to one of the colonies, the Soviet scientists were astonished to see that the second colony also met the same fate as the first, even though the viruses could not possibly have penetrated the barrier. Other first and second colonies of cells, separated by the quartz glass, both perished when only the first colony was murdered with chemical poisons or lethal radiation and the second left unexposed. What killed the second colony in each case?

Since ordinary glass does not permit ultraviolet rays to pass but quartz glass does, it seemed to the Soviet scientists that here was a key to the mystery. They recalled that Gurwitsch had theorized that onion cells could emit ultraviolet rays, and they resurrected his ideas from the limbo to which they had been consigned in the 1930s. Working with an electronic eye amplified by a photomultiplier and registered by a self-recorder which traced a graph marking the energy levels on a moving tape, they found that when life processes in the tissue cultures remained *normal,* the ultraviolet glow, invisible to the human eye but detectable as oscillations on the tape, remained *stable.* As soon as the affected colony began to battle against its infection, the radiation intensified.

Reports on this work in Moscow newspapers disclosed that, however fantastic it might seem, the ultraviolet radiation from the afflicted cells *carried information* encoded in the fluctuation in intensity which was somehow received by the second colony, just as words are transmitted and received in dots and dashes in the Morse code.

Since the second colony seemed in each case to die in exactly the same way as the first, the Soviets realized that it was as dangerous for healthy cells to be exposed to the transmitted signal of dying cells as it was for them to be exposed to viruses, poisons, and lethal radiation. It appeared

that the second colony upon receiving the alarm signal from the dying first colony began to mobilize for resistance and that its very "restructuring for war" against a nonexistent enemy proved as fatal as if it had indeed been attacked.

Moscow newspapers suggested that the Novosibirsk work may help to pinpoint what inner reserves the human body possesses to resist disease and quoted Shchurin on how it may help to open new horizons in diagnosis: "We are convinced that the radiation is capable of giving the first warning about the beginning of malignant regeneration and of revealing the presence of particular viruses. At the present time the early identification of many ailments, for instance the numerous forms of hepatitis, presents major difficulties."

Thus, fifty years after his work, his countrymen have finally brought recognition to Gurwitsch's brilliant research. Coincidentally they have also validated the work of another obscure compatriot, Semyon Kirlian, who has managed to capture on film extraordinary pictures of the force fields around humans and plants so accurately described and measured by Burr and Ravitz.

CHAPTER 13

The Mystery of Plant and Human Auras

The long train was on the last leg of its journey from Moscow to Krasnodar, a south Russian inland port on the Kuban River, two hundred miles northwest of the volcanic Elbrus, Europe's highest mountain peak in the Greater Caucasus range.

In one of its "soft" cushioned cars reserved for Soviet officials, a plant specialist, bored with watching the flat countryside, still only partly recovered in 1950 from the Nazi ravages of the "Great Patriotic War," reopened his satchel to check the condition of two similar leaves which he had plucked in a greenhouse before leaving the Soviet capital. Relieved to see that the leaves were still sparkling fresh and green in their bedding of moist cotton wool, he sat back in his fauteuil to admire the approach of the Caucasian piedmont.

Late that evening in a small Krasnodar apartment, a corner of which was fitted out as a miniature laboratory, Semyon Davidovich Kirlian, an electrician and amateur photographer, and his wife, Valentina, were making some adjustments to equipment they had begun building two years before the Nazi attack on their country.

With their new invention they had discovered they could photographically reproduce—without lens or camera—a strange luminescence which seemed to issue from all living things but was unapprehensible by the human eye.

A knock on the door surprised them, as no visitor was likely to call at that time of evening; they were even more surprised when a total stranger announced he had come all the way from Moscow to see if they could make for him photographs of the strange energy which he had heard they alone could make visible on film. From his brief case the stranger pulled the two identical leaves and handed them to the Kirlians.

Excited at the prospect that their discovery was to be put to an official test, the Kirlians stayed up till after midnight, but were disappointed to note that while they could make excellent pictures of energy flares from one of the leaves, they could get only a weak facsimile from the other. They worked on through the night, trying to get photos of the luminescence as similar as the leaves themselves, but were wholly unsuccessful.

In the morning, crestfallen, they showed their results to the scientist, who shouted in amazement: "But you've found it! You've proven it photographically!" He explained that one leaf had been plucked from a healthy plant, the other from a diseased specimen. Although the two leaves appeared identical to the human eye, the pictures plainly differentiated between them. Illness was evidently manifest in a plant's energy field before becoming visible as a symptom in its physical body.

That plants, as well as animals and human beings, have fields of fine sheaths of subatomic or protoplasmic energy which permeate the solid physical bodies of molecules and atoms was a centuries-old allegation by seers and philosophers. This extra dimension or "aura" depicted in ancient iconography around the bodies of saints, with golden halos around the heads, has been referred to by persons gifted with extrasensory perception since the beginnings of recorded history. By laying film or plate in contact with an object to be photographed and passing through the object an electric current from a high-frequency spark generator which put out 75,000 to 200,000 electrical pulses per second, the Kirlians had come across a way of photographing this "aura"—or something akin to it.

Leaves from plants, sandwiched with film between the electrodes of their device, revealed a phantasmagoria hitherto restricted to clairvoyants, a micro-universe of tiny starry points of light. White, blue, and even red and yellow flares were pictured surging out of what seemed to be channels in the leaves. These emanations, or force fields round a leaf, became distorted if the leaf was mutilated, gradually diminishing and disappearing as the leaf was allowed to die. The Kirlians were next able to magnify this luminescence by adapting their photographic processes to optical instruments and microscopes. Rays of energy and whirling fireballs of light appeared to shoot out of plants into space.

The Kirlians also examined all kinds of "inanimate" substances, including metal coins. Each had a different luminating pattern. Most interesting was the fact that while a two-kopeck coin showed only a constant glow around its edges, human fingertips seemed to shoot forth flaming energy in bursts like miniature volcanoes.

After their photographic demonstration of pathology in the leaf from the sick plant for the Muscovite visitor, it was another ten years before the Kirlians began to emerge from obscurity in the USSR.

In the early 1960s Dr. Lev Fedorov of the USSR's Ministry of Public Health, struck by the possibilities of the new photography for medical diagnosis, awarded the Kirlians a first research grant but when Fedorov died soon thereafter, official funding from Moscow began to dwindle and academic skeptics were once more in control.

It was only when a journalist took up the Kirlians' story that interest was again aroused. "This situation," wrote I. Belov, "is as bad as before the revolution, when the evil hand of Tsarist bureaucrats determined there was too much uncertainty in novelty. *Twenty-five years have passed* since the Kirlians made their discovery, yet the Ministries in charge still haven't released the funds."

Belov's effort had its effects. In 1966, a conference bringing together many scientists interested in all aspects of what was coming to be called "biological energy" was held in Alma Ata, capital of the Kazakh Republic. In proceedings of the conference, entitled *Problems in Bioenergetics*, a Moscow biophysicist, Viktor Adamenko, joined with the Kirlians to author a seminal paper "On Research of Biological Objects in High-Frequency Electrical Fields." The paper stressed the enormous difficulties of studying the spectrum of "electrobioluminescence" but added that when these are overcome, "we will be able to obtain important information about bioenergetic processes in a living organism."

For all the mounting Soviet interest, it was another three to four years before American science—which had branded as fake Wilhelm Reich's 1939 discovery of a life energy in plants and humans which he called orgone—paid attention to the new developments. What attracted this attention was not the Soviet scientific publications but a book, *Psychic Discoveries Behind the Iron Curtain*, by two North American journalists, Sheila Ostrander and Lynn Schroeder, which appeared in the summer of 1970.

Excited by what she had read in the Ostrander-Schroeder volume, a former Broadway actress, now professor at the Neuropsychiatric Institute of the University of California at Los Angeles, Thelma Moss, Ph.D., wrote to Russia and received an invitation to visit Professor Vladimir Inyushin at Alma Ata.

Working with several colleagues, Inyushin had written up his research into the Kirlians' work in 1968 in a book-long scientific paper: *The Biological Essence of the Kirlian Effect.* Though Kirlian himself had maintained that the strange energy in his pictures was caused by "changing the nonelectrical properties of bodies into electrical properties which are transferred to film," Inyushin and his collaborators went several steps further. They declared that the bioluminescence visible in Kirlian pictures was caused not by the electrical state of the organism but by a "biological plasma body" which seemed to be only a new word for the "etheric" or "astral" body of the ancients.

In physics plasma is defined today as an electrically neutral, highly ionized gas composed of ions, electrons, and neutral particles which has been called the "Fourth State of Matter" (after solids, liquids, gases).

As far back as 1944, as the Allied armies were storming "Fortress Europe," a book by the Russian V. S. Grishchenko, *The Fourth State of Matter,* appeared in French in Paris. Credit for coining the term bioplasma may thus belong to Grishchenko. The same year the discoverer of "mitogenetic radiation," A. G. Gurwitsch, published his book in Moscow entitled *The Theory of a Biological Field,* summing up twenty years of work.

Inside the "bioplasmic" body, said Inyushin, processes have their own labyrinthine motion, different from the energy pattern in the physical body, yet the bioplasmic body is not a chaotic, but a whole unified organism which acts as a unit, is polarized, gives off its own electromagnetic fields, and is the basis for "biological" fields.

When Thelma Moss arrived on an evening flight in Alma Ata, she was invited by Inyushin to visit his laboratory and lecture to his students. Elated, she went to sleep sure that she would be the first American scientist to visit a Soviet institution engaged in studying Kirlian photography. The following morning when Inyushin came to pick her up at her hotel, he regretfully told her that "permission for the visit had not come from Moscow."

Moss was nevertheless able to learn from Inyushin that during six years of research with Kirlian photography he had been able to note that specific areas of the human body revealed characteristic colors which might prove significant in medical diagnoses. The clearest photos, he told Moss, were those taken at four o'clock in the afternoon, the worst at midnight. When Moss asked Inyushin point-blank if his "bioplasma" body was what occult Western literature refers to as the "aura" or the "astral" body, he said: "Yes!"

In ancient philosophies and in Eastern and Theosophical teaching, the energy body which duplicates the human body is also called the etheric body, fluidic body, or prephysical body. It is believed to be the unifying agent for the material body, a magnetic area where immaterial or subatomic vortices of the cosmos are transformed into the individual, the channel through which life communicates with the physical body, the medium for telepathic and clairvoyant projection. For decades scientists have been trying to find a way to make this body visible.

While Moss was in Alma Ata, the eminent American psychiatrist Montague Ullman, director of the department of psychiatry at the Maimonides Medical Center in New York City, was simultaneously interviewing Viktor Adamenko in Moscow.

Ullman was informed, somewhat to his surprise, that Adamenko and other Soviet scientists had been able to determine that the "bioplasma" not only undergoes a drastic shift when placed in a magnetic field but is concentrated at hundreds of points in the human body which seem to correspond to the ancient Chinese system of acupuncture points.

Thousands of years ago the Chinese mapped seven hundred points on the human skin as paths along which they believed a life force or vital energy to circulate. The Chinese insert needles at these points to correct imbalances in the energy flow, and to cure disease. Spots where the Kirlian lights flared most brilliantly on a human body appeared to match the acupuncture points mapped by the Chinese.

Adamenko is still unsure about Inyushin's attribution of the phenomena to a "bioplasma body," because there is as yet no "rigorous proof" of its existence, and therefore prefers to define the visible emanations as "a cold emission of electrons from the live object into the atmosphere."

In the United States this "cold emission of electrons" is almost universally translated as a "corona discharge," which is compared to the static electricity emitted by a person after walking across a carpet and touching a grounded metal. The name is derived from the faintly colored luminous ring which surrounds celestial bodies and is visible through a haze or thin cloud or the luminous irregular envelope of highly ionized gas outside the chromosphere of the sun. But giving it an academic name has explained neither its substance nor its function.

As president of the American Society for Psychical Research, Ullman found it extremely interesting that Dr. Anatoli Podshibyakin, a Kiev electrophysiologist, had discovered that bioplasma, if that is what it is, *instantly* reacts to changes on the surface of the sun even though cosmic particles, ejected by the sun, take about two days to reach the earth.

Many parapsychologists view man as an enmeshed, integral part of life on earth and in the universe. They maintain he is linked to the cosmos via his bioplasmic body, and reacts to changes in the planets as well as to the moods and illnesses of others, to thought, emotion, sound, light, color, magnetic fields, the seasons, cycles of the moon, tides, thunderstorms, strong winds and even levels of noise. If there is a change in the universe and environment, say the parapsychologists, a resonance is produced in the vital energy of the human body which in turn affects the physical body. It is through his bioplasmic body that parapsychologists believe a man can be in direct contact with a living plant.

Still another U.S. parapsychological researcher, Dr. Stanley Krippner, director of the extraordinary Dream Laboratory at the Maimonides Medical Center in New York—where pictures have been successfully directed at sleepers in order to produce in their minds desired dreams—trekked to Russia in the summer of 1971. While in Moscow, Krippner was the first American invited to give an address on parapsychology to the Institute of Psychology in the Academy of Pedagogical Sciences. The lecture was attended by some two hundred psychiatrists, physicists, engineers, space scientists, and cosmonauts in training.

Krippner found out that Genady Sergeyev, a neurophysiologist working at the Ukhtomskii Military Institute in Leningrad, had made Kirlian photographs of Nina Kulagina, a sensitive who can, by simply passing her hand over but not touching them, move paper clips, matches, cigarettes, and other objects on a table top.

Sergeyev's photographs revealed that while Kulagina performs these psychokinetic feats, the "bioplasmic field" around her body expands and pulses rhythmically and *a ray of luminescence seems to shoot out of her eyes.*

In the fall of 1971, William A. Tiller, chief of the Materials Science Department at Stanford University (Palo Alto, California) and one of the world's experts on crystals, was the first American physicist invited by Edward Naumov, chief coordinator for Technical Parapsychology in Moscow, to investigate Kirlian photography in the USSR.

Although, like Moss and Ullman, Tiller was not permitted to visit Soviet laboratories, he was able to spend several days with Adamenko. When he returned to the United States, Tiller recommended in a highly technical report that the Kirlian method and devices, among others,

were "so important to parapsychological and medical investigations that attention should be focused on immediate construction of such devices and the duplication of the Soviet results."

Tiller, who like Adamenko does not see the need for postulating any new "bioplasma," and substitutes for it the "cold emission of electrons," has been building extremely sophisticated equipment for taking Kirlian photographs in his Palo Alto laboratory.

One of the first actually to make Kirlian-type pictures in the United States was Thelma Moss, who worked on the project with one of her students, Kendall Johnson. With their apparatus, Moss and Johnson were the first Americans to take color photos of leaves and pick up almost every region of the visible spectrum. American coins, appropriately enough, come out in red-white-and-blue, as do photos of the energy from the fingertips of the human hand.

Henry C. Monteith, an electrical engineer in Albuquerque, New Mexico, working at home, put together an apparatus consisting of two 6-volt batteries, a vibrator used to power automobile radios, and an ignition coil sold at all auto-supply stores. Like the Russians, Monteith found that a live leaf gave beautiful and varied self-emissions that cannot be adequately explained by conventional theory. He was further mystified when he discovered that a dead leaf gave, at most, only a uniform glow. Exposed to only 30,000 volts, the dead leaf did not reveal anything at all on film, even when bathed in water, but the live leaf shimmered in a radiance of self-emissions.

As the potential implications of a photographic process in existence for more than thirty years—which seemingly gave substance to the notion of the existence of an *aura,* a subject considered by most Western scientists to be on the "lunatic fringe" of investigatory effort—began to be realized in the United States, demand mounted for more hard information. Stanley Krippner enlisted the cooperation of several financial backers and organized the First Western Conference on Kirlian Photography and the Human Aura in the spring of 1972 at Manhattan's United Engineering Center, where a crowd of doctors, psychiatrists, psychoanalysts, psychologists, parapsychologists, biologists, engineers and photographers packed the ground-floor auditorium to overflowing. At the conference startling pictures by Moss and Johnson were shown of a leaf before and after being pricked. Done with Kirlian techniques, the photo of the wounded leaf revealed an enormous blood-red pond of energy in its center which took the place of the bright azure and pinkish hue which showed up before the pricking.

The mystery of the link between human emotional or psychic states and emanations radiating from the fingertips is deepened by Moss's further finding that pictures of both her own and Kendall Johnson's fingers differ from day to day and hour to hour.

Since the photos of leaves change with variations in parameters, Moss conjectures that "at whatever frequency we take a picture, we are resonating, or vibrating at the same frequency, *with one particular aspect of the material;* thus, not a whole picture, but different pieces of information are picked up."

Tiller speculated that the radiation or energy coming out of a leaf or a human fingertip actually might be coming from whatever is present *prior to the formation of solid matter.* This, says Tiller, "may be another level of substance, producing a hologram, a coherent energy pattern of a leaf which is a force-field for organizing matter to building itself into this kind of physical network."

Tiller thinks that even if part of the network were cut away, the forming hologram would still be there. Apparently this is just what the Russians have been able to prove with a plant leaf. A picture printed in the *Journal of Paraphysics* (published in Downton, Wiltshire, England) shows a Russian Kirlian photograph of a leaf with one part cut away. Yet, where nothing would show ordinarily, the outline of the missing part of the leaf remains.

That this was not just Russian subterfuge was strikingly confirmed when Douglas Dean made photos of the fingertip of a New Jersey healer, Ethel de Loach, whose files bulge with successful case histories. One picture, taken while the healer was at rest, showed only a dark blue radiation streaming out of the skin and revealing the tip of the long nail. A second picture, shot when she was asked to heal, revealed in addition to the blue radiation an enormous orange and red flare leaping out of a point below the actual fingerprint. Both pictures were subsequently

published on the cover of the medical journal *Osteopathic Physician.* Kirlian photos of faith healers reveal a smaller glow after healing, while those healed have greater emanations, indicating some sort of energy flow from the hands of the healer into the body of the patient, giving substance to Galvani's and Mesmer's theory of "animal magnetism."

At the Human Dimensions Institute at Rosary Hill College in Buffalo, New York, one of the professors, Sister M. Justa Smith, a Catholic nun and biochemist, began thinking that healing energy coming from or through a healer's hands would have to affect the enzyme system *before* diseased cells could change to a state of health. Sister Justa—who had finished a doctoral dissertation proving that magnetic fields increase, while ultraviolet light decreases, enzyme activity—after engaging the cooperation of a healer, found that when he was in an "optimum psychological state," or good mood, the energy coming from his hands could activate the pancreatic enzyme trypsin in a way which compared to the effects of a magnetic field measuring from 8,000 to 13,000 gauss. (Human beings normally live in a magnetic field of 0.5 gauss.) Sister Justa is continuing experimentation to find out whether a healer can activate other enzymes in the body and whether this activation can be of help to the maintenance of health.

How magnetic fields affect life and how they might be related to the energy of the "aura" is a mystery only beginning to be unveiled. In recent years scientists have found, for instance, that snails perceive extremely weak magnetic fields and, since they can also distinguish their direction, could be said to incorporate structures which behave like navigational compasses.

Jan Merta, whose own projections of what he terms "auric energy" have not only turned dowsing devices held in a doctor's hands against the doctor's will and efforts to prevent it, but also so disturbed the magnetic components of the video tape recording the procedure that the film blacked out while supposedly recording a crucial sequence, has developed a whole theory about auras, part of which suggests that magnetic fields might significantly affect a learning process. Merta took thirty mice and housed them in small cages made of transparent plastic. Ten of them were exposed to the south pole, ten to the north pole, with field strength of 5–10 gauss of a bar magnet. The third ten were left untreated. With an ingenious learning device Merta was able to establish that those mice which had lived under the influence of a magnetic field were not only more active than the nonmagnetized mice, but somehow were able to learn quicker.

It would seem that some correlation exists between the activity of the "bioplasmic" or "auric" fields—if that is what they are—around living things and their subjection to various types of radiation. Certainly there is no doubt, in light of the pioneering Soviet work and its American confirmation, that the health, physical or emotional, of plants and animals can be objectified with the Kirlian technique.

The main strength of the Russian research, according to Professor Tiller, is that "it has been able to provide us with detectors and devices with which we can begin to show cause-effect relationships between psycho-energetic phenomena and the kind of read-outs which our colleagues find acceptable and that our logical system has come to accept as proof. We're *at that stage of naïveté* that we need this proof."

The first Kirlian conference was so successful that a second meeting was held in New York's Town Hall in February 1973. One of the most striking presentations was that of Dr. John Pierrakos, a Greek-born psychiatrist who showed detailed drawings of auras which he can visually perceive around plants, animals and human beings and which he is able to monitor in continual movement around neurotically and psychotically disturbed patients. In her book *Breakthrough to Creativity*, published in 1967, Shafica Karagulla, M.D., reported how many physicians use their observations of the human energy field in their diagnostic work. Because they were guarded about discussing their unusual abilities outside their own circle, Karagulla did not refer to any of them by name. Pierrakos is perhaps the first physician publicly to state that his perceptions of the human aura assist him in his diagnoses.

"Man is an eternal pendulum of movement and vibration," Pierrakos told the Town Hall audience. "His spirit is captured in a body in which forces throb and pulsate like the beat of a heart. Often, they thunder and quake in his body with strong emotions that shake the very foundations of his physical being. Life goes on, rhythmically and quietly pulsating with the warm feeling of love or cascading with avalanches of violent

emotion, for movement and pulsation is life. When movement diminishes, the person becomes ill, and when the movement stops, the person is dying."

Pierrakos likened human bodies to time capsules in which biological functions are performed "for a century or so" after which the capsule changes the shape of its existence. "During this time, like the flower that brings the blossom and the seed that brings the flower and the fruit, man's time capsule has to become aware of what is going on within and without." To do so, asserted Pierrakos, we must describe and understand, fuse and integrate two attributes: *life energy* and *consciousness* —the former seen as the aura around the body with gradations similar to that of the atmosphere which thins as it proceeds outward from the earth. Though to his Hellenic ancestors energy was "something producing movement," Pierrakos holds that this nebulous definition should be made more precise. "Energy is a living force emanated by consciousness," he suggests. "By observing the energetic field emanating from the body—not unlike the steam over boiling water which, correctly observed, gives an idea of the water's nature—I get an idea of what is happening in the body," Pierrakos said.

In his pictures, Pierrakos illustrated the three layers he sees around most of his patients. The first, a dark band no more than one-sixteenth to one-eighth of an inch thick, lies close to the skin and looks like a transparent crystalline structure. The second, a broader dark blue layer, reminiscent of a cluster of iron filings, forms an ovoid envelope around the body when seen from the front. The third is a lightish blue haze of radiant energy which, when the patient is in good health, extends several feet away from the body and accounts for why we describe happy zestful persons as "radiant."

Pierrakos also showed how in patients with disturbances there are interruptions in these layers and changes in their colors of which he can see only the grosser aspects. When a psychotic patient told Pierrakos that she was "secure" because another person stood next to her constantly "on guard," he asked her to let him see this other person. All at once he noticed a mass of light blue-gray energy in the shape of a human body next to his patient.

The energy field of plants can also be severely affected by disturbed patients, says Pierrakos. "In some experiments with plants conducted in my office with Dr. Wesley Thomas, we found that a chrysanthemum's field contracts markedly when a person shouts at it from a distance of five feet, and loses its blue-azure color, while its pulsation diminishes to one third. In repeated trials, keeping live plants more than two hours daily near the heads of screaming patients (a distance of three feet away), the lower leaves started falling down and the plant withered within three days and died."

Pierrakos related that the number of pulsations the energy field emits per minute is also an indication of the internal state of a human being. The pulsations are much slower in older persons than in children, and in sleep than in wakefulness.

Since the direction of the flow of energy on the front of the body starts in the midriff and proceeds downward in a sort of curving L toward one of the legs and upward in an inverted L to the opposite shoulder, then reverses this flow on the back side of the body, the whole energy pattern around the body forms a figure 8. Put together in symbolic form, the two pairs of L shapes, front and back, have from time immemorial been represented in cultures throughout the world as the *swastika,* a Sanskrit word for "well-being."

The same kind of energy field observable in humans is seen by Pierrakos macrocosmically over the ocean with miles-high fountains of radiation bursting forth from narrower bands of pulsation below. Since the amount of activity in this earthly aura plotted by Pierrakos against the time of day reveals the lowest ebb just after midnight and the highest shortly following noon, this directly correlates with Rudolph Steiner's account of how the chemical ether is exhaled and inhaled by our planet.

A research team of physicists and electronics specialists is currently seeking to objectify Pierrakos' "sensitive" sight. Under the auspices of the Center for Bio-Energetic Analysis they are developing a means of detecting the radiations of the human animal and plant auras with a sensitive photomultiplier tube, an instrument which measures photons or light energy from the "etheric" field around a body. In a preliminary report they stated in Town Hall that, to date, their work indicates strongly that human beings radiate a strange field, detectable by the tube, the properties of which remain to be analyzed and explained.

Pierrakos, who can also see the energy pumping forth from plants and trees, warns of the danger of comparing the phenomena revealed by Kirlian photography to known radiations such as X-rays. "The study of the aura could become completely mechanized and objectified without reference to the great phenomena of life within the entity," he says.

In this observation Pierrakos is not far from the philosopher-mathematician Arthur M. Young, inventor of the Bell helicopter, who stresses that in back of the whole hierarchy of active energies, known or unknown, may lie *intent.* "Content requires substance," says Young, "whether by reference to actual physical objects or to human feelings or emotion. Substance is indeed what the work connotes, that which stands under—*sub stance*—the interactions of the physical world. To the physicist this is *energy.* To the human being it is *motivation.*"

Through *motivation* or *intent,* or some other agency of will, is it possible for living forms to effect changes in their own physical systems? Is it possible for plants and men—which materialists assert are only renderable at death into so much compost, soap, or chemicals—to grow the way they want?

In the Soviet Union, a country which was originally founded on the most materialist of philosophies, the developments resulting from Kirlian photography have raised certain profound questions about the true nature of life—vegetal, animal and human—about mind and body, about form and substance. Thelma Moss believes that research in the field has actually become of such great scientific importance to both the Russian and U.S. governments that they are keeping their official efforts strictly secret. Nevertheless, a spirit of friendly rivalry and of cooperation has arisen between groups, thus far small, of Russian and American scientists.

As Semyon Kirlian put it in a letter to the First Western Conference to take up the implications of his work, "the new research will have such enormous significance that an impartial assessment of the methods will be carried out only by minds in succeeding generations. The possibilities are immense; indeed, they are practically inexhaustible."

PART IV

CHILDREN OF THE SOIL

CHAPTER 14

Soil: The Staff of Life

Despite Carver's prescient observations on how to bring life back to the cotton-debased soils of Alabama by rotating crops and fertilizing the soil with natural humus, the farmers of that state—and those in every other state of the Union—have since Carver's death been lured by the promise of large profits to deal with the land, not in a natural, but in an artificial way in order to force from it every ounce of productivity. Instead of exerting patient and tender efforts to keep their soils in natural balance they have been seeking to subjugate nature rather than cooperate with her. Everywhere there are indications that in the process of being raped rather than loved, nature is protesting. If the process goes on, the victim may die of bitterness and indignation, and with her all that she nurtures.

An example—one among thousands—is Decatur, Illinois, a farming community in the heart of the United States cornbelt. As the summer of 1966 was drawing to a close, steamingly hot and sultry, the corn stood in the fields as high as an elephant's eye, promising a bumper crop in every direction, perhaps eighty to a hundred bushels to the acre. In the twenty years since World War II the farmers had almost doubled the land's yield in corn by the use of nitrate fertilizers, unaware of the deadly danger they were courting.

The following spring one of Decatur's seventy-eight thousand townsmen—whose living depended indirectly on the success of the corn harvest—noticed that a cup of drinking water from his kitchen faucet tasted funny. As the water was supplied directly from Lake Decatur, an impoundment of the Sangamon River, he took a sample to the Decatur Health Department for testing. Dr. Leo Michl, a Decatur health official, was alarmed to find that concentrations of nitrate in the waters of Lake Decatur and the Sangamon River itself were not only excessive but potentially lethal.

Nitrate, in itself innocuous to the human physical constitution, can become deadly when converted by intestinal bacteria; these combine nitrate with the blood's hemoglobin into methemoglobin, which prevents the natural transport of oxygen in the bloodstream. This can cause a disease known as methemoglobinemia, which kills by asphyxiation; infants are particularly susceptible to it. Many cases of the mysterious epidemics of "crib death" are now attributed to it.

When a Decatur newspaper ran a feature suggesting that the city's water supply had become polluted with excessive nitrate and that fertilizers being poured on the surrounding cornfields might be the source of the trouble, the story exploded like a bombshell in the cornbelt communities. At the time of the water analysis, farmers were resorting almost exclusively to nitrogen fertilizer as the cheapest, and indeed the only, means to produce over eighty bushels of corn to the acre, an amount dictated by the economics of corn production as necessary to realize a profit. Corn, or maize as it is known in the English-speaking world outside North America, is a heavy consumer of nitrogen, which,

under *natural* conditions, is stored in the soil as a part of its humus, a brown-black material composed almost wholly of decayed vegetable matter.

For countless ages before man began to till the soil, humus was accumulated by return to the soil of vegetation which died and rotted. When man began to harvest crops he saw to it that humus, rich in nitrogen and other elements upon which plants depend, was replaced in the form of animal wastes and straw, the components of barnyard manure. In many countries of the Far East, man's own excrement, euphemistically termed "night soil" by Westerners, is applied to the land instead of being allowed to float away through sewage systems into rivers.

An almost inexhaustible supply of such a natural manure is still available to Decatur in nearby Sioux City, Iowa, America's heartland city on the Missouri River, where millions of animals have been fed and slaughtered and from which they have been shipped to the nation's retail markets for over half a century. A pile of steer manure has accumulated longer than a football field. This mountain of organic waste, which poses a headsplitting disposal problem to the city fathers, could easily be processed into natural soil-enlivening products were anyone interested in saving the soil. Nor is the Sioux City manure pile an exception. Dr. T. C. Byerly, leader of the USDA's waste-disposal programs, states that wastes from livestock operations in the United States are presently equal to those produced by the entire U.S. population and that by 1980 they will double in size.

Instead of returning this natural humus-nitrogen to the soil, the farmers chose to apply artificial nitrogen fertilizers. In Illinois alone the consumption rose from ten thousand tons in 1945 to well over half a million tons in 1966, and is rising constantly. Since the amount of nitrogen applied is more than the corn can naturally take up, the excess washes out of the soil into the local rivers: in the case of Decatur, all the way into the drinking cups of citizens.

Joe Nichols, a physician and surgeon who founded the Natural Food Associates in Atlanta, Texas, reported that a survey on farms throughout the Middle West disclosed that the corn growth was so heavily fertilized with synthetic nitrogen that it was unable to convert carotene into vitamin A and that the cattle feed produced from it was also deficient in vitamins D and E. Not only were the cattle not gaining weight but they were not even reproducing as well as they should have, and, as a result, the farmers were losing money. When certain strains of corn were cut for silage, the nitrate content was so high the silos blew up and the juice that ran out killed every cow, duck, and chicken unfortunate enough to drink it. Even when silos did not explode, the nitrogen-laden corn in them became lethal, in the form of nitrous oxide fumes sufficient to kill a man unsuspectingly breathing it.

The swirl of controversy which broke upon the Illinois cornbelt when the truth became public had already arisen in scientific circles when Dr. Barry Commoner, director of the Center for the Biology of Natural Systems at Washington University in St. Louis, Missouri, presented a prophetic paper on the relation between nitrogen fertilizer and the nitrate level in Midwestern rivers at the annual meeting of the American Association for the Advancement of Science. Two weeks later, a vice-president of the National Plant Food Institute, a lobby whose goal is to protect the interests of the $2-billion American fertilizer industry, sent copies of Commoner's paper for rebuttal to soil experts at nine major universities. Because they had spent most of their careers advising farmers that the best way to insure bountiful crops is to apply artificial fertilizers to the land, many scientists in these centers of academic learning were as irritated at Commoner's allegations as were the fertilizer-lobby officials and rushed to take up cudgels in the lobby's and their own defense.

An exception was Washington University's Dr. Daniel H. Kohl, an expert in the process of photosynthesis, who concluded that the problem was so serious the fate of the planet might be at stake. When he joined Dr. Commoner to ascertain, by isotopic analysis, exactly what was happening to the excess nitrogen fertilizer in Illinois soils, his efforts were immediately and viciously attacked by his departmental colleagues on the grounds that such work was not a proper part of the department's goal of pure research.

Dr. Commoner in his book *The Closing Circle* challenged his aca-

demic colleagues by pointing out that the new technology allowing more corn to be produced on less acreage than before might be a success economically but was ecologically a disaster. Commoner characterized the nitrogen-fertilizer industry in its hurtling dash for profits as one of the "cleverest business operations of all time." Evidence suggests that in the presence of artificial nitrogen, the natural fixation of nitrogen from the air by soil bacteria stops and, as a result, it is increasingly difficult for farmers to give up the use of the artificial product. Like addictive drugs, fertilizer nitrogen creates its own demand, the buyers having been "hooked" on the product.

Dr. William Albrecht, a professor of soil science at the University of Missouri, who, more than a quarter of a century ago was almost single-handedly struggling to stress the importance of healthy soil to crops, animals, and men, states that, with respect to analyzing fodder, cows are more intelligent than people. Regardless of how tall and green forage looks to the eye when grown with an excess of artificial nitrogen, says Albrecht, the cow will refuse it and will eat the surrounding grass shorter and shorter. "Though the cow cannot classify forage crops by variety name, or by tonnage yield per acre, she is more expert than any biochemist at assessing their nutritional value."

Albrecht's years of research were admired by the director of studies of France's National Veterinary School at Alfort, near Paris, Dr. André Voisin. In 1959 Dr. Voisin produced a book, *Soil, Grass and Cancer*, which was translated into English by the secretary of the Irish Agricultural Organization Society and published by New York's Philosophical Library. The thrust of Voisin's important work is that man, in his effort to produce food for an exploding world population, has forgotten that his body comes from soil or, as the Bible put it, "dust and ashes."

Voisin's realization that plants and animals are intimately associated with the soil where they are born was strengthened when he visited the Ukraine and saw that, within a few generations, the giant dappled Percheron draft horses, developed on the soils of a French district south of Normandy, had dwindled to the size of Cossack horses, though their bloodlines had been kept pure by the Soviets and their conformation remained the same, though miniaturized. This should remind us, says

Voisin, that all living things are biochemical photographs of their environment. Our ancestors, he says, were well aware of the fact that the dust of the soil itself is what finally determines vigor and health.

Developing his theme that the soil makes the plant, the animal, and man, Voisin exposed his readers to a fascinating panoply of data which illustrates that animals and plants on the land, not chemists in laboratories, are the supreme judges of agronomic methods. Voisin also provided copious examples to prove that, by itself, chemical analysis of foodstuffs, plants, and soil is wholly insufficient to the evaluation of their essence. Voisin points out that chemists work mainly on "analytical groups," which can be said to be "mere creations of their minds." Noting that farmers have long been given advice on the nutrition of their animals on the basis of certain tests for nitrogen content, Voisin quotes the 1952 Nobel Prize winner in chemistry, R. L. M. Synge, who stated that it was wholly presumptuous in this way to conclude anything about the real nutritive qualities of grass, or human food.

The dean of agriculture at the University of Durham in England was so impressed with Voisin's lecture to the British Society of Animal Production in 1957 that he summed it up for the assembled audience, saying: "As Monsieur Voisin has forcibly explained to us, a herbage which appears ideal to the chemist as judged by his analysis is not necessarily ideal for the cow."

While Voisin was in England, he visited one farm on which the incidence of a disease known as grass tetany afflicting a 150-head herd of cattle was particularly high. Voisin learned from the farm owner that his livestock had been foraging, not on seasoned pastureland, but on new sowings of young grass to which enormous applications of industrial fertilizer, particularly potash, had been applied. Voisin told the farmer that when potash is applied to grass and other forage plants, the plants gorge themselves immediately and indulge in "luxury consumption." This results in an enormous increase of the potash content of the plants in a very short time and diminishes the quantity of other elements absorbed, such as magnesium, the lack of which leads directly to tetany.

When a local veterinary arrived at the farm to care for some of the stricken animals, Voisin asked him whether he knew to what extent his

client had employed potash to fertilize his grazing land. The animal doctor, who had no idea that he was talking to one of the most distinguished French representatives of veterinary science, curtly replied: "This question concerns the farmer. My role is to care for sick animals and to cure them." Voisin was aghast at this stock reply. "I think," he wrote, "that it is not merely a question of healing the animal or man stricken by disease, it is necessary to heal the soil so as not to have to heal the animal or man."

To Voisin it appears that the rise of the artificial fertilizer industry has caused man mechanically and unthinkingly to rely to such an extent on its products that he has forgotten his intimate relationship with the soil as nature made it, that his adulteration of the dust from which he springs may be sealing his destiny on planet earth. Though this predicament is hardly a century old, its progression has been geometric in the proliferation of degenerative diseases in both animal and man consequent on the overuse of artificial fertilizers.

It all started with Baron Justus von Liebig, a famous German chemist who published an essay in 1840, interestingly entitled *Chemistry in Its Application to Agriculture and Physiology.* In this essay he appeared to indicate that everything required by living plants was to be found in the mineral salts present in their ashes once the plants had been incinerated to destroy all the organic matter they contained. Though this theory ran directly counter to centuries of agricultural practice, and indeed to common sense, the visual results of the application of artificial fertilizers composed of nitrogen, phosphates, and potash, together with calcium oxide, or lime, seemed to prove Liebig's theory, and later resulted in the skyrocketing climb of fertilizer production by the chemical industry, of which the figures for Illinois are but one example among thousands.

Dr. Albrecht of the University of Missouri terms this sudden blind dependence upon nitrogen, phosphorus, and potassium, the main constituents of artificial fertilizers, or NPK—as they are known in chemistry—an "ash mentality," since ashes suggest the idea of *death* rather than life. Like a senile yet undeposable king, the ash theory still rules the world's agricultural realms, despite the attack on it by a far-seeing minority of individuals, a group collectively called "organic agriculturalists," who have seized upon Justus von Liebig as the progenitor of what they see as a worldwide cataclysm.

Already at the turn of the century, as the fertilizer industry was getting into stride, a British doctor and medical researcher, Robert McCarrison, later knighted for his thirty years' service as head of the Nutrition Research Agency for the Imperial Government of India, and director of its Pasteur Institute at Coonoor, had come up with a contrary conclusion after spending a period of time working among the peoples of the remote Gilgit Agency, a rugged, mountainous area south of the Wakhand Valley, which is Afghanistan's "tail."

McCarrison was struck by the fact that the Hunzas, an ancient people claiming descent directly from the soldiers of Alexander the Great, not only could walk 120 miles at a stretch in the roughest mountain country in the world, or cut two holes in a winter lake and swim from one to the other under the ice for the fun of it, but, with the exception of an occasional eye inflammation due to badly ventilated fires in their huts, were wholly free of disease and lived to a great age. McCarrison also found the Hunzas' health to be matched by their superior intelligence, wit, and urbanity; though they were numerically few and their neighbors warlike, they were rarely attacked—because they always won.

As neighboring people living in the same climate and geographical conditions were afflicted with many diseases which never appeared among the Hunzas, McCarrison began a comparative study of the dietary practices of Gilgit Agency peoples which he extended to various races all over India. By feeding diverse Indian diets to rats—foolish enough to eat whatever humans will eat—McCarrison found that his rats reflected the conditions of growth, physique, and health of the people eating the same foods. The rats which ate the diets of the peoples such as the Pathans and Sikhs increased their body weight much faster and were much healthier than those ingesting the daily fare of peoples like Kanarese and Bengalis. When offered the food of the Hunzas, which was limited to grain, vegetables, and fruits, along with unpasteurized goat milk and the butter made from it, the rodents appeared to McCarrison the healthiest ever raised in his laboratory. They grew rapidly, were apparently never ill, mated with enthusiasm, and had healthy offspring.

When they were killed and autopsied at twenty-seven months—the equivalent of fifty-five years in humans—nothing whatsoever was wrong with their organs. Most amazing to McCarrison was the fact that throughout their lifetimes they were gentle, affectionate, and playful.

Contrasted to these "Hunza rats" others contracted precisely the diseases of the people whose diets they were being fed and even seemed to adopt certain of their behavioral characteristics. Illnesses revealed at autopsy filled a whole page. All parts of their bodies, from womb and ovary to skin, hair, and blood, and respiratory, urinary, digestive, nervous and cardiovascular systems, were afflicted. Moreover, many of them, snarling and vicious, had to be kept apart if they were not to kill each other.

In laboratory work based on the newly discovered accessory food factors, named *vitamins* in 1921 by the Polish-born American biochemist Casimir Funk, McCarrison was able to prove that pigeons given a diet which in people produces goiter developed polyneuritis. What was surprising to McCarrison was that other healthy birds fed on normal diets harbored the same microbes but did not get ill. McCarrison believed it was the faulty diet which led to the microbic triumph, not the presence of the microbes themselves.

During a lecture to the British College of Surgeons McCarrison described how, in the course of more than two years, his rats fed on the diets of the more vigorous and well-developed Indian races never fell ill. But the *British Medical Journal*, in a leading article on McCarrison's address, concentrated only on the diseases which diet would help to prevent and completely overlooked the astonishing fact that the radiant health of a group of people could be transferred dietarily to a group of rats, simply by diet. Doctors, used to textbook explanations that pneumonia was due to exhaustion, chills, a blow on the chest, the pneumococcus microbe itself, weakness in old age, or other illnesses, were unimpressed with McCarrison's finding that, in every case, his Coonoor laboratory rats had fallen ill with pneumonia because of faulty food. The same was true for diseases of the middle ear, peptic ulcers, and other afflictions.

American medical circles were no more receptive to the basic truth which McCarrison was propounding than their British colleagues. During a Mellon lecture delivered before the Society for Biological Research at the University of Pittsburgh, where McCarrison spoke on "Faulty Food in Relation to Gastro-Intestinal Disorders," they listened impassively as he said of the Hunzas: "Indeed their buoyant abdominal health has, since my return to the West, provided a remarkable contrast with the dyspeptic and colonic lamentations of our highly civilized communities." Then as now, the weight of McCarrison's evidence that Hunzas enjoy a remarkably disease-free and long life failed to mobilize any medical-research expedition to Hunza land. His stunning data were buried in the *Indian Journal of Medical Research.*

Only when a British doctor, G. T. Wrench, brought out a book, *The Wheel of Health,* in 1938 was McCarrison's evidence given broad public exposure. In the introduction to his work Wrench asked thought-provokingly why, as students, young doctor aspirants were always presented with sick or convalescent people for their teaching and never with the ultrahealthy. It was abhorrent to Wrench that medical schools—presuming that knowledge about health in its fullness was picked up by a baby at its birth—taught only disease. "Moreover," wrote Wrench, "the basis of our teaching upon disease is pathology, namely the appearance of that which is dead from disease." Then, as today, it seems the emphasis was on *pathology,* not natural health. Neither Wrench's admonition nor the startling evidence of McCarrison—who after retiring as a major general became physician to King George V—seemed to have any effect on the health authorities of the United States and other countries. In 1949 Dr. Elmer Nelson, in charge of nutrition at the U.S. Food and Drug Administration, was reported by the Washington *Post* to have declared in court: "It is wholly unscientific to state that a well-fed body is more able to resist disease than a less well-fed body. My overall opinion is that there has not been enough experimentation to prove that dietary deficiencies make one more susceptible to disease."

Some time before McCarrison arrived in the Gilgit Agency, Albert Howard, a young mycologist and agricultural lecturer to the Imperial Department of Agriculture at Barbados in the West Indies, concentrating on fungus diseases of sugar cane, came to the conclusion that the

true cause for plant diseases would never be found by researchers sequestered in small laboratories and greenhouses full of flowerpots. As he put it: "In Barbados I was a laboratory hermit, a specialist of specialists, intent on learning more and more about less and less." Because another part of his job was to tour the Windward and Leeward Islands and advise people on how to grow cacao, arrowroot, peanuts, bananas, citrus fruits, nutmegs, and a host of other plants, Howard found that he learned much more from men in actual contact with the land and its abundance than he ever had in his botany classes.

He began to detect a fundamental weakness in the organization of the research into plant pathology. "I was an investigator of plant diseases," he wrote, "but I had myself no crops on which I could try out the remedies I advocated. It was borne in on me that there was a wide chasm between science in the laboratory and practice in the field."

Howard's first big chance to combine theory and practice came in 1905, when he was appointed imperial botanist to the Government of India. In the Bengali town of Pusa, site of the agricultural research station about to be founded by Lord Curzon, then Viceroy to India, Howard decided to see whether he could create, on a seventy-five-acre holding, plants with such health that they would not require poison sprays to resist disease. Howard took as his teachers, not learned plant pathologists, but the natives of the region. He felt that, since the crops grown by cultivators around Pusa were remarkably free of pests, he would make an in-depth study of Indian agricultural practices. As he put it, he "speedily found my reward."

By following the practices of the Indians, who used no pesticides or artificial fertilizers but returned to the land carefully accumulated animal and vegetal wastes, Howard was so successful that by 1919 he had learned "how to grow healthy crops, practically free from disease, without the slightest help from mycologists, entomologists, bacteriologists, agricultural chemists, statisticians, clearing-houses of information, artificial manures, spraying machines, insecticides, fungicides, germicides, and all the other expensive paraphernalia of the modern experimental station."

Howard was further astonished that his herd of work oxen, the ordinary power unit of Indian agriculture, when fed only the produce from his fertile land, never came down with foot-and-mouth disease, rinderpest, septicemia, and other cattle diseases, which frequently devastated herds of the modern experimental stations. "None of my animals were segregated," he wrote; "none were inoculated; they frequently came into contact with diseased stock. As my small farmyard at Pusa was only separated by a low hedge from one of the large cattle-sheds on the Pusa estate, in which outbreaks of foot-and-mouth disease often occurred, I have several times seen my oxen rubbing noses with foot-and-mouth cases. Nothing happened. The healthy, well-fed animals failed to react to this disease exactly as suitable varieties of crops, when properly grown, did to insect and fungous pests—no infection took place."

Howard recognized that the entire basis for eliminating disease in plants and animals was the fertility of the soil and that the first prerequisite for all subsequent work was the bringing of the whole Pusa experiment station to the highest state of fertility. To do this he determined to copy the age-long practices of China and build a large-scale system for utilizing farm wastes to turn them into humus.

Unfortunately, while the idea was taking shape in his mind, the Pusa agricultural research organization had developed to the point where, as Howard saw it,

> A series of watertight compartments—plant breeding, mycology, entomology, bacteriology, agricultural chemistry and practical agriculture—had become firmly established. Vested interests were created which regarded the organization as more important than its purpose. There was no room in it for a comprehensive study of soil fertility and its many implications by one member of the staff with complete freedom of action. My proposals involved "overlapping," a defect which was anathema both to the official mind (which controlled finance) and to a research institute subdivided as Pusa always had been.

Howard therefore laboriously collected funds to found a new center, the Institute of Plant Industry, at Indore, three hundred miles northeast of Bombay, where he had complete freedom of action. Since the fundamental prerequisite for growing cotton, the principal commercial crop around Indore, was raising soil fertility, Howard was in his element. He

accordingly developed what came to be known as the "Indore process" of humus production. Within a short time he found not only that the yields of his cotton were three times those of the surrounding countryside but that the cotton was remarkably free of diseases. "These results," Howard later wrote, "were progressive confirmation of the principle I was working out—the connection between land in good heart and disease-free crops; they were proof that as soon as land drops below par, disease may set in." Howard was firmly convinced that the two most important goals were to keep the texture of his soils right and not to overwork his land beyond a volume of operations for which it had sufficient natural reserves.

Based on his findings, Howard wrote a book, *The Waste Products of Agriculture: Their Utilization as Humus*, which was greeted with favorable and even enthusiastic reviews around the world. But, when the book was circulated to agricultural scientists working on cotton problems in research stations all over the British Empire, the reception was hostile and even obstructive. This was because Howard's successful methodology challenged the ingrained beliefs that *breeding methods alone* could improve cotton yields and the quality of plant fibers, and disease was to be reduced by *direct assault with pesticides*.

Furthermore, the time factor was ridiculed. How could one possibly waste several years bringing the land back into what Howard called "good heart"? This would demand the abandonment of chemical fertilizers and the time-consuming production of Indore compost, a mixture of decaying animal and plant matter at a ratio of three to one. Howard clearly saw the threat he posed to the established order: "The production of compost on a large scale might prove to be revolutionary and a positive danger to the structure and perhaps to the very existence of a research organization based on the piecemeal application of the separate sciences to a complex and many sided biological problem like the production of cotton."

Research workers on many other crops throughout the Empire took the same dour view as that of the cotton specialists and they were strongly supported by the moguls of the burgeoning artificial fertilizer and pesticide industries.

When Howard went home to England at the end of 1935, he was invited by the students of the School of Agriculture at Cambridge University to address them on "The Manufacture of Humus by the Indore Method." Because he had distributed printed copies of his remarks beforehand in order to insure that a lively discussion would follow his lecture, practically the whole staff of the school was present when he mounted the lecture platform. But since he had been so consistently attacked by plant specialists in England, India, and other parts of the world, it was no surprise to Howard that nearly all of the school's faculty from chemists to plant breeders to pathologists heatedly opposed his remarks. Only the student body seemed enthusiastic and, as Howard recalled, vastly amused at finding their teachers on the defensive and vainly endeavoring to bolster up the tottering pillars supporting their temple. "Here again I was amazed by the limited knowledge and experience of the world's agriculturists disclosed by this debate. I felt I was dealing with beginners and that some of the arguments put forward could almost be described as the impertinences of ignorance." It was obvious from this meeting that little or no support for organic farming would be obtained from the agricultural colleges and research institutes of Great Britain.

Howard was correct. When later he read to the British Farmers' Club a paper on "The Restoration and Maintenance of Fertility," representatives of experimental stations and of the fertilizer industry in the audience poured ridicule on his ideas. To their protestations Howard replied that he would shortly have his answer "written onto the land itself." Two years later Sir Bernard Greenwell, who had meticulously followed Howard's directions on his two estates, gave an account to the club which more than bore out Howard's findings. But the scientists and the fertilizer salesmen, knowing that success was the one unanswerable argument in favor of organic farming, failed to attend the lecture.

Despite the truculence of these vested interests, Howard, like McCarrison, was knighted by the British Crown for his achievements. Yet only a few sensible individuals began to follow his lead. One of these was Lady Eve Balfour, who since childhood had suffered bad bouts of rheumatism and continual head colds each winter from November to April. Learning

of Howard's research just before World War II, she initiated an Indore-type operation on her own farm at Haughley in Suffolk. Instead of bakers' loaves she ate bread made only from whole-grain flour ground from her own compost-benefited wheat. During the winter following the change in her overall diet, she was entirely free from colds for the first time in her life and was no longer bothered with rheumatic pains in prolonged periods of cold, damp weather.

During the war, Lady Eve's book *The Living Soil* appeared in heavily rationed England. The result of long detective work in libraries and interviews with health specialists who were convinced of the soundness of Howard's and McCarrison's views, it amassed a compendium of scattered data on the links between humus-grown plants and the health of animals and humans fed upon them. Lady Eve compared man's prideful "conquest of nature" with the conquest of Europe taking place under the Nazis. "As Europe is in revolt against the tyrant," she wrote, "so is nature in revolt against the exploitation of man."

Lady Eve soon discovered that her piglets, attacked at the age of one month by a disease called white scour, which the textbooks explained was due to iron deficiency, and for which accordingly they recommended doses of chickweed or other plants rich in that element, could be cured equally effectively by being fed actual soil from fields rich in humus to which no chemical fertilizers had been applied, whereas soil from land "exhausted" from the application of fertilizers had no effect upon the disease's progress.

About the same time Friend Sykes, a British farmer and breeder of thoroughbred horses, attracted by Howard's ideas, bought a 750-acre derelict farm in Wiltshire at nearly one thousand feet altitude, overlooking the Salisbury Plain, on which the land had been completely farmed out. Sykes's previous experience as an agricultural consultant had taught him that specialized farms, on which only certain crops or one variety of animals were raised, resulted in the inevitable weakening of stock and plants by disease. He came to see that outbreaks of disease could be completely eradicated by an "enlightened practice of good husbandry," particularly the introduction of mixed agriculture.

A student of ecology long before the subject became a household word, and an opponent of DDT more than ten years before Rachel Carson shocked the world with her *Silent Spring*, Sykes wrote in his *Food, Farming and the Future*, published in 1951: "The first thing that Nature does when she has been treated with poison is to battle against it and try to breed a resistant strain of the form of life that is being attacked. If the chemist persists in his poisonous methods, he often has to invent more and stronger poisons to deal with the resistance that Nature sets up against him. In this way, a vicious cycle is created. For, as a result of the conflict, pests of a hardier nature and poisons still more powerful are evolved; and who is to say that, in this protracted struggle, man himself may not ultimately be involved and overwhelmed?"

Sykes's experience with his crops, based on his intuition that the soil had a *latent fertility* which could be brought out simply by being tended, and without the application of any fertilizer whatsoever, was little short of fantastic. Sykes had the soil on one twenty-six-acre field analyzed. The laboratory report indicated severe deficiencies of lime, phosphate, and potash and appended a recipe of artificial fertilizers to correct the condition.

Ignoring the report, Sykes simply plowed and harrowed his field and, *without adding any fertilizer*, sowed oats. To the amazement of his neighbors he got a crop yielding ninety-two bushels per acre, which was followed by an equally successful crop of wheat. After tilling the soil again throughout the summer, he again sent a sample of it to the laboratory and found that only a deficiency of phosphorus remained, the lime and potash having been completely restored. In spite of the unanimous views of experts that cereal crops could not be successfully grown without a heavy dressing of phosphates, Sykes merely subsoil plowed the acreage and achieved a harvest of wheat larger than the first one. Subsoil plowing digs deeper into the ground and aerates this otherwise packed and useless earth. When Sykes ordered his subsoiler plow in Chantry, the agent who took his order said: "What on earth do you want a tool like that for in this God-forsaken country? My firm has been in business over a hundred years and has never supplied such an implement before." Sykes's wheat crop, which had been undersown with rye grasses and clover, produced two and a half tons of hay to the acre in one cut the

following year. Sykes then replowed his land, planted it to oats, and was rewarded with a crop yielding over one hundred bushels to the acre. A third laboratory analysis of his soil showed no deficiencies whatsoever.

Sykes described this procedure in an essay, "Farming for Profit with Organic Manures as the Sole Medium of Re-Fertilization," in which he concluded that he had made his livestock healthy, his plants disease free without poison sprays, and had been able to plant the same varieties of wheat, barley, and oats from their seeds six consecutive years in a row although other farmers had had to make changes.

Having achieved among his other successes a reversal of the trend in seed degeneration which has led to increasing dependence by farmers on hybrid varieties that are of questionable nutritional value, Sykes teamed with Lady Eve Balfour and others to form the Soil Association, the principal object of which was to unite people, of whatever country, working for a fuller understanding of the vital relationships among the soil, plants, animals, and man. Its philosophy centered on the idea that, when quality is sacrificed to quantity, total food supply diminishes.

The Soil Association began a research project on land donated in Suffolk, the referees for which stated:

> Humanity has been badly frightened by the invention of the atomic bomb. Yet the slower but more widespread devastation wrought by exhausting the soil upon which we depend for subsistence, is ignored by the majority of people, who think of calamity only in terms of disaster or war. Wasteful exploitation of the soil's fertility is due in part to the desire for quick cash returns, but in a greater degree to ignorance. Many scientists and agriculturalists now realize that their knowledge of the natural processes underlying soil fertility is incomplete. They recognize that these processes are only partly explicable in terms of agricultural chemistry and that the purely inorganic approach to the study of soil science is a line of thought as dead as the mechanical determination of nineteenth-century physics. "Dead" is the appropriate word; for the missing factor is that of life itself.

Shortly before the organization of the Soil Association in Britain, J. I. Rodale, editor of a health magazine in Pennsylvania, also came across the work of Sir Albert Howard. "To say I was stunned," wrote Rodale afterward, "would be a definite understatement. Surely the way food is grown has something to do with its nutritional quality. Yet this theory had not found its way into the articles of any of the health magazines I was reading. To physicians and nutrition specialists carrots were carrots were carrots." In 1942 Rodale bought a farm of his own in Emmaus, Pennsylvania, and set about publishing Sir Albert Howard's book, *An Agricultural Testament.* He then launched a journal, *Organic Gardening and Farming,* which today, after three decades of growth, has some 850,000 subscribers. A companion magazine to enlighten the public on the links between health and organically grown foods, called *Prevention,* was started by Rodale in 1950 and now circulates to over one million readers increasingly anxious about the quality of American food.

For his efforts in fighting for integrity in foods Rodale was harassed by the U.S. Federal Trade Commission, which sought to stop the sale of his book *The Health Finder* because it was advertised as being able to "help the average person to remain comparatively free of many terrible diseases." Rodale fought the case in court in a battle which cost him nearly a quarter of a million dollars. He won hands down but was not able to sue the government to recoup his losses.

Rodale's campaign began to challenge the usual view of people living in the cities and suburbs of the United States—and this is the vast majority—that soil is a static, inert substance. He challenged the use of the word *dirt* as a synonym in English for *soil.* The former is used to mean something mean, contemptible, or vile, whereas soil is alive and clean.

Below its surface the earth teems with organisms. Earthworms, called *Annelida* after the Latin word for rings, because they are made of one hundred to two hundred ringlike segments, each an independent miniature body, burrow in the ground to depths of more than the height of a tall man, acting as nature's plow, eating the soil as they move, ejecting it again as castings to produce rich topsoil. Called by Aristotle the "intestines of the soil," they could also be considered its vascular system, since, when they are lacking, soils get hard-packed as if their arteries had hardened.

In 1881, a year before his death, Charles Darwin brought out a book, *The Formation of Vegetable Mould through the Action of Worms,* in

which he made the statement that, without worms, vegetation would degenerate to the vanishing point. He estimated that in a single year more than *ten tons* of dry earth per acre passed through the digestive systems of earthworms and that in a field well populated with them *one inch* of topsoil would be created *every five years.* Darwin's earthworm book moldered on the shelf for fifty years before it was re-examined; even then his ideas did not penetrate into the curricula of the agricultural schools, and it is not realized that with heavy application of chemical fertilizers and pesticides, a field can lose its entire earthworm population, so important for keeping it in a state of health necessary to the production of nutritious crops.

The favorable action of earthworms is often mocked, though in an experiment run about 1950 their ability to improve poor soil was definitely demonstrated. Twenty barrels were filled with impoverished soil and planted with grass. Half the barrels contained live, the other half dead, worms so that all shared identical amounts of organic matter. Each barrel was treated with an equal amount of organic fertilizer. The barrels with the live worms produced four times as much grass.

Just after World War I, Dr. William Beebe, first to explore the ocean in a bathysphere, decided after a bird-collecting expedition in Brazil that he needed something to do on the sea journey back to New York: so he decided to examine jungle soil. Working on shipboard with a magnifying glass and an old bag of earth mold and decaying leaves, Beebe found himself plunged into a strange world of miracles. By the time he reached New York Harbor Beebe had discovered in his soil over five hundred separate specimens of life; he believed that more than twice as many remained to be identified.

If Beebe had resorted to the microscope, and thus come across bacteria, he would have been helpless to count them. Sir E. John Russell, in his book *Soil Conditions and Plant Growth,* says that in one tiny gram of soil treated with farmyard manure there are some twenty-nine million bacteria; however, where chemical fertilizers were used, the number was cut almost in half. In an acre of rich earth, bacteria are estimated to weigh more than a quarter of a ton; as they die, their bodies become converted to humus, enriching the soil in a natural way.

In addition to bacteria are myriads of other microscopic organisms:

actinomycetes, filamentous forms resembling both bacteria and fungi; tiny algae, related to seaweeds; protozoa, animals made up of a single cell apiece; and the strange chlorophyll-less fungi themselves, ranging from one-celled forms to branched bodies, including yeasts, molds, and mushrooms.

The vegetative part of one kind of fungus associates with the roots of many green plants in a way beneficial to both that is still mysterious. Though it seems to have escaped the attention of many agricultural scientists, these fungi, called "mycorrhizae," were discovered by Dr. M. C. Rayner in England to have their threads consumed by tree roots with which they were associated. Traveling in France, Sir Albert Howard found that the roots of the healthiest vines for wine grapes were rich in mycorrhizae. No artificial fertilizers had ever been used on the vines, yet they were noted for the high quality of their wines.

Another great advantage of natural agriculture, well known to yesterday's farmer, has been forgotten in the highly specialized mono-crop agriculture of today: the advantage of symbiosis in plants. As the Russian essayist Vladimir Soloukhin has pointed out in *Grass*, modern Soviet agronomy has lost all feeling for the benefits of plant companionships. Though the specialists mock the idea that cornflowers growing in a field of waving rye have a salubrious effect on this cereal crop and consider the blue-blossomed plants—known to Americans as bachelor's buttons—as only noxious weeds, Soloukhin asks: "If the cornflower were an evil weed, would not the farmers of the world have grown to hate it before the appearance of the learned agronomists?"

How many botanists, asks Soloukhin, realize that the first sheaf of rye harvest was lovingly decorated with a cornflower wreath and placed in front of an icon, or that cornflowers were held by country folk to supply bees with abundant nectar for honey even in the driest weather? Suspecting that all this folk wisdom had a solid basis in fact, Soloukhin checked in scientific literature and found evidence supporting the accuracy of peasant intuition. He read that if a hundred wheat grains are mixed with twenty seeds from the ox-eye daisy the sprouting wheat will be overwhelmed, but that if only one daisy seed is added, the wheat will grow better than if no daisies come up in its field. The same is true for rye and cornflowers.

Soloukhin's view on plant symbiosis supports that of an American professor of botany and conservation, Dr. Joseph A. Cocannouer who, while Sir Albert Howard was working in India, ran the Department of Soils and Horticulture at the University of the Philippines for a decade and set up an extensive research station in Cavite province. In his book *Weeds: Guardians of the Soil*, published nearly a quarter of a century ago, Cocannouer sets forth the thesis that, far from being harmful, plants usually considered noxious and troublesome, such as ragweed, pigweeds, purslane, and nettles, bring up minerals from the subsoil, especially those which have been depleted from the topsoil, and are excellent indicators of soil conditions. As companion crops they help domesticated plants to get their roots down to food which would otherwise be beyond their reach.

Writing of the "law of togetherness of all things," Cocannouer warned that the whole of world agriculture was beginning to ignore it. "In America," he wrote, "in our frenzied efforts to take advantage of high prices for agricultural products, we are mining our soils instead of farming them." The same was beginning to be true of Europe, he added, where, since World War II, few farmers have been practicing the *law of return*.

Farmers are becoming more and more mechanical-minded, says Cocannouer, one of whose best friends told him: "You and your Nature stuff! That's all very well in theory . . . but starving people are looking to America for food. We've got to feed 'em. We've got to mechanize our agriculture and make our land produce to its limit!"

Today, Americans live in a country where food production is supposed to be the world's most efficient. Yet food prices have continued to rise. The cliché holds that back in 1900 one U.S. farmer could feed only five people besides himself and that today he can feed thirty. But Michigan University food scientist Georg Borgstrom says these mathematics are illusory. At the turn of the century farmers, in addition to working their land and raising livestock, delivered their own milk, butchered their own animals, churned fresh farm butter, salted meat, baked bread, and farmed with draft animals for which they produced feed. Now these draft requirements are fulfilled by expensive machinery using increasingly costly and depletable fossil fuels, and the husbandman's arts have been taken over by factories. In less than twenty-five years several million poultry raisers, whose chickens roamed the land ingesting all sorts of natural vegetable and mineral products as well as insects, have disappeared, to be replaced by some six thousand semiautomated outlets where broilers, packed wing to wing in cages, are fed diets full of artificial supplements.

All these off-farm activities figure in the high cost and dubious quality of food. In fact, if one divides the twenty-two million workers building farm machinery and farm-to-market roads, delivering and processing farm produce and engaged in other food-production tasks, it becomes clear that it takes about the same number of people to feed Americans today as it did in 1900.

Cocannouer nevertheless realized that the views of his nature-scoffing friend were bound to prevail. He was in despair that no publicity had been given Luther Burbank's firm belief that all agricultural learning should begin with a study of nature.

Now there are signs that the agricultural worm may at last be turning and that university scientists are beginning to wake up to the views propounded long ago by McCarrison, Howard, and Rodale. As if they were discovering something new, Drs. Robert F. Keefer and Rabindar N. Singh, agricultural researchers at West Virginia University in Morgantown, issued a press release on March 4, 1973, to the effect that "what man eats is determined partly by the fertilizer that farmers put on their crops." In their experiments the two professors say that they have determined that the amounts of trace elements in sweet and fodder corn, so important in the diets of animals and humans, are dropping dramatically owing to the kinds and amounts of fertilizers grown in some soils.

Their somewhat belated rediscovery of this basic truth has also reinforced a survey conducted in eleven Midwestern states, where it was found that the iron, copper, zinc, and manganese content in corn has fallen off severely in the past four years. The application of huge doses of nitrogen fertilizer such as that which has alarmed the citizens of Illinois, may, says Singh, "have far-reaching effects on the health of animals and men." He adds that work of another of his West Virginia

colleagues shows that fertilization of pastures with high rates of nitrogen may produce changes in the milk of grazing animals, as revealed by feeding it to rats.

In light of the findings of such pioneers as McCarrison, Howard, Albrecht, Voisin, Sykes, and Lady Eve Balfour, the West Virginia professors' research comes very late in the day, and their caution seems somewhat ludicrous in the face of mounting rates for degenerative diseases in the United States.

It is a strange fact that U.S. medical schools, concerned mainly with the study of diseased tissues and bodily systems and organs rather than with healthy people, do not even have a single fundamental course on nutrition in their curricula.

CHAPTER 15

Chemicals, Plants and Man

In the early nineteenth century an American of English descent named Nichols cleared hundreds of acres of rich virgin land in South Carolina, on which he grew crops of cotton, tobacco, and corn so abundant that with the revenue he built a big house and educated a large family. Not once in his lifetime did he add anything to the soil. When it became depleted and his crops dwindled, he cleared more land and continued his exploitation. When there was no more land to be cleared the family fortunes declined.

Nichols' son, grown to manhood, looked at the poverty-stricken acreage, took Horace Greeley's advice and moved west to Tennessee, where he cleared two thousand acres of virgin land; like his father he planted cotton, corn, and tobacco. When his own son was grown to manhood, the land was once more so depleted from having living things taken from it and none returned that he moved on to Horse Creek in Marengo County, Alabama, there to purchase another two thousand acres of fertile soil and raise a family of twelve children on the proceeds; the town became Nicholsville; Nichols became the owner of a sawmill, a general store, and a gristmill. This man's son also grew up to see devastation where his father had grown rich. He decided to move further west and settled in Parkdale, Arkansas, where he bought one thousand acres of good land on the bayou.

Four moves in four generations. Multiplied by thousands, this is the story of how Americans raised food on a continent which was there for the taking. The great-grandson of the original Nichols, together with thousands of other farmers, inaugurated a new era. After World War I he began by farming his new acreage, instead of just mining it, adopting the new government-recommended artificial fertilizers. For a time his cotton crops prospered, but soon he noticed that his pest population was much worse than it had been. When the bottom fell out of the cotton market his son Joe decided that medicine, not farming, was to be his career.

At the age of thirty-seven Joe Nichols was a full-fledged physician and surgeon in Atlanta, Texas, when he suffered a massive heart attack which nearly killed him. He was so frightened that for weeks he gave up his practice to consider his situation. All he had been taught in medical school, plus the opinions of his colleagues, suggested his prognosis was extremely doubtful. There was no answer for his affliction beyond nitroglycerin pills, which alleviated his chest pains but caused equally painful headaches. With nothing better to do than to leaf through the ads of a farming magazine, Nichols casually came across the line "People who eat natural food grown in fertile soil don't get heart disease."

"Pure quackery! Quackery of the worst sort," said Nichols of the magazine, which was *Organic Gardening and Farming,* edited by J. I. Rodale. "He isn't even a doctor!"

Nichols remembered that for lunch on the day of his massive heart attack he had consumed ham, barbecue meat, beans, white bread, and pie, which he considered a healthy meal. As a doctor he had advised hundreds of patients on diet. But a line in the magazine nagged him: What *was* natural food? What *was* fertile soil?

At the local library the librarians were helpful in bringing Nichols books on nutrition. He also scoured the medical literature, but could find no answer to what constituted natural food.

"I had an A.B. and an M.D. degree," says Nichols, "was fairly intelligent, had read a lot, owned a farm, but I didn't know what was natural food. Like many another American who hadn't really investigated the subject, I thought natural food meant wheat germ and black molasses, and that all natural-food addicts were faddists, quacks, and nuts. I thought you made land fertile by dumping commercial fertilizer on it."

Now, more than thirty years later, Joe Nichols' thousand-acre farm near Atlanta, Texas, is one of the showplaces of the state; he has never again been afflicted with a heart attack. He ascribes both successes to the advice which he took from Sir Albert Howard's book *Agricultural Testament* and Sir Robert McCarrison's *Nutritional and Natural Health.* On his farm, not another ounce of chemical fertilizer went into the land, nothing but natural compost.

Nichols realized that all his life he had been eating "junk food," food produced from poisoned land, food that had led straight to a massive heart attack. A third book, *Nutrition and the Soil* by Sir Lionel J. Picton, convinced him that the answer to metabolic disease, whether it was heart trouble, cancer, or diabetes, was indeed natural, poison-free food grown on fertile soil.

The food we eat is digested and absorbed from the intestine into the bloodstream. Essential nutrients are carried to the individual cells all over the body, where repair work is done by metabolism, the process by which stable nonliving matter is built up into complex and unstable living material, or protoplasm. The cell has an amazing capacity to repair itself provided it gets proper ingredients through proper nutrition; otherwise it becomes stunted or goes out of control. The cell, or basic unit of life where metabolism occurs, needs essential amino acids, natural vitamins, organic minerals, essential fatty acids, unrefined carbohydrates, and several more as yet unknown, but presumably natural, factors.

Organic minerals, like vitamins, are found in balanced proportions in natural food. The vitamins themselves are not nutrients, but substances without which the body cannot make use of nutrients. They are parts of an extremely complex, intricately interrelated whole.

In "balance" means that all the nutrients used by the tissues must be available to the cell simultaneously. Furthermore the vitamins essential to proper nutrition and good health must be natural. There is a great difference between natural and synthetic vitamins, not a chemical but a biological difference. There is something missing in the artificial that is of biological or life-enhancing value. Not yet widely accepted, this fact has been unequivocally established by the work of Dr. Ehrenfried Pfeiffer, a biochemist and follower of the great natural scientist and clairvoyant Rudolf Steiner. Dr. Nichols thinks the Pfeiffer techniques can reveal exactly why natural foods or those containing natural vitamins and minerals and enzymes—another chemical compound, of vegetable or animal origin, which causes chemical transformation—are superior to those grown and preserved with chemicals.

When Pfeiffer came to the United States at the outbreak of World War II, and settled at Three-Fold Farm in Spring Valley, New York, he worked out Steiner's "Biodynamic" system for making composts and for treating the land, and set up a laboratory to investigate living things without breaking them into chemical constituents.

Before his arrival in the United States Pfeiffer had developed in his native Switzerland a "sensitivity crystallization method" to test finer dynamic forces and qualities in plants, animals, and humans than had thus far been detectable in laboratories. Dr. Steiner, who had given a series of esoteric lectures at the Silesian estate of Count Keyserling in the 1920s for agronomists concerned about the falling productivity of their crops, had asked Pfeiffer to find a reagent which would reveal what Steiner called "etheric formative forces" in living matter. After months of tests with Glauber's salt, or sodium sulfate, and many other chemicals, Pfeiffer discovered that if a solution of copper chloride to which extracts of living matter had been added was allowed to evaporate slowly over fourteen to seventeen hours it would produce a crystallization pattern determined not only by the nature but by the quality of the plant from which the extract was taken. According to Pfeiffer, the same *formative forces* inherent in the plant and acting to bring about its form and shape would combine with living growth forces to form the pattern of crystal arrangement.

Dr. Erica Sabarth, current director of the Pfeiffer-established laboratory in Spring Valley, showed the authors rows of beautiful crystallizations, looking like exotic undersea corals. She pointed out how a strong, vigorous plant produces a beautiful, harmonious, and clearly formed crystal arrangement radiating through to the outer edge. The same crystallization made from a weak or sick plant results in an uneven picture showing thickening or incrustation.

Pfeiffer's method, says Sabarth, can be applied to determine the inherent quality of all sorts of living organisms. When a forester sent Pfeiffer two seeds taken from different pine trees, and asked if he could detect any difference in the trees themselves, Pfeiffer submitted the seeds to his crystallization tests and found that, whereas one crystal picture was an example of harmonious perfection, the other was distorted and ugly. He wrote to the forester that one of the trees should be a fine specimen, the other must have a serious defect. By return mail the forester sent Pfeiffer enlarged photographs of two grown trees: the trunk of one was mast straight; the other was so crooked it was useless for lumber.

At Spring Valley Pfeiffer developed an even simpler and less time-consuming method to demonstrate how life veritably pulsates from living soils, plants, and foods, but not from inorganic minerals, chemicals, and synthetic vitamins, which are dead. Requiring none of the complex equipment of the standard chemical laboratory, it uses circular filter-paper discs fifteen centimeters in diameter, provided with a small hole in the center for insertion of a wick. The discs are laid in open petri dishes in which stand small crucibles containing a 0.05 silver-nitrate solution. This solution climbs up through the wick and spreads over the discs until it has expanded about four centimeters from the center.

From the brilliant-colored concentric patterns Pfeiffer has been able

to disclose new secrets of life. Testing natural vitamin C taken from such products as rose hips, he established that the pattern of vitality was far stronger than from artificial vitamin C, or ascorbic acid. Rudolf Hauschka, a follower of Rudolf Steiner, suggests that vitamins are not chemical compounds that can be synthetically produced but "primary cosmic formative forces."

Before his death, Pfeiffer pointed out in his own booklet *Chromatography Applied to Quality Testing* that Goethe had stated a truth more than 150 years ago which is of the utmost importance with regard to the recognition of natural biological quality: *The whole is more than the sum of its parts.* "This means," wrote Pfeiffer, "that a natural organism or entity contains factors which cannot be recognised or demonstrated if one takes the original organism apart and determines its component parts by way of analysis. One can, for instance, take a seed, analyse it for protein, carbohydrates, fats, minerals, moisture and vitamins, but all this will not tell its genetic background or its biological value."

In an article, "Plant Relationships as Made Visible by Chromatography," published in the winter, 1968, issue of *Bio-Dynamics,* a periodical to further soil conservation and increase fertility in order to improve nutrition and health, Sabarth stressed that the chromatographic technique "especially reveals the quality, even the living force of the organism." She added that she plans to explore the possibilities of the method not only as it applies to seeds and fruits but with regard to the roots of plants and all the other plant parts.

In modern processed foods the vitamins, trace elements, and enzymes are arbitrarily removed, mostly so as to render the food more durable. As Nichols puts it: "They remove the life, in effect, killing it, so that it will not live and die later."

The leading culprits in the way of poisonous foods picked by Nichols are the bleached flour that goes into white bread, white sugar, refined table salt, and hydrogenated fats. One of the most innocent-looking of comestibles, the normal soda cracker eaten with soup, contains all of the above-mentioned noxious elements. "It is junk," says Nichols, "which leads straight to heart disease."

From long before the so-called dawn of history bread has been a basic nutrient for man. In mythology, the origin of domesticated grains is attributed to Attis or Osiris. In the ruins of Swiss lake dwellers remains of bread have been found which was baked at least ten thousand years ago.

A grain or berry of wheat consists basically of a hard nutty kernel called the germ at one end, a nub of solid starchy endosperm on which the kernel feeds when planted as a seed until its roots can grow, and three layers of protective husk collectively called bran. Essential enzymes, vitamins and minerals, including iron, cobalt, copper, manganese, and molybdenum are in the germ and husk. Other grains—barley, oats, rye, corn—have analogous constructions, and bread can be made from all of them. Wheat germ is one of a very few places in nature in which the entire vitamin B complex is found, hence bread was called "the staff of life." Whole wheat also contains traces of barium, a shortage of which in the human body can lead to cardiac disease, and vanadium, also essential to the health of the heart.

From time immemorial wheat berries have been ground between two circular stones. Until the advent of steam power the mills were worked by hand, the first steam mill being erected in London in 1784. In stone mills, the entire grain was ground into flour. In that process some of the husk was reduced to powder, which gives color to whole meal. In Deuteronomy 32, verse 14, man is enjoined to eat "the fat of the kidney of wheat"—meaning the germ. The development of iron rollers, by a Frenchman in the early nineteenth century, brought with it a separation of wheat germ, bran, and endosperm. Iron rollers were first used in place of stones in 1840 by the Hungarian Count Szechenyi in his mill in Pest. In 1877 a satisfactory roller mill was imported from Vienna to England. Soon they were employed in Canada. Governor Washburn of Minnesota, a miller, brought the Hungarian process to Minneapolis and began to devitalize American flour. By 1880 their use was universal.

From a commercial point of view the roller mill had three advantages over the old grinding stones. By separating the husk and germ from the starchy flour, the miller had two products for sale instead of one. The husk and germ were sold as "offal," or animal fodder. Removal of the germ made it possible to keep the flour in good condition for a much

longer time, which increased the miller's profit. When the roller mill was introduced it became possible to adulterate wheat with 6 percent of added water. For this the germ had to be removed or the flour would not keep. It could then be sold separately.

In so-called "enriched" white bread, with the vitamins and minerals removed, nothing is left but raw starch, which has so little nutritive value that most bacteria won't eat it. Into this insipid starch synthetic chemicals are arbitrarily injected, which form only part of the missing vitamin B complex, and are not properly ingestible by human beings because they are not "in balance." For thirty years white flour was bleached with nitrogen trichloride, in what is known as the "agene process." This uses a poison which affects the central nervous system. It gives puppies fits, and may contribute to mental illness in humans. In 1949 millers voluntarily changed to chlorine dioxide for bleaching. This, says Nichols, is also a poison. Other chemicals used to "improve" flour include benzoyl peroxide, potassium bromate, ammonium persulfate, and even alloxan. Chlorine dioxide destroys the remaining vitamin E in flour, and causes the starch to swell, which is a boon to the baker. Researchers in England found that removal of the natural vitamin E from bread reduces the intake of a workman from about a thousand units a day to between two and three hundred.

To compound this trouble, just as white flour was being introduced into England so was margarine, the invention of another Frenchman, as a cheap substitute for butter, devoid of vitamins A and D. The general health of the country deteriorated. Men from northern England and southern Scotland, large and powerful during the Napoleonic Wars, became short and frail and unfit for military service by the time of the Boer War. A commission set up to investigate the phenomenon concluded it was caused by men moving to the cities, where they lived not on wholesome country bread but on white bread and white sugar. In 1919 when the U.S. Public Health Service announced a definite connection between overrefined flour and the diseases of beri-beri and pellagra—vitamin-deficiency diseases of which over 100,000 cases were reported in Mississippi alone—the millers went into action, not to change the flour, but to get the Public Health Service to shut up. Within six months the Public Health Service abjectly issued a "correction" to its bulletin. White bread, they said, was perfectly wholesome—if eaten in conjunction with an otherwise adequate diet of fruit, vegetables, and dairy products. As Gene Marine and Judith Allen were to remark in reporting the story in their recent book *Food Pollution:* "So is cardboard."

The next villains in this melodrama of life are white sugar and glucose, the heavy syrup fruits are packed in and the sweetener for most soft drinks. In the seventeenth century, European manufacturers developed a process by which after eight weeks of hard labor sugar could be refined to something approximating whiteness. This whiteness, at first so expensive, caused white sugar to be considered by the poor more worthy of being consumed. White sugar, says Nichols, is one of the most dangerous food items on the market. All the good part, the molasses, the vitamins, and minerals, are removed. There is nothing left but carbohydrates and calories—of which we have too many already. The refining is now done for purely commercial reasons; the sugar keeps better. White sugar can be stored in hundred-pound cloth sacks for years in dirty warehouses and still be sold for a profit.

Most table syrup, says Nichols, is nothing but cornstarch treated with sulfuric acid, then artificially colored and flavored. Unlike natural fruit sugars, honey, molasses, or maple syrup, it goes straight into the bloodstream, causing instant hyperglycemia—or too much sugar in the blood. This drowns the human cells in sugar. The pancreas, heeding the alarm, puts out too much insulin and produces a state of hypoglycemia, or *too little* sugar in the blood. This seesawing, says Nichols, is the cause of the vicious but ubiquitous coffee break: when a man begins his day with refined sugar in his coffee and glucose on his cereal or pancakes, he shoots his blood full of sugar, which triggers a pancreas reaction. By ten o'clock he has hypoglycemia; so he has sweetened coffee or a soft drink or a candy bar. This fills his blood with instant sugar. Again the pancreas reacts. By noon he is down again; and so on throughout the day. A side effect of hypoglycemia is that it causes a lowering of resistance, makes a person nervous and not mentally alert, an easier prey to viral and bacterial diseases.

One of the less-suspected poisons on the dining-room table is com-

mon refined salt or sodium chloride. Not in small doses, but over a long period, it can cause high blood pressure and heart disease. Sea salt contains trace minerals in balance, but by the time the salt hits the supermarket it has been refined to pure sodium chloride with all trace minerals removed. Furthermore it is treated under high heat with sodium silicate, a drying agent, which makes it free flowing in wet weather. This, says Nichols, disturbs the delicate balance of sodium and potassium in the cells of the heart. The delicacy of chemical combinations is such that if the two basic elements of table salt were to be taken separately in the same amounts, they would kill immediately.

The next and even more vicious cause of heart disease, says Nichols, is hydrogenated fats. These include most of the fats and oils commonly found in shortening, in store-bought peanut butter, and in practically all commercial bakery products, crackers, cookies, and breads. Much ice cream is made from mellorine, a cheap hydrogenated oil. Hydrogenation consists in using a heated nickel catalyst to force hydrogen into the gaps between the carbon atoms of linoleic acid. This prevents the resulting fatty oil from going rancid; but it also destroys essential fatty acids. These, says Nichols, not being absorbable by the body cells, have to go somewhere in the body, and end up lining the blood vessels, causing heart disease.

DDT and other pesticides also go straight to the seed oil of corn or cotton. There is no way to remove them, and they are cancer causing. Though DDT has largely been banned, its successors Dialdrin, Aldrin, and Heptaclore, are equally insidious. "Personally," says Nichols, "I wouldn't have corn oil in my kitchen." He recommends any of the cold-pressed oils, such as olive oil, or safflower oil, which yield a wonderfully clear, almost transparent, oily fluid.

Nichols points out that whereas natural rice is one of the best foods in the world, and is one of the richest sources of natural vitamin B complex, white processed rice is nothing but raw starch, an item already superfluous in the high-carbohydrate American diet. American missionary wives in the Philippines managed to kill off hundreds of prisoners in the local jails by philanthropically substituting polished rice for natural rice in the prison diets, causing beri-beri.

The peanut butter which Carver went to such pains to produce is now mostly being made from rancid peanuts, says Nichols, since the food chemists have learned to clean it up, deodorize it and decolor it so that it can be sold to unsuspecting mothers. By one means or another and with hundreds of toxic additives to choose from, chemists can fix food so that it is very difficult for the citizen to tell that the food is going or has already gone bad.

One of the most important items in human diet is protein, which provides eight essential amino acids, the building blocks of the body. There are twenty-two amino acids. Eight are called essential for the adult, ten are necessary for growing children. If those are included, the body can build the others.

Meat is the most popular source of protein in the United States; but the prime steak of today has come from beef that has been force-fed for 180 days with low-quality-protein hybrid grains sprayed with poison insecticides. These go straight into the fat of the meat, especially into the marbling, and, says Nichols, lead straight to heart disease. To put an extra 20 percent weight on cattle—and produce a multimillion-dollar profit—the cattle raisers feed their animals diethylstilbestrol (DES), which can be carcinogenic in both men and women.

Though the FDA finally banned DES in the spring of 1973, it has now been replaced by a compound called Synovex, which contains estradol benzoate, considered by many experts to be cancer-causing. Says Dr. Mortimer Lipsett, "Whatever dangers you want to attribute to DES, you can attribute to Synovex." Beef, steers, hogs, sheep, and poultry are also still getting sixteen other drugs, singly or in combination, which the FDA suspects are carcinogenic when ingested by humans. To detect excess amounts of the toxin in meat, even if the entire army were to join the federal meat inspectors of the FDA, it is unlikely they could stop the chemicals getting to your table. And a huge proportion of our meat is never inspected. Of the ten billion frankfurters eaten in one recent year in the United States, about three and a half billion were consumed within the states where they were manufactured; hence they were not inspected.

The organ meat of animals, says Nichols, is only edible if the animal

has been fed organically. The livers of prime animals are confiscated much of the time because they contain abscesses and toxic substances. Commercially grown chickens have arsenic and stilbestrol in their bodies and much of it winds up in the liver. The liver is the detoxifying organ of the body, and that's where these poisons go. Store-bought eggs are mostly infertile, do not taste as good as fertile eggs, and are nowhere near as good for you, says Nichols, because there is a subtle biological difference. Hens that lay commercial eggs are cooped up where they cannot move, have seldom if ever seen a rooster, let alone been caught by one. "How," asks Nichols, "can an unhappy hen lay a good egg?"

In the pyramid of life, plants play an essential role, as man cannot ingest essential elements directly from the soil. They must be brought to him through the good graces of living plants, which likewise feed all animals, directly or indirectly. Via plant and animal our bodies grow out of the soil. Microorganisms break up the chemicals in the soil and make them acceptable to plants. Plants can synthesize carbohydrates from the air, rainfall, and sunshine. But, before the life processes can convert these carbohydrates into amino acids and proteins, they must have help from the soil fertility. Neither man nor animal can synthesize the necessary proteins from the elements. Animals can only assemble them from the amino acids, providing the necessary kinds and amounts of each can be collected or produced by plants with the help of microbes.

Protein-producing plants demand a long list of elements from the soil: nitrogen, sulfur, and phosphorus are required to make part of the protein molecule; calcium and lime are also required; and magnesium, manganese, boron, copper, zinc, molybdenum, and other elements are needed in connection with protein construction, even if only in such small amounts as are called "trace."

If the soil is not properly fertile, not teeming with microorganisms, the whole process goes out of kilter or grinds to a halt. To keep the microorganisms alive, great quantities of decaying organic matter need to be added to the earth. On the forest floor dead plant matter and dead animal matter go back into the land. Leaf mold, through decay, continues to give life to the land, returning to the soil what the tree took as nutrient.

It should be obvious that soil is vital to health. Healthy soil, properly composted, with the right bacteria, fungi, and earthworms, free from chemical fertilizers and pesticides, produces strong, healthy plants which naturally repel pests. Healthy plants make strong, healthy animals and strong, healthy human beings. Poor land grows poor food—poor in vitamins, minerals, enzymes, and proteins; this produces poor, sick people. Worn out land causes people to leave the farms and go live in the slums.

It's a strange fact, but plants grown on well-balanced, fertile soils do not have the same attraction for insects as those grown on poor soils, artificially stimulated by chemical fertilizers. Fertile soils have a natural immunity to insects and disease, just as a properly nourished body has an immunity to disease. Bugs and worms tend to gravitate toward a plant, or a field of plants, that has already been weakened by disease or improper development.

The end result of chemical farming, says Nichols, is always disease: first to the land, then to the plant, then to the animal, then to man. "Everywhere in the world where chemical farming is practiced the people are sick. The only ones to benefit are the companies that produce the chemicals."

Simultaneous with the application of fertilizers, the chemical companies began to douse the land with chemical pesticides, abetted by the government and with the tacit support of university professors. Three hundred million pounds of different chemical poisons are now produced under twenty-two thousand different brand names, which result in the destruction of wild life and essential insect and microbe life. Of mass spraying, Dr. George J. Wallace, Michigan University zoologist, went on the record to say that it "poses the greatest threat that animal life in North America has ever faced—worse than deforestation, worse than illegal shooting, worse than drainage, drought, oil pollution, possibly worse than all these decimating factors combined."

Not only wild life but fish in fresh water and even in the ocean are gradually being poisoned by a combination of insecticides and herbicides. Yet the DDT which wiped out fish and small game left its prime target, the boll weevil, flourishing. Despite the application of chemical pesticides the insects are gaining the upper hand, doing $4 billion worth of damage to crops each year. And no amount of argument appears to put over the fact that *healthy* crops are naturally pest resistant, keeping the insects at bay.

In the book *Silent Spring,* which Justice William O. Douglas called "the most important chronicle of the century for the human race," Rachel Carson made clear that the environment, which supports human life, is being stressed to the point of collapse. As Friend Sykes foresaw, doctors attribute to DDT and its more poisonous descendants the rise in leukemia, hepatitis, Hodgkin's disease, and other degenerative diseases. A correlation between the rise in the birthrate of mentally retarded children and the increase in the use of fertilizers and poisonous chemicals is stunning. Twenty thousand mentally retarded children were born in 1952. There were 60,000 by 1958; six years later the figure had risen to 126,000, and by 1968 it was well over half a million. Nowadays one child in eight is born mentally retarded in the United States, according to Dr. Roger J. Williams, discoverer of pantothenic acid and director of the Clayton Foundation Biochemical Institute in Texas, the first biochemist to be elected president of the American Chemical Society.

When Nichols realized what was happening to the country as a result of both chemical fertilization and chemical pesticides he took two steps. He went organic on his farm, and he sought other doctors and scientists who had made the same discoveries. Together they organized Natural Food Associates, of which Nichols became the first president. Their object was to start correcting the situation with a nationwide campaign to get the facts before the people, on the grounds that only an aroused public opinion could save America from poor food grown on poor soil. Nichols says he was determined to tell everyone just how to get natural food: "No matter how old you are, which sex you are, what color you are, where you live—north, south, east, or west, on an isolated farm or in a big city apartment."

By any means they could, Nichols and the NFA blasted the shibboleth that America is the best-nourished, healthiest nation on the face of the globe. "Nothing," said Nichols, "could be farther from the truth.

The truth is that America is the most fed and the worst nourished nation on earth. America today is suffering from a biological blight. We are facing metabolic disaster. We are a nation of sick people. Heart disease is rampaging through America; it is our Public Enemy number one. It is the leading cause of death among Americans. Fifty years ago coronary thrombosis was rarely seen by a physician. Today it strikes even the young. . . . Cancer, diabetes, arthritis, dental caries, and other metabolic diseases are rapidly increasing. Even children are falling victim to them."

Listing the facts, Nichols reported that sixteen hundred autopsies showed that in every one of the patients past the age of three years there was already disease in the aorta, the main artery of the body that carries blood from the left ventricle of the heart to all the organs and parts except the lungs. In every patient past the age of twenty, disease was already in the coronary artery.

"This should be evidence enough that practically everybody in the United States today has cardiovascular disease. We have an epidemic. And we have an epidemic of cancer. Cancer is now the leading cause of death, after accidents, in children under fifteen years of age. Babies are born with cancer! The American Cancer Society says cancer will eventually strike one in every four Americans now living. Can a nation call itself healthy when one of four must expect to get cancer, when three of four who get cancer will die of it?"

Almost immediately the agricultural chemical industry and the food processors attempted to discredit the NFA, calling them food faddists, quacks, and charlatans. They were accused of being "unscientific." The initial detractors were soon joined by the U.S. Department of Agriculture and the U.S. Department of Health, Education and Welfare, operating through the Food and Drug Administration, and even the American Medical Association. University professors, in search of fat grants, supported the claims of the FDA. A campaign was launched to make Americans believe that what the Natural Food Associates were saying was pure myth. Newspaper and magazine articles, even entire books, were published in a huge effort to destroy the effect of NFA and its credibility with the public.

The U.S. Department of Health, Education and Welfare put out a bulletin, "Food Facts vs. Food Fallacies," in which it called everything Nichols said a myth. To discredit Natural Food Associates and their objectives the AMA and the FDA organized a "Congress on Quackery," which toured the United States, holding seminars on food faddism and quackery. As Nichols put it, "They were really after men and women whose espousal of 'natural foods' or 'organic foods' or 'health foods' threatened to lower the profits of the food industry."

The stars of the show were Dr. Fred Spare and Dr. Jean Mayer, chairman of the Department of Nutrition at Harvard University's Medical School, who insisted that to get a proper balanced diet all an American had to do was go into the nearest grocery store and get a variety of the four food groups: fruit and vegetables; milk and dairy products; cereals; meat and eggs. The U.S. Public Health Department launched an all-out propaganda campaign, supported by the food processors and chemical trusts that make the poisonous food additives. Science editors, food editors, and medical editors in the daily newspapers joined their ranks.

When the NFA tried to tell the country that DDT was a cancer-producing chemical they were labeled quacks and faddists; their charges called a myth. In the end—after more than a decade of poisoning—the FDA itself was finally obliged to label DDT a dangerous poison, though pressure from agricultural interests caused the FDA to revoke its ban on DDT in milk, and establish a legal tolerance for the amount of DDT allowable in milk.

Although Australian investigators charged that BHT, or butyl-hydroxy-toluene, an anti-oxidant (originally used to preserve color motion-picture film), which turned up in processed foods, was teratogenic, that is, it interfered with the development of an embryo, the FDA allowed BHT as a freshness preserver. When newsmen questioned FDA about its research they were told the papers were secret. In the end it turned out there were only two reports on BHT in the FDA files—both written by members of the staff of the makers of BHT.

In 1960 the panel on food additives in President Eisenhower's Science Advisory Committee, which included members of the National

Academy of Sciences, university professors, and representatives of the Rockefeller Foundation and of cancer research institutes, stated that "Americans today are better fed and in better health than at any time in history. . . . The integrated contributions of the engineering, agricultural and chemical sciences have resulted in increasing quantities of uniformly high-quality and pure foods which have contributed demonstrably to the physical well being of the nation."

Thirteen years later FDA Commissioner Charles C. Edwards was still insisting that it was "established" that the vitamin content of food is not affected by the soil foods are grown in. "Vitamin or mineral deficiencies," he stated, "are unrelated to the great majority of symptoms like tiredness, nervousness, and rundown conditions." He then proclaimed that: "Scientifically it is inaccurate to state that the quality of soil in the United States causes abnormally low concentration of vitamins or minerals in the food supply produced in this country. . . . There is no relationship between the vitamin content of foods and the chemical composition of the soil."

But there is still hope if we get back on the track, says Nichols, if we begin to cleanse the poisons from every link of the food chain, so as to restore the country to proper nutrition and avoid the long decline that blighted North Africa and the Near East. To do so, and save the nation from metabolic disaster, says Nichols, we must change from an economy of exploitation to one of conservation. In the long run the country must give up chemical fertilizers and gradually revive the soil organically. Organic fertilizer can now be bought in a sack or packaged just like ordinary commercial fertilizer, and at no greater cost. Deposits of raw rock phosphate and potash with marine trace minerals and other deposits are readily available.

A great advantage of organic rock fertilizers is that after a few years of application they are no longer needed. Whereas the chemical farmer is obliged to put on more and more fertilizer each year, the organic farmer can put on less and less. Eventually the organic farmer will make more money, as it will cost him less to operate.

Organic farmers say it is not true that a man with extensive acreage cannot find enough organic matter. He has been told, says Nichols, that

he must steal from one acre to get natural fertilizer for another acre; but in fact he can grow his own organic matter on every acre, by following a few simple rules. And the organic method can be applied to any kind of agriculture. All animal manures, garbage, perhaps even sewage sludge, can be composted and returned to the land. If we could halve the waste of these materials, says Nichols, we could double the fertility of our soils and thus double the food supply.

The restoration of soil fertility, according to organic farmers, would go a long way toward solving problems of floods and water shortages which cannot be solved until organic matter is restored to the soil. The usual 100 pounds of soil in East Texas won't hold 30 pounds of water. But 100 pounds of humus will hold 195 pounds of water like a sponge. Fertile soil is usually dark in color and soft to the touch. When it rains the water soaks into this soil.

The construction of dams on rivers will never completely solve the water problem, say the organic farmers. The underground water level will continue to fall until organic matter is restored to the topsoil. As Nichols puts it: "We must learn to trap the raindrop right where it falls, instead of washing our topsoil into the rivers." A third of the arable topsoil in the U.S. has already been washed into the sea over the years, and is still being lost faster than it can be replaced. During floods, millions of tons of rich topsoil are washed downstream. Soil erosion costs half a million acres of land a year. We live from about eight inches of topsoil, containing earthworms, bacteria, fungi, and other microscopic forms of life, that provides us with vegetation, trees, insects, and animals. The only inexhaustible wealth is a fertile soil. Topsoil is the greatest natural resource of any nation; civilizations of the past have been destroyed when their fertile soils were lost.

In the coming age of famine, says Nichols, proper nutrition from a fertile soil will be the first source of wealth. And we must stop contaminating the rest of the planet. He warns that the massive use of commercial fertilizer in the so-called underdeveloped nations of the world will bring them the same massive increase in metabolic disease that we already have in America. Yet the chemical companies keep pouring out propaganda and pressure for greater consumption of their product. Dr. Raymond Ewell, vice president for research at the State University of New York at Buffalo, who has been considered one of the world's leading chemical economists, says blithely that if "Asia, Africa and Latin America are not using quantities of fertilizer approaching 30 million tons by 1980, they are almost certain to be engulfed in widespread famine."

Nichols, on the other hand, says that if we continue to exploit and teach exploitation of the soil here and abroad, the result will inevitably be war, just as it was when Japan went into Manchuria looking for protein from the soybean. Peace in this world, says Nichols, depends on conservation of natural resources, not their exploitation.

CHAPTER 16

Live Plants or Dead Planets

Among the independent farmers of the nation still working the land, a band of hardy individuals have finally realized that the blandishments of the artificial fertilizer and pesticide salesmen are questionable and are setting about to avoid the harmful results of chemical farming before it is too late.

Hereford is not only the name of a popular breed of beef cattle developed in one of the English counties bordering on Wales, it is also a small town on the upper reaches of the Palo Duro River, which runs through the Texas Panhandle, a 170-mile-square area of the Lone Star State which, about a century ago, was a wild short-grass prairie roamed by thousands of American bison. For millennia the flat plains of Deaf Smith County, of which Hereford is the seat, produced a rich herbage and a variety of succulent weeds whose roots extended through two to four feet of clay-loam topsoil into the *calicahi,* a subsoil rich in calcium and magnesium, drawing up these elements and depositing them as they died on the surface to maintain a vital protein-rich graze for the wild bovines. The minerals in the soil were delicately balanced and the humus naturally provided by the dying vegetation along with the bovine droppings was sufficient to hold its own against the harsh climate, hot and dry in summer, bitterly cold in the snow-sparse winters. It was only half a century ago that farming began in the region; the first furrows were cut into the land by the metal moldboards of plows; golden grain was sown as far as the eye could reach. Where the land was not planted, herds of cattle replaced the buffalo.

As the years went by, the farmers realized that deep plowing was hurting rather than helping the soil. So they switched to breaking up the rich clay-loam to a depth of merely six to eight inches with chiseling tools pulled by low-horsepower tractors. At the same time they were delighted to discover that water from underground aquifers could be pumped up and applied to the soil to supplement the rainfall from thunderstorms which intermittently turned the prairie skies into a dark panoply of lightning-threaded cumulus and the creeks into "rivers a mile wide and an inch deep."

By the time the children of the first generation of farmers had grown into manhood, things had begun to go wrong in Deaf Smith County. Dissatisfied by smaller harvests obtained from depleted soil, farmers began adding artificial fertilizers to their land as recommended by agricultural research stations and academic advisers. In less than a decade disaster was in sight. The chemicals were burning up the organic material in the soil, upsetting the delicate natural balance of minerals. As a result, the soil began to dissipate. When mixed with irrigation water it coagulated into enormous clods weighing up to fifty pounds each. To break them up the farmers had to resort to huge 135-horsepower tractors capable of dragging enormous chiseling tools through the bricklike consistency of their land. Some of the farmers, appalled at the prospect of

an end to irrigation farming in the Panhandle, owing to the unmindful application of the wrong kind of nutrients to the once rich land, were determined to react.

One of these, Frank Ford, after graduating from Texas Agricultural and Mechanical University, purchased an eighteen-hundred-acre farm in Hereford on which the land was badly eroded because of the prevailing agricultural practices. "There were gullies so deep you could hide a tractor in them," Ford recalls, but today they have all been filled and the land terraced and leveled smooth.

Ford committed himself to organic farming, using natural manures on his acreage and putting a complete stop to the use of pesticides, substituting in their stead ladybugs to kill brown mites and other pests. He also banished herbicides. Refusing to be persuaded, like other farmers, that his seeds should be chemically treated against wireworms and rust, he resolved that he would not plant any seeds he could not eat.

In addition to farming, Ford put capital into Arrowhead Mills, which specializes in the production of high-quality stone-ground flour with no preservatives, as well as other whole, natural foods. To assure himself a steady supply of organic products Ford had to persuade his fellow farmers to adopt organic methods. Attracted by his fair prices, a group of them have now organized the Deaf Smith County Organic Farmers Association, with the aim of not only growing healthier food but of protecting and improving the soil of West Texas.

Working with this group is Fletcher Sims, Jr., who came to the Texas Panhandle in 1949. One thing that caught Sims' attention was the fact that the first feedlots for cattle opened in the Panhandle, about 1965, were beginning to pile up tons of cattle manure which no one knew how to dispose of. Within a few years the waste from one lot two miles from his home in Canyon, Texas, downriver from Hereford, had collected into a pile over fifty feet high, covering forty acres, or more than thirty football fields, requiring a fleet of bulldozers and other equipment worth a quarter of a million dollars to pack. Sims further estimates that feedlots throughout the nation contain millions of cubic yards of manure which will eventually become worthless as fungi reduce them to minerals.

At the same time it seemed to Sims that the agricultural schools were going out of their way to misuse the cattle wastes on the land. At Texas A and M nearly one thousand tons of manure per acre was being plowed three feet under the soil, which Sims knew can do only violence to both soil and manure, since in the process topsoil is buried, subsoil exposed, and the manure prevented from becoming aerobically fermented. Another Texas college was pumping an organic slurry onto fields at concentrations that killed the crops; and an experimental station not far from Canyon was dumping raw manure at the rate of three hundred tons per acre onto soil on the premise that it is only a waste product to be disposed of. Other scientists were suggesting that building materials be made from manure, one group in the state of Washington even working on how to make livestock feed with it.

In the face of what Sims considered these sad and asinine approaches, he realized that the manure could best be turned into valuable compost. Dr. Joe Nichols introduced Sims to the compost work that had been done for years in Pfeiffer's research laboratory at Spring Valley, New York.

During several visits to Spring Valley Sims learned that compost making goes through distinct phases: one in which original starches, sugars, and other components are broken down by bacteria, fungi, and other organisms; a second in which the new materials are consumed by microorganisms to build up their own bodies. It was of the utmost importance, Sims was told, that the right kind of microfauna and microflora be present and that the second phase be timed correctly so that there would not be too much loss of organic matter.

"If compost is not worked properly," Sabarth told Sims, "the original proteins and amino acids break down into simple chemical compounds. In other words, organic matter gets lost as carbon dioxide, or as nitrogen escaping as ammonia and nitrates. Many gardeners think of their composts as being 100 percent organic because all their original materials are organic. But nature isn't that simple. Living cells have 70 to 90 percent water, only 15 to 20 percent proteins, amino acids, carbohydrates, and other carbon compounds. Only 2 to 10 percent is mineral: potash, calcium, magnesium, and the trace elements that are inorganic. The organic compounds can be preserved in the bodies of the microorganisms. They escape when they become free in some stage of the breakdown. The N, P, and K concept comes into its own only when compost has been mineralized, but by then the biological values have been lost. In compost making you need to have a quick method for telling whether bacterial action is breaking down nitrogen-containing compounds too fast, which is indicated by the ammonia smell. If compost piles heat too fast they must be turned to interrupt the ammonia production so that bacteria rebuild more stable nitrogen compounds in bacterial protein."

The standard tests of the American Organization of Agricultural Chemists, Sabarth informed Sims, cannot reveal the state of matter in which organic materials are present since they rely on combustion or oxidation of compounds. The ashes give only the total amount present, but say nothing as to whether they originate from minerals or from living cells and tissues. Pfeiffer's colored chromatograms so well define the various stages of fermentation, whether decomposition, humus formation, or mineralization, that after years of work the laboratory was able to develop a Biodynamic compost starter with a proper population of microorganisms for anyone's use.

Sabarth showed Sims chromatogram pictures, one of which illustrated how the material from a cranberry bog, though it contained an incredible 18 percent organic matter, was actually inert. Standard chemical analysis would not have revealed its biological valuelessness. A picture of adobe soil from California revealed that analysis of the minerals within it meant little because it had no well-developed microflora, and thus was infertile. When soils have only minerals but no organic matter, said Sabarth, the plants in them are like people forced to eat salty foods. They are driven to drink water and more water. Plants absorbing an excess of mineral salts take in an excess of moisture. Though they look lush to the eye, they are no longer in balance, and therefore no longer resistant to disease.

To his amazement Sims learned that with Pfeiffer's chromatograms Sabarth had been able to establish scientific proof that certain plants, beans and cucumbers, for instance, grow better if planted in conjunction with each other, and that other plants, such as beans and fennel, seem to fare badly together. Furthermore, the storage together of such crops as apples and potatoes mysteriously robs each of its most life-giving properties.

Pfeiffer came to realize that it is only our human egotistical point of view that labels a weed a weed, and that if they were viewed as a functioning part of nature, weeds would have much to teach. Pfeiffer proved that a whole group of weeds, including sorrels, docks, and horsetails, are sure indicators that the soil is becoming too acidic. Dandelions, which lawn owners so feverishly dig up, actually heal the soil by transporting minerals, especially calcium, upward from deep layers, even from underneath hardpan. The dandelion is thus warning the lawn owner that something is wrong with the life of his soil.

Pfeiffer showed that daisies play the same role, in that analyses of their incinerated ashes show them to be rich in calcium, the most important constituent of lime. Pfeiffer doubted whether the orthodox view, holding that the daisies have selectively "fixed" lime, was correct, since they could grow in limeless soil providing there is enough silicon present together with microorganisms. Pfeiffer came to the conclusion that, when soil lacks lime, silicon-loving plants such as daisies move onto it. When they die, they bring to the soil the missing calcium he had found in his analyses. But he could not answer the question "How does the calcium get into the daisies?"

Pfeiffer performed experiments on plant symbiosis to show that in some way camomile stimulates heavier growth of wheat, with fuller ears, but only when the ratio of camomile to wheat plants is no more than one to one hundred. Thus his latter-day research confirms the age-old wisdom of the Russian peasantry about cornflowers and rye.

Sims came to the realization that the prospects of Pfeiffer's unique tests seemed endless. He was fascinated that two chromatograms of wheat, one grown with inert chemicals, the other biologically, looked so different.

Sims took back with him to Texas a supply of the Biodynamic starter composed of some fifty different microorganisms, many coming from the outstanding soils of the world and each with its particular mission to fulfill, both in the compost as it is being made and in the soil onto which it is distributed. What makes the starter so inscrutable to the average scientist is the fact that there are homeopathic quantities of vital elements, enzymes, and other growth substances which work at dilutions of up to 1,000,000,000 to 1.

Applying the Biodynamic process to what may have been the first commercial compost operation using the Pfeiffer starter, Sims took raw manure which he could get free from the feedlots and treated it in such a way that microorganisms disassembled compounds in the waste and assembled them into new and beneficial ones. At the same time, disease organisms and seeds from weeds or grains are automatically destroyed and harmful chemicals are biologically degraded when the temperature in the piles reaches 140 degrees Fahrenheit. Laying out piles of compost in windrows, Sims turned them from time to time, using a machine of his own design with a capacity of six hundred tons per hour.

Within one month, his compost, having never been subjected either to grinding or screening, became a fine, dark brown, friable, earthy material, wholly devoid of manure odor. The cow dung was transformed, miraculously as it were, by *biological* action. As the farmers began to buy Sims's products and apply it to their land, startling results were not long in coming. John Wieck of nearby Umbarger, after only two years' treatment of his soil with half a ton of Biodynamic compost per acre and no other fertilizer or insecticides, and only two irrigations to supplement some three inches of rain, was able to harvest a fantastic 172½ bushels per acre of corn, or more than double the maximum crop achieved on the artificially nitrogenized lands of Illinois.

In the northern part of the Panhandle ten miles from Oklahoma's Cherokee Strip, another Texan, Don Hart, whose irrigated land had begun to tighten up from the use of commercial fertilizers, realized that he and his neighbors might soon be sitting on wasteland. Hearing of Sims's success, he not only began to compost his acres but soon started a composting business of his own to supply other farmers. Within a short time he found that his soil felt like a plush, moisture-laden carpet underfoot. A reporter visiting his acreage in late 1971 wrote that anyone who wanted to convince himself of the advantage of Biodynamic compost had only to drive along a road where from the car he could see on one side a beautiful crop of healthy corn plants coming up on Hart's field and on the other, planted two weeks before Hart's, a virtual nightmare: a few sickly plants starting out of hard-packed and cracked ground.

Southeastward across the enormous state of Texas, Warren Vincent has been encouraging farmers to grow rice organically in order to combat the rice growers' main nemesis, barnyard or water grass, on which herbicides of the kind used so devastatingly to defoliate the jungles of Vietnam have been extensively applied. Vincent encourages his neighbors to rotate rice with Bahaia grass, which turns the land back to sod, controls weeds, and makes an excellent pasturage for animals. Now that consumers are beginning to discover that organically grown brown rice is nutritionally far better than that grown with artificial fertilizer, other pioneering rice farmers have dared to go organic.

In northern California, 120 miles south of the towering Mount Shasta, which looks like Japan's Fuji, four Lundberg brothers, owners of Wewah Farm, have begun to grow brown rice organically. Though converting to organic methods involved additional costs, they remembered that their father had taught them that any farmer worth his salt has an obligation to improve the land he uses and, if possible, leave it to the next generation in a better condition than when he took it over, a philosophy which, applied worldwide, could make of this planet a Garden of Eden.

Despite generalized warnings against giving up the extended family of chemical products, the Lundberg brothers located a source of manure and composted it before working it into an initial seventy-six acres. Their first crop averaged thirty-seven hundred pounds per acre, low when compared to chemically treated rice, but high enough to be economically feasible, given the premium prices paid for organic rice. Their initial experiment convinced them to go all the way and convert the whole of Wewah's three thousand acres to organics. The Lundbergs next imported special milling equipment from Japan and established their own organic processing plant. This would not remove the rice's protective outer shell, the nutritious portion of the grain and to some the tastiest.

There are now indications from not only the public but also notables in California's government and even in its universities that the Lund-

bergs may be on the right trail. Floyd Allen, a reporter for *Organic Gardening and Farming,* visiting the state legislature in Sacramento, heard one assemblyman declare that the organic way was "a good mother philosophy." Allen was surprised to sit in the office of an eminent pesticide specialist at the University of California at Riverside and hear the man announce: "I wish someone would do something about the quality and taste of food. I'd like to eat a tomato that tastes like tomatoes used to taste."

The organic approach has also been adopted in the Middle West by dairy farmers who wish to sell their milk to such producers as Eldore Hanni, president of the Wisconsin River Valley Cheese company north of Wausau, who has been making organic cheese since 1962. When the Grade A raw milk arrives at the company it is pumped directly into the cheesemaking vat, completely by-passing pasteurization. No preservative or color is added and no imitation ingredients are used. To preserve the natural enzymes of raw milk, heating temperatures during manufacture of the cheese are not allowed to exceed 102 degrees Fahrenheit. Hanni's partner, Eldred Thiel, claims his cheese has the old-time flavor—"like my Dad used to make." The cheesemakers' suppliers are certified by the firm as "natural farmers," who take up to five years to make sure that no trace of chemicals remain on their land.

Among fruit growers who have seen the light is Ernest Halbleib, owner of Halbleib's Orchard and Organic Farm at McNabb, Illinois, who refutes the almost universal assertion that apple growers cannot get along without chemicals. Halbleib states that insects arrive in orchards just to point out the very mistakes that man is making. Producers who are fogging their orchards with deadly chemicals are finding that the single application sufficient ten years ago now has to be repeated many times in the growing season as bugs become resistant to instant death.

More than twenty years ago Halbleib went to Washington, where he testified to the FDA against poison sprays, poison fertilizers, and poison seed treatment, not a word of which he would take back today. Since that time, he has watched his colleagues administer over five hundred new chemicals to their trees. Today, says Halbleib, there is not one apple grower in his fruit belt that is not in distress. They have used so much poison on their soil that the manager of the USDA chemallurgical plant in Peoria, Illinois, told him that 100,000 acres in his area alone have been so toxified that they won't grow grass or even weeds and that the same is true for huge portions of once-rich potato land in the state of Maine.

"What do we want?" asks Halbleib. "To have children making their blood with poisoned food? Have you looked into the reason for such large enrollment in insane asylums and hospitals? Instead of pouring out funds to build more of them, why doesn't someone study the *cause* of disease?"

Lee Fryer, an agricultural and nutritional consultant who runs Earth Foods in Washington, D.C., states that in 1968 the figure spent on commercial fertilizers in the United States exceeded $2 billion. This sum would buy more than 100 million tons of Fletcher Sims's Biodynamic compost, which, if applied at the rate of one ton per acre would cover the whole state of California with enough left over for an area as large as the six New England states. For the cost of only a few days of the Vietnam war, the whole of the United States of America's soil could be given an annual treatment.

Fryer pointed to the successful use of seaweed as a natural fertilizer and soil improver as developed in the British Isles by a former chartered accountant, W. A. Stephenson, author of *Seaweed in Agriculture and Horticulture,* who quit his Birmingham job at forty and moved to the country, at the suggestion of a biochemist friend, to build a business which distributes seaweed fertilizer in liquid form all over the world.

One of the first to use seaweed successfully on a commercial operation in the United States is Glenn Graber of Hartville, Ohio, who farms four hundred acres of the blackest, richest peat soil to be found anywhere in the United States, on which he raises carloads of radishes; Bibb, Boston, iceberg, romaine, and leaf lettuces; and some fifty other vegetables. Six days a week for half the year an average of four huge trailer loads of produce leave Graber's farm for the market.

About 1955 Graber noticed that a destructive species of nematode or "roundworm" was appearing on his land and that "bluebottom" was wilting a large percentage of his crops as well as those of his neighbors.

Because the plague hit at a certain time of year, blame was universally put on the weather. Graber also found from analysis that his soil indicated a lack of trace minerals. Raised on the NPK concept which he had been following to the letter, Graber wondered what he could do to improve matters. He learned that marvelous things had been accomplished with seaweed at the Clemson College of Agriculture in South Carolina, where researchers had used seaweed meal and a liquid seaweed extract manufactured in Kristiansand, Norway, to achieve gains in sweet peppers, tomatoes, soya and lima beans, and peas.

On the basis of the little-heeded Clemson research, Graber decided to act, and ever since he has been applying kelp, imported from Norway in granulated form, to his land at the annual rate of two hundred pounds to the acre. Toward the end of the first season he noticed that healthy green mold was forming in the tracks of his farm equipment, his nematode infestation was dramatically reduced, and the bluebottom eradicated. Since then he has never put a pound of artificial fertilizer on his land, relying completely on seaweed, rock phosphate from Florida, and ground granite from Georgia, and on bacterial action and cover crops to produce nitrogen.

As his soil improved, Graber next realized that he was wasting money on pesticides, and abandoned their use, turning instead to a spray made of liquefied kelp applied at the rate of three gallons per acre over crops throughout the season. Graber is not sure how the liquid seaweed acts as a pesticide and says no research has yet been done to find out. Though he does not entirely escape infestations of pests from his neighbors' fields, Graber believes that when he incurs a 10 percent drop in his onion crop due to maggot flies, his neighbors are losing over half their crop, in spite of every insecticide they try. He is convinced that healthy plants on healthy soil resist pests naturally. To prove it he walked one visitor through a field of parsley swarming with leafhoppers, which brushed against their pants legs but were apparently not feasting on the best-looking and best-tasting parsley the visitor had ever tried.

Since his abandonment of commercial fertilizers, Graber has been able to give up a plow requiring two tractors to haul it. By simply cover-cropping his land with barley and rye, he not only adds humus and nutrients to the soil but allows it to be aerated by the plants' strong roots and by earthworms and microorganisms which flourish in it. The hardpan problem he once had disappeared as if by magic.

Another dividend to Graber is frost resistance. In one particularly unseasonable cold spell, when the mercury dipped to a chilly twenty degrees Fahrenheit, all of his freshly transplanted tomatoes and peppers withstood the cold with not a single loss, though he remembered that under the same conditions they all expired when artificially fertilized.

Graber thinks the problem of getting organically grown vegetables to the consumer is compounded because the present organic outlets do not have enough volume to warrant low-cost distribution in any one area. He thinks the only road to travel is to work through large food chains, which must find a means to isolate organically grown produce on their shelves from the conventional supplies.

Such an approach has recently been pioneered in West Germany by Latscha Filialbetriebe of Frankfort, a fast-growing family-owned supermarket chain of 123 stores with a bent for innovation. Latscha has introduced chickens, eggs, fruit juices, apples, and frozen green vegetables which are guaranteed to have only minimal quantities of "residuals" such as antibiotics, hormones, lead, and the full spectrum of pesticides. All plant products come from farms cultivated along organic gardening lines as developed by the German State Institution for Plant Protection in Stuttgart.

Latscha says that none of its controlled products costs more than 15 percent more than ordinary equivalents and that its juices and deep-frozen items can be offered at prices under those charged for standard brands. Though the premium it pays to a cooperative dairy to produce milk without such additives as chlorinated hydrocarbons and DDT is passed on to the customer, the certified milk has climbed to 10 percent of Latscha's sales and the chain's overall revenues have increased despite a generally falling market demand.

In Cambridge, Massachusetts, the Star Markets are beginning to act somewhat like Latscha. They take a trailerload a week of mixed vegetables that have been grown organically by Glenn Graber and market them in separate bins.

Oliver Popenoe, founder of Yes! Inc., one of the dozen natural-food outlets in the metropolitan area of Washington, D.C., applauding the Star Markets' effort, puts his finger on the reason why their example has not yet been widely followed: "The problem with most food chains is that their management and staffs lack commitment to organic principles," says Popenoe. "This makes it very difficult for them to market organically grown produce which *looks* about the same, or even worse to the eye, than chemicalized produce, and costs more. They suffer from a credibility gap. Credibility is everything when it comes to buying organic produce. There is no way I know of *knowing* it is organic unless you subject it to a gas chromatograph test for pesticide residues. Since such proof costs twenty-five to thirty dollars for each item tested, even the most purist of grocers use them sparingly. I think this is the main reason why the market for organic produce is so thin. Unless one knows one's farmer personally, or has great faith in the honesty of one's grocer, one hesitates to pay more for an uncertain benefit."

When Graber was asked how his fields compare with those of his neighbors, he replied candidly: "In ideal weather conditions they can beat me in yield and also in time but in adverse conditions it's the reverse." More important to Graber is the fact that he is confident that he is improving his soil as he goes along. Graber has recently begun to have a look at Biodynamic compost. At the beginning of the 1973 season he ordered enough of the product from Zook and Ranck in Gap, Pennsylvania, to treat his soil for vegetable crops at the rate of fifteen hundred pounds per acre. By running comparative tests over the next two years, Graber thinks he will be able to determine whether the compost will additionally help his soil and crops. What convinced him to begin trying the compost was his impression at an agricultural fair in Pennsylvania that not one of the farmers who visited Zook and Ranck's booth had an adverse comment about Biodynamic compost. All of them had good results and were full of praise. "You can well believe that if a farmer had spent his money for nothing," says Graber, "he would be raising the very devil."

In Switzerland a farmer working one hectare of land next to the Theological Faculty of the University of Fribourg grows enough vegetables during an eight-month season using the biodynamic method and the help of only one assistant to feed the two hundred theological students in the faculty's dormitories and send a large overflow to the public market. "I could teach this method to anyone," says the farmer, "as long as he has a natural or artificial supply of water. Just think what this could do for Third World countries with their rising population and food shortages."

For all their success in organic farming, some farmers like Glenn Graber feel that many organic proponents tend to be too "purist" and, as such, have alienated the chemical interests who might well change their closed thinking if met halfway. "It's about time the two camps got together to determine what's right and what's wrong," says Graber. This is also the opinion of Dr. John Whittaker, a veterinarian in Springfield, Missouri, who is animal health editor for the remarkable new monthly, *Acres USA*. Published in Kansas City by Charles Walters, Jr., the magazine calls itself a voice not for organic farming but for what Walters thinks is a better term: Eco-Agriculture.

Whittaker is nevertheless not at war with the chemists. He says that what is needed is to create common ground on which organic-minded farmers can meet with farmers who honestly have accepted the pronouncements of the chemical establishment. "On the one hand," he states, "the chemists have got to stop viewing the natural movement as a group of little old ladies working in geranium beds. The truth is there can be no sudden death of the technology now extant. There has to be a phasing down, a buffering process, a marriage. We have to learn from each other."

Asked how technology might harmonize with nature, Whittaker points to the development of metal proteinates, a process which takes minerals and "chelates" or hooks them to organic matter such as protein. One of the clearest statements about how proteinates work is that of Whittaker's fellow veterinarian, Phillip M. Hinze, who looks upon the physical body not only as a compilation of chemicals but as an electric complex as well.

"The animal body," says Hinze, "may be thought of as a very complex battery that not only receives, stores, and uses electricity for chemical

purposes, but also maintains itself by assimilating vitamins, minerals, amino acids and other products. The body recognizes these substances when they come along. Every organic substance has an electromotive property which determines whether it can be assimilated. When an animal needs nutrients, a signal is sent out to capture that nutrient from food that has been ingested. If there is no sickness, and the needed ingredients are present, they will be assimilated. Unfortunately the needed ingredients don't always correspond with substances considered suitable for food. For instance, the requirements of the animal body for metals are often met by feeding rations containing inorganic forms of these metals. But it happens that inorganic forms of nutritionally essential metals have different electromotive properties than the same metals complexed with organic materials such as amino acids. A pig can't eat a nail. It needs organic iron."

So does the soil; overharvested, overirrigated and overgrazed, it no longer contains the necessary organic minerals to produce good food in the form of plants.

This truth has been recognized by Dr. Mason Rose, Director of the Pacific Institute for Advanced Studies, one of the first educational institutions in Los Angeles to break away from the standard university compartmentalization of knowledge and to teach the manufacture of soil humus and the breeding of bacteria.

Other groups, aware that man, having fouled his nest, must now clean it, have been experimenting with ecological farming techniques. A salient example is the New Alchemy Institute, which projects a host of activities, including backyard fish-farming, in climates as varied as those of the Canadian Maritime Provinces, New Mexico, California, and Costa Rica. The New Alchemists say their trio of goals are "To Restore the Lands, Protect the Seas, and Inform the Earth's Stewards." This is what the planet's vegetal covering on *terra firma* has been doing since long before the advent of man to his stewardship. In that sense, plants are the oldest alchemists.

CHAPTER 17

Alchemists in the Garden

The medieval alchemist, whose dream of transmuting one element into another was maliciously ridiculed for centuries, may now be vindicated —thanks to the efforts of living plants.

Early in this century a young Breton schoolboy who was preparing himself for a scientific career began to notice a strange fact about the hens in his father's poultry yard. As they scratched the soil they constantly seemed to be pecking at specks of mica, a siliceous material dotting the ground. No one could explain to Louis Kervran why the chickens selected the mica, or why each time a bird was killed for the family cooking pot no trace of the mica could be found in its gizzard, or why each day the flock produced eggs with calcareous shells though they apparently had not ingested any calcium from land which was entirely lacking in limestone. It took Kervran many years to establish that the chickens were transmuting one element into another.

Reading a novel by Gustave Flaubert called *Bouvard et Pécuchet,* young Kervran came across a reference to Louis Nicolas Vauquelin, a celebrated French chemist, who, "having calculated all the lime in oats fed to a hen, found still more in the shells of its eggs. Therefore, there is a creation of matter. In what way, no one knows."

It seemed to Kervran that, if the hen had somehow been able to manufacture calcium in its own body, everything he was taught in his chemistry class needed reviewing. Ever since the end of the eighteenth century, when Vauquelin's contemporary Antoine Laurent Lavoisier, known as the "father of modern chemistry," had laid down the principle that in the universe "nothing is lost, nothing is created, everything is transformed," it had been believed that elements could be shifted about in different combinations but could not be transmuted one to another; millions of experiments appeared to verify Lavoisier's contention.

The first crack in this seemingly unshatterable wall around the atom came at the start of the twentieth century with the discovery of radioactivity, which showed that some twenty elements could indeed change into something different, apparently no longer obeying the law of the conservation of matter. Radium, for instance, disintegrates into electricity, warmth, light, and various substances such as lead, helium and other elements. With the advent of nuclear physics, man was even able to create certain elements which had been missing on the famous chart drawn by the Russian peasant genius Dmitri Mendeleyev, because they were thought either to have vanished radioactively in former times or to have never existed in a natural state.

Ernest Rutherford, the British physicist who first theorized the existence of the atom's nucleus, showed in 1919 that one could transmute elements by bombarding them with alpha particles—identical to helium atoms less their electrons—a practice which has continued to the present time, with increasingly "heavier artillery." But even these breakthroughs did not shatter Lavoisier's dictum about the eighty or more nonradioactive elements. Chemists still hold that it is impossible to create another element by chemical reaction, and even maintain that all reactions occurring in living matter are solely chemical. In their view chemistry can and must explain life.

As a young graduate engineer and biologist, Kervran remembered Vauquelin's experiment and decided to repeat it. He fed a chicken on oats alone, the calcium content of which he had carefully measured. He then checked the calcium content in both the eggs and feces issuing from the chicken and found the bird had produced four times as much calcium as it had ingested. When Kervran asked his biochemist colleagues how the extra calcium originated, they replied it had come from the chicken's skeleton. This, Kervran realized, might do in an emergency, but if a chicken were required to make shells very long its skeleton would soon be reduced to pulp. In fact, a chicken deprived of calcium lays soft-shelled eggs within four or five days. However, if fed potassium, the chicken's next egg has a hard shell composed of calcium. The chicken is evidently capable of transmuting the element potassium—which is found in high concentrations in oats—into the element calcium.

Kervran also learned that about the time of Vauquelin's retirement, an Englishman, William Prout, made a systematic study of the variations in calcium in incubating chicken eggs and found that when chicks hatched they contained four times more lime than was originally present in the egg and that, furthermore, the lime content of the shell had not changed. He concluded that there had to be an endogenous formation of lime from within the egg. This was long before scientists knew anything about the atom, says Kervran, so it was too early to talk about atomistic transmutation.

One of Kervran's friends pointed out to him that as far back as 1600 a Flemish chemist, Jan Baptista Helmont, had planted a willow sapling in a clay pot containing two hundred pounds of oven-dried soils and for five years had given the tree nothing but rain or distilled water. When Helmont removed the tree and weighed it he found it had gained 164 pounds whereas the weight of the soil remained approximately the same. Helmont wondered if the plant had not been able to turn water into wood, bark, and roots.

Another vegetal anomaly which interested Kervran was that of *Tillandsia*, or Spanish moss, which can grow on copper wires without any contact with the soil. When burnt there was no copper residue in its ash, but iron oxides and other elements, all apparently supplied simply by the atmosphere.

Henri Spindler, another French scientist, became fascinated with how *Laminaria*, a variety of algae, seemed to be able to manufacture iodine. Searching for answers in half-forgotten literature on the dusty shelves of libraries, Spindler found that a German researcher by the name of Vogel had planted cress seeds in a container covered by a glass bell jar and fed them nothing but distilled water. A few months later when Vogel burned the adult plants, he found they contained twice the amount of sulfur which had been present in their seeds. Spindler also uncovered the fact that, soon after Vogel, two Britishers by the names of Lawes and Gilbert discovered at the famous Agricultural Research Institute at Rothamsted, England, that plants seemed to extract from the soil more elements than it contained.

For seventeen years the Rothamsted researchers cropped a clover field, mowing it two or three times a year, and sowing it only every fourth year, without adding any fertilizer at all. This piece of land gave cuttings so abundant that it was estimated that if one had to add what had been removed in the period between the arrival of one swarm of seventeen-year locusts and another, it would be necessary to dump on the field over 5,700 pounds of lime, 2,700 pounds of magnesia, 4,700 pounds of potash, 2,700 pounds of phosphoric acid, and 5,700 pounds of nitrogen, or more than ten tons of the products combined. Where had all these minerals come from?

Delving deeper into the mystery, Spindler came across the work of a Hanoverian baron, Albrecht von Herzeele, who, in 1873, brought out a revolutionary new book, *The Origin of Inorganic Substances*, which offered proof that, far from simply absorbing matter from the soil and the air, living plants are continuously creating matter. During his lifetime von Herzeele made hundreds of analyses indicating that, in seeds sprouting in distilled water, the original content of potash, phosphorus, magnesium, calcium, and sulfur quite inexplicably increased. Though the law of the conservation of matter held that exactly the same mineral content in plants grown in distilled water would be found as in the seeds from which they spring, von Herzeele's analyses proved also that not only mineral ash but every one of the plants' components increased, such as the nitrogen which burned off during incineration of the seeds.

Von Herzeele also discovered that plants seemed to be able to *transmute*, in alchemical fashion, phosphorus into sulfur, calcium into phosphorus, magnesium into calcium, carbonic acid into magnesium, and nitrogen into potassium.

One of the many odd facts in scientific history is that von Herzeele's writings, published between 1876 and 1883, were given the silent treatment by official academia, which was supporting the fashion that biological phenomena could be explained atomistically according to chemical laws. Indeed, most of Herzeele's works never found their way onto library shelves.

Spindler drew the attention of some of his colleagues to von Herzeele's experimentation. One of them was Pierre Baranger, a professor and director of the laboratory of organic chemistry at the famous Ecole Polytechnique in Paris, which, since its establishment in 1794, has trained the best scientific and engineering minds in France. To check von Herzeele's work, Baranger began a series of experiments which were to last the best part of a decade.

These experiments amply confirmed von Herzeele's work and indicated that atomic science might be faced with a veritable revolution.

When Baranger announced his discoveries to the scientific world in January, 1958, before a distinguished audience of chemists, biologists, physicists, and mathematicians at Switzerland's Institut Genevois, he noted that if his investigations were further developed a certain number of theories which did not seem to have the benefit of a sufficiently experimental basis might have to be modified.

This cautious approach dictated by scientific mores was made more explicit by Baranger in an interview for *Science et Vie* in 1959. "My results look impossible," said Baranger, "but there they are. I have taken every precaution. I have repeated the experiments many times. I have made thousands of analyses for years. I have had the results verified by third parties who did not know what I was about. I have used several

methods. I changed my experimenters. But there's no way out; we have to submit to the evidence: plants know the old secret of the alchemists. *Every day under our very gaze they are transmuting elements.*"

By 1963 Baranger had incontestably proven that in the germinations of leguminous seeds in a manganese salt solution, manganese disappeared and iron appeared in its place. Trying to shed more light on the mechanisms involved, he discovered a whole web of complexities related to the transmutations of elements in seeds, including the time of their germination, the type of light involved, even the exact phase of the moon.

To understand the enormity of Baranger's work one has to realize that nuclear science asserts that in order to form the stability of elements such gigantic "energies of fixation" are needed that the alchemists, unable to produce and direct such energy, could never have transmuted one element into another as they claimed. Yet plants are constantly transmuting elements in a manner completely unknown to science without having to resort to enormous modern atom smashers. The tiniest blade of grass and the frailest crocus or petunia is able to achieve what modern-day alchemists known as nuclear physicists have heretofore found impossible.

In speaking of his new research, the quiet, courteous Baranger said: "I have been teaching chemistry at the Ecole Polytechnique for twenty years, and believe me, the laboratory which I direct is no den of false science. But I have never confused respect for science with the taboos imposed by intellectual conformism. For me, any meticulously performed experiment is a homage to science even if it shocks our ingrained habits. Von Herzeele's experiments were too few to be absolutely convincing. But their results inspired me to control them with all the precaution possible in a modern lab and to repeat them enough times so that they would be statistically irrefutable. That's what I've done."

Baranger established that seeds of Cerdagne vetch growing in distilled water showed no change in phosphorus or potassium content. But seeds growing in a calcium salt solution varied their phosphorus and potassium content by the enormous factor of 10 percent, and that calcium increased in both groups. "I understand perfectly well," Baranger told the science writers, who grilled him with every possible objection during the course of their interview, "that you are astonished by these results. For they are astonishing. I understand perfectly well that you are seeking the error which could make nonsense of these experiments. But so far no such error has been found. The phenomenon stands: plants can transmute elements."

As upsetting and contradictory as Baranger's experiments seemed, it was pointed out by *Science et Vie* that nuclear physics itself has reached a stage wherein its practitioners use four separate and quite contradictory theories about the atomic nucleus. Moreover, they add, the very secret of life has not yet been found, perhaps because no one has yet looked for it in the atomic nucleus. So far, they went on, life has been considered to be mainly a chemical and molecular phenomenon, but perhaps its roots are to be located in the most remote sub-basements and cellars of atomic physics.

The practical consequences of Baranger's findings cannot be overestimated. One of these is that certain plants can bring to the soil elements useful for the growth of other plants, which could lead to many changes in received doctrines about fallows, rotations, mixed crops, fertilizers, or, as Friend Sykes found out through actual trials on his Wiltshire land, the manuring of infertile soils. Moreover, as Baranger opines, nothing prevents us from thinking that certain plants are capable of producing rare elements of industrial importance. They appear to supply us with an example of subatomic transformation which we are not capable of performing in the laboratory without bringing into action particles of high energy in exactly the same way we are not capable of bringing about at ordinary temperatures the syntheses of innumerable products, either alkaloids or others, which are extracted from plants.

Kervran, a man with continuing ties to the land despite his urban academic duties, began to be fascinated by another phenomenon of a global nature which has long been known to agricultural specialists. He read in Didier Bertrand's *Magnesium and Life*, published in French in 1960, that each time wheat, maize, potatoes, or any other crop is harvested, elements in the earth used by plants in their growth process are taken out. Since virgin arable soil contains from 30 to 120 kilograms of

magnesium per hectare, Bertrand stressed that most of the earth's arable land should long since have been exhausted of this element. Not only is this not the case, but in various parts of the world, such as Egypt, China, and the Po Valley in Italy, soils continue to remain highly fertile in spite of the enormous quantities of magnesium taken from them through harvests of crops over thousands of years. Is it because plant life is able to upset the periodic table of the elements, to make magnesium from calcium or carbon from nitrogen, for instance, that lands have been able to replace the products they need, wondered Kervran.

With the Celtic directness of a Breton, Kervran published his *Biological Transmutations* in 1962, the first of a series of books which offered a whole new perspective on living creatures. It made clear that those who believe in a system of farming which takes into account chemistry alone are in for a rude shock and that man and animals nourished on diets formulated by chemists will not long survive. Kervran freely accepted the notion that Lavoisier was right as far as chemical reactions were concerned. The mistake made by science, he said, is to contend that *all* reactions in living organisms are chemical in nature and that, consequently, life should be interpreted in chemical terms. Kervran suggests that the biological properties of a substance are only inadequately determined by chemical analysis.

Kervran wrote that one of the main purposes of his book was "to show that matter has a property heretofore unseen, a property which is neither in chemistry nor in nuclear physics in its present state. In other words the laws of chemistry are not on trial here. The error of numerous chemists and biochemists lies in their desire to apply the laws of chemistry at any cost, with unverified assertions in a field where chemistry is not always applicable. In the final phase the results might be chemistry, but only as a consequence of the unperceived phenomenon of transmutation."

Rudolf Hauschka in his brilliant book *The Nature of Substance* carries Kervran and Heerzele's ideas even further, saying that life cannot possibly be interpreted in chemical terms because life is not the result of the combination of elements but something which precedes the elements. Matter, says Hauschka, is the precipitate of life. "Is it not more reasonable," he asks, "to suppose that life existed long before matter and was the product of a pre-existent spiritual cosmos?"

Supporter of Rudolf Steiner's "spiritual science," Hauschka is lapidary in his approach when he states that the elements as we know them are already corpses, the residue of life forms. Though chemists can derive oxygen, hydrogen and carbon from a plant, they cannot derive a plant from any combination of these or other elements. "What lives," says Hauschka, "may die; but nothing is created dead."

Hauschka, who also duplicated many of Heerzele's experiments, found that plants could not only generate matter out of a nonmaterial sphere, but could "etherealize" it once more, noting an emergence and disappearance of matter in rhythmic sequence, often in conjunction with phases of the moon.

In Paris, Kervran, a pleasant and forthrightly cooperative man of seventy with a prodigious memory for detail, told the authors that powerful energies are at work in the germination process of seeds which synthesize enzymes, probably by transmuting matter within them. His experiments have also convinced him that lunar forces are extremely important in germination, though botanists have long asserted that only warmth and water are required.

"We cannot deny the existence of something just because we don't know about it," said Kervran. "The kind of energies to which the great Austrian natural scientist and clairvoyant Rudolf Steiner refers as cosmic etheric forces must exist if only from the fact that certain plants will only germinate in springtime no matter what amounts of heat and water are administered to them during other parts of the year. There are varieties of wheat said to germinate only as the days lengthen, but, when days are artificially lengthened, the wheat does not always germinate."

We do not know what *matter* really is, says Kervran. We do not know what a proton or an electron is *made of*, and the words serve only to cloak our ignorance. He suggests that inside atomic nuclei may lie forces and energies of a totally unexpected nature and that a physical theory to explain the low energy transmutations with which he deals must be sought, not in the hypotheses of classical nuclear physics based on powerful interactions, but in the field of hyperweak interactions in

which there is no assurance of the operation of the established lawsof conservationof energy or even the existence of a mass/energy equivalent.

Physicists, says Kervran, are mistaken in claiming that physical laws are the same for the living as for inanimate matter. Many physicists declare, for instance, that a negative entropy, a force which in biology would build up matter, is an impossibility, since the second principle of thermodynamics of Carnot-Clausius, regarding the breakdown of energy, states that there is only positive entropy, i.e., that the natural state of matter is chaos and that all things run down and become random, losing heat and not acquiring it.

In contradiction to the physicists, Wilhelm Reich held that the accumulators he built to collect an energy, which he named "orgone," permanently raised the temperature inside their tops, thus making nonsense of the second law of thermodynamics. Despite the fact that he demonstrated the phenomenon to Albert Einstein in his house in Princeton, and that Einstein confirmed the phenomenon, though he could not account for it, Reich was considered mad.

Reich maintained that matter is created from orgone energy, that under appropriate conditions matter arises from mass-free orgone, and that these conditions are neither rare nor unusual. All of this further suggests that in living nature there exists, below the level of Lavoisier's classical molecular chemistry, a deeper level of nuclear chemistry which associates and dissociates nucleons, the components of atomic nuclei. In molecular combinations heat energy is produced. At the nuclear level a much more powerful energy, that of fission or fusion as in A or H bombs, must be added. What remains unexplained is why these fantastic energies are not released in biological transmutations.

Science et Vie has postulated that if plasma-type nuclear reactions take place in bombs, in nuclear reactors and in stars, then there must be a wholly different type of reaction, specifically utilized by life, which brings about fusion in a strangely quiet way. The magazine suggests the analogy of a strongbox which can be opened by dynamite or by a combination lock. Like the lock, the atomic nucleus can prove stubborn when confronted with blind violence but pliable to skillful manipulation. The secret of life, so long suspected by vitalists, is as much a secret as the locksmith's combination. The cleavage between the animate and the inanimate is to be found at the level of manipulation of the nuclear lock. It appears that, whereas man has to use dynamite, plants and other living organisms know the combination.

Kervran also wonders whether microorganisms can even take sand and make it fecund. After all, he maintains, humus comes today from organic matter but at one time there was no organic matter on earth.

This raises the question of whether Dr. Wilhelm Reich was not on the track of the discovery of the century when he purported that he had observed at the microscope energetic vesicles or "bions" which are not alive but "carry biological energy." Exposed to sufficiently high temperatures and made to swell, all matter, even sand, undergoes vesicular disintegration, wrote Reich, and the resulting vesicles can later develop into bacteria.

Kervran, who has now retired from his duties as one of France's more eminent professors in order to embark on the career of a determined alchemist, asks why chemically pure reactions such as the combination of one atom of nitrogen and one atom of oxygen can be realized in a test tube only at extremely high temperatures and pressures whereas living organisms can perform the same feat at room temperature. He feels that the biological catalysts known as enzymes are in some way responsible.

In a yearbook entitled *Alchemy: Dream or Reality?* published in 1973 in Rouen by the students of the prestigious Institut Nationale Superieur de Chimie Industrielle, Kervran writes that microorganisms are a concentration of enzymes. Their ability to transmute elements is not a mere hooking of peripheral electrons to form bonds as in classical chemistry but involves a fundamental alteration of the nucleus of elements.

Most transmutations have been observed to take place within the first twenty elements of the periodic table. They further always seem to involve hydrogen or oxygen. Thus the transmutation of potassium to calcium is accomplished through the addition of a hydrogen proton.

Kervran expects the phenomena he describes, and the data he supplies, to irritate chemists because it involves, not the displacement of electrons in the peripheral atomic layers and the chemical bonding in

molecules which lie at the heart of their discipline, but the alteration in structural arrangements of atoms induced by enzyme activities in living matter. Since this takes place within atomic nuclei, a new science distinct from chemistry is involved. Though strange at first sight, the new language is so simple that the average high school student can easily follow it. Thus, if one has sodium with eleven protons written ${}_{11}Na$ and oxygen with eight protons written ${}_{8}O$ one need only add the protons together to get nineteen, the number which exists in potassium written ${}_{19}K$.

Following this reasoning, calcium (Ca) can come from potassium (K) with the interaction of hydrogen (H) according to the formula ${}_{1}H$ plus ${}_{19}K$ equals ${}_{20}Ca$, or from magnesium with the interaction of oxygen in ${}_{12}Mg$ plus ${}_{8}O$ equals ${}_{20}Ca$, or from silicon with the interaction of carbon in ${}_{14}Si$ plus ${}_{6}C$ equals ${}_{20}Ca$.

Since nature's atom smashing, according to Kervran, is performed by biotic life, microorganisms are thus nature's prime mover in maintaining balance in soils.

In Kervran's view some transmutations are biologically beneficial, others dangerous. Since the harmful ones can be countered, the whole problem of deficiencies in the soil remains to be reassessed. Indiscriminate application of NPK fertilizers to the land can alter the content in plants of just those elements necessary to healthful nutrition. In this connection, Kervran cites the work of an American researcher, who, knowing nothing of Kervran's theory of biological transmutations, found that in hybrid corn too rich in potassium the content of molybdenum decreases. "What *are* the optimal quantities of these two elements in plants?" asks Kervran, then continues: "This does not appear to have been studied, and there is not only one answer, since values differ not only between species but between varieties of the same species."

Even if potassium fertilizers were no longer available to agriculturalists, Kervran says, this would represent no catastrophe since microorganisms could produce potassium from calcium. If yeasts and molds for penicillin are already being produced on an industrial scale, why not factories for growing microorganisms for the transmutation of elements? Already in the late 1960s Dr. Howard Worne started Enzymes, Inc., at

Cherry Hill, New Jersey, where microorganisms bombarded with strontium 90 were being mutated so as to produce enzymes that would transmute waste carbon into usable carbon simply by having microorganisms ingest one material and excrete a new one. Dr. Worne is now in New Mexico using microorganisms to transform solid waste from garbage and stockyards into humus for the compost-hungry Western states and methane gas for the energy-hungry Eastern states.

The understanding of the phenomena of biological transmutation, though as yet unrecognized by the majority of the world's agriculturalists, seems to have been anticipated by the advocates of biological cultivation, who, above all, realized that a price must be paid for *reliance on chemistry in a biological context.* Cultivation based on classical chemistry alone, stresses Kervran, fails wherever intensive and abusive methods are employed. The marked crop increases, such as those for the Illinois corn, can thus last only a certain time.

Though not applied as abusively as in America, where huge areas have been lost to cultivation because of a surfeit, even the more limited European use of artificial fertilizers has led, says Kervran, to a mounting lack of resistance in plants to pests. The increase of infestation is no more than a consequence of biological imbalance.

"Classical soil scientists and agronomists attached to the dogma that biology equals chemistry," writes Kervran, "cannot conceive that all that is in plants has not been put into the soil. They are not the people to advise farmers; farmers should be guided by the enlightened and intelligent agriculturalists who have long recognized the division between a purely chemical and biological agriculture. They might then achieve their own conversion, and carry out some of the experiments described in this book for themselves. If they are men of good faith, they will admit their past errors, but one doesn't ask that much—only that they act."

Pointing out that the great English astromomical physicist Fred Hoyle gave up the theory of the steady state universe which he utilized for nearly a quarter of a century and which made him famous, Kervran notes that Hoyle himself has recognized that if future observations confirm that physics has taken a wrong direction then "the properties of matter, the laws of chemistry, for example, would be completely changed."

It is in bulletins such as that of the British Soil Association that Kervran sees articles confirming his ideas of biological transmutation in the soil. In the French analog of this bulletin, *Nature et Progrès,* one researcher reports that, after analyzing month by month for one year the phosphorus content of identical soils, one benefited by fermented compost containing no phosphorus and the other by phosphorus-rich farmyard manure, the first sample had 314 milligrams of phosphorus at the year's end as against only 205 milligrams for the second. The researcher concluded: "Therefore the soil containing the greater amount of phosphorus was the one without any external supply of this mineral. A miracle of the living soil."

If Dr. Barry Commoner sees the buyers of artificial fertilizer becoming "hooked" on their product, Kervran says the same thing for plants. Offering them chemicals, he writes, is simply drugging them to achieve higher yields—for a time. He compares this process to stimulating human appetites with an *apéritif* and then not following it up with a meal.

Louis-Victor de Broglie, winner of the Nobel Prize for his prediction of the wave properties of the electron, has said: "It is premature to want to assess vital processes according to the very insufficient physio-chemical concepts of the nineteenth or even the twentieth centuries." Kervran, who puts this quotation at the start of the British edition of his book, adds: "Who is to say in which present-day branch of physics 'mental energy,' the strength of will or character, should be placed? One can associate memory with information and negative entropy with cybernetics (or should it be chemistry?) but nothing tells us if intelligence itself will not someday be expressed by a physical or chemical law."

Jean Lombard, a geologist, in a preface to Kervran's second book, *Natural Transmutations,* published in 1963, stated that Kervran had opened up a wide field, which in itself could lead to clarification of confusions in geological theory. Lombard also wrote: "The true workers of science, who are always ready to welcome new suggestions, sometimes ask themselves if the greatest obstacle to the progress of science is not bad memory on the part of scholars; they wish to remind the latter that some of their predecessors were burnt at the stake because of proposed 'interpretations' which have now become foremost truths. If pioneers of science were still being burnt, I would not give much for Louis Kervran's skin."

Reviewing Kervran's third book, *Low Energy Transmutations*, published in 1964, Professor René Furon, of the Faculty of Sciences at Paris University, wrote: "This book completes the two previous ones. It can no longer be denied that nature makes magnesium out of calcium (in some cases the reverse takes place); that potassium can come from sodium; and that carbon monoxide poisoning can occur without inhalation of CO gas."

It appears that outside France, not Western, but Japanese scientists have been the first to take Kervran's work seriously. When Hisatoki Komaki, a professor of science, read a Japanese translation of Kervran's book *Biological Transmutations*, he tied Kervran's findings into ancient Eastern cosmology and wrote to Kervran to say that the transmutation of sodium, a *yang* element, into potassium, a *yin* element, was of far-reaching interest, more especially since Japan has a paucity of potash deposits but ample supplies of sea salt.

Komaki abandoned his teaching to become head of a biological research laboratory at the Matsushita Electric Company and informed Kervran that he would try to confirm the sodium-to-potassium reaction and interest his collaborators in applying it on an industrial scale. Komaki's research proved to him that various microorganisms, including certain bacteria and two species each of molds and yeasts, were capable of transmuting sodium into potassium and that the yield of bacteria themselves was enormously raised when only a small amount of potassium was added to the cultures. Komaki has placed on the market a product made of brewer's yeast which, applied to composts, raises the potassium content in them. How this process relates to the action of Biodynamic sprays as conceived by Rudolf Steiner and developed by Ehrenfried Pfeiffer remains to be determined.

Kervran's work is also attracting important notice in the Soviet Union. Professor A. P. Dubrov of the Institute of Earth Physics of the USSR Academy of Sciences, who has been working on the links between radiosensitivity in animals and the geomagnetic field, wrote to Kervran at the end of 1971 to suggest that the magnetic field of the earth itself

might well play an important role in biological transmutation, and that elements might be affected depending on whether biological forms are oriented north-south.

In 1971, a Russian book, *Problems of Transmutations in Nature*, was published in a limited edition in Yerevan, capital of the Armenian Republic. Its editor, V. B. Neiman, notes in a lead article, "Transmutations in Nature: The Present Status of the Problem and Objects for Further Study," that the fundamental problems of entropy and negentropy must be re-examined, and maintains that the diversity of elements on earth is due to a series of nuclear transmutations with analogous processes applied to biological phenomena.

Neiman dug out the most extraordinary quotation from Lenin's *Materialism and Empirocriticism*, proving that the father of the Soviet Union tried to incorporate in his materialistic philosophy a notion more palatable to vitalists and mystics than to hard-core Communist pragmatists. "However miraculous, from the viewpoint of common sense," wrote Lenin, "the conversion of imponderable ether to ponderable matter may seem, it is but a further confirmation of dialectic materialism."

In the same collection, P. A. Korol'kov contributed an essay on the "Spontaneous Metamorphism of Minerals and Rocks," in which he shows how silicon can be converted to aluminum. In his summary of a conference held in July, 1972, devoted to chrome deposition in the Urals, Siberia, Kazakhstan, and the Soviet Far East, Korol'kov comes to the conclusion that the traditional geological views on the genesis of chromite and associated ores do not accord with new data presented at the conference.

"The fact is," writes Korol'kov, "that we are witnesses and participants in a scientific-technological revolution, that is, we are living in a time in which we are being subjected to a radical revision, not of minutiae, but of the basic status of an inherited natural science. The time has come to recognize that any chemical element can turn into another, under natural conditions. And I am not alone in maintaining this. I know a dozen persons in the USSR who hold the same views."

If Soviet scientists are coming around to a whole new view of matter

—and even citing Lenin on the possibility of its manufacture by the ether itself—it would seem that the ecological revolution so necessary to safeguard the future of humanity, and pleaded for in the United States since Fairfield Osborn wrote *Our Plundered Planet* shortly after World War II, may have a chance of taking place despite the host of adversaries who see in it the demise of their personal fortunes.

In a review of the American edition of Kervran's book for the International College of Applied Nutrition, V. Michael Walczak, M.D., an internist practicing in Studio City, California, said of Kervran's work: "It offers a totally different approach to our understanding of nutritional supplementation of the elements and how it functions in the physiologic and biochemical pathways of our bodies. It attempts to prove that our concepts of simple supplementation for deficiencies is not only questionable, but in serious error."

Though many nutritionists untrained even in simple chemistry are giving people huge and unnecessary doses of calcium because it is the mineral in largest quantity in the body, Walczak, who is now limiting his practice to internal metabolism and nutrition, states that his own research shows that 80 percent of his patients—with diets supplemented or unsupplemented—have *too much* calcium and too few trace minerals with respect to calcium. The lack of trace elements in soils, and in foods, Walczak maintains, leads to an imbalance in enzyme function.

Walczak says he is preventing disease by administering the right amounts of enzymes, hormones, vitamins, and minerals, which together he calls "the key to life," and also curing a host of degenerative diseases. He concludes that the "gold" which the medieval alchemists tried for centuries to derive from lead may very well turn out to be the secret for obtaining good health and long life.

Walczak's views are supported by Richard Barmakian, a nutritionist in nearby Pasadena, who wrote to Kervran's American publishers that the U.S. version of *Biological Transmutations* should prove to be "the most significant work of this century, scientifically and possibly otherwise." It was only after he had read the book that Barmakian thought he might at last get to the core of the problem of calcium-metabolism abnormalities and deficiencies which he says are "so tragically prevalent

in pseudo-civilized countries of the world today and especially in the U.S.A."

This view was echoed by *Organic Gardening and Farming*, now published by J. I. Rodale's son, Robert, which stated that Kervran had showed that current chemical treatment of the soil is totally wrong and is rapidly destroying the quality of the soil worldwide: "We're sure that as our understanding of the life processes involved in organic farming grows, the scientific community will be in for many surprises." The economist Charles Walters, Jr., publisher of *Acres USA*, also concurs: "Louis Kervran has opened a door. His works have received important recognition from Russians, Japanese, French and Chinese who don't have to ask the United States Department of Agriculture and the petrochemical firms what to think, as is the case with too many extension agents, land grant colleges and farmers under the thumb of bank examiners."

If doctors, nutritionists, editors, and economists in the United States are now beginning to see in Kervran the herald of a new age, as are professional scientists abroad, it may be that a revolution is at hand. Perhaps the time is near when the dictators of nutritional and agricultural policies, who have forced upon all natural life, from the smallest microorganisms to human beings, a drenching of chemicals to the point where the only recourse against adulterated food products is the growing of one's own private garden under natural conditions, will have to listen to the prophets who have warned against the chemification of the soil since the beginning of this century.

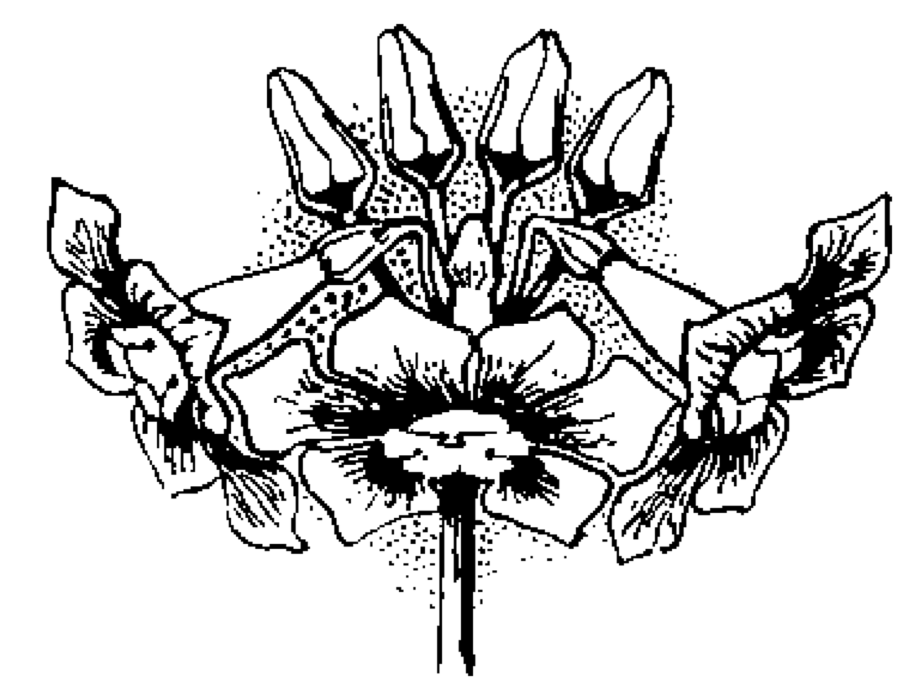
In an age in which science itself has become so specialized and the science of life, or biology, so molecular that our technological society seems to be producing a crowd of white-coated "idiot savants" who plead lack of competency in all but their own narrow divisions of knowledge, the broad outlooks of Goethe, Pfeiffer, Howard, Commoner and Voisin and the new discoveries by Louis Kervran may be the one antidote to catastrophe.

PART V

THE RADIANCE OF LIFE

CHAPTER 18

Dowsing Plants for Health



On the brighter side of life, a French engineer, André Simoneton, has found a straw which may keep the population of the planet from going under; his device, usable by man, woman, or child, is designed to make it possible to select healthy food from bad before ingesting it: it is a simple pendulum attached to a short piece of string used by diviners of water, lost objects, or the future.

For millennia the art or science of dowsing with forked stick or pendulum has been practiced by Chinese, Hindus, Egyptians, Persians, Medes, Etruscans, Greeks, and Romans. In the Renaissance it was revived by such notables as Goethe's predecessor as Director of Mines in Saxony, Christopher von Schenberg, who had his portrait painted holding a dowsing rod, a custom emulated in modern time by Lloyd George, who had himself photographed in the same pose.

Though dowsing has not yet been accepted as a science in America, in France it is no longer relegated to the domain of the witch and warlock—despite the fact that over the centuries many a French dowser has paid with his life for practicing "sorcery." Among the more celebrated victims were Jean du Chatelet, Baron de Beausoleil, and his dowser wife Marine de Bertereau, who, working under the protection of Maréchal d'Effiat, Louis XIV's superintendent of mines, discovered several hundred profitable mines in France only to be arrested for sorcery and succumb in prison, she in Vincennes, he in the Bastille. The persecution has continued in France mostly against doctors who find themselves dragged before tribunals for perpetrating dowsing cures on patients officially declared uncurable.

That dowsing is no longer considered anathema by the Church is thanks largely to the efforts of a long series of French abbés such as Mermet, Bouly, Vallemont, Richard, Carrie, Descosse, and Ferran, and the recent intercession in Rome of such an eminent churchman as Cardinal Tisserant.

In the scientific community the art is now on the fringe of recognition thanks to professors such as Yves Rocard of the Collège de France, head of the physics department of the prestigious Ecole Normale Supérieure, who is recognized not only as a brilliant physicist but as an admirable dowser. His book on the science of dowsing, *Le Signal du Sourcier,* as yet unpublished in English, has been translated in the Soviet Union where geologists have recently been dowsing for minerals from airplanes and helicopters, and also locating underground archeological artifacts.

The Mecca for dowsers in Europe is located in a small Parisian side street, now lost between the luxury of the Faubourg Saint Honoré and the tourist-ridden arcades of the rue de Rivoli, appropriately named for Saint Roch, canonized for protecting the populace against various pestilences. The actual Kaaba is an old curiosity shop called the Maison de Radiesthesie, "*radiesthesie*" being generic for dowsing and for the search for radiations beyond the electromagnetic spectrum, an appellative given to the art by the Abbé Bouly, who coined it from the Greek for "sensitivity" and the Latin for "radiance."

On the shelves of this now venerable institution, run for the last half century by Alfred Lambert and his wife, are scores of books on dowsing —dowsing for water, for objects, and for health. In addition to those written by Catholic clergymen, there are others by aristocrats such as Count Henry de France and Count André de Belizal and by several distinguished French physicians.

There are also brass and mahogany showcases protecting various exotic machines, some simple, some sophisticated, designed to tune in, amplify or shield radiations, healthy or toxic. The machines are used mostly by doctors from all over the world for diagnostic and curative purposes, though the fundamental instrument in each case is the simple pendulum. These lie in stacked drawers on velvet cushions designed in many shapes and sizes from various materials, including ivory, jade, and octagonal quartz or crystal, though any weight on any string or chain is said to be effective.

In the United States, Dr. Zaboj V. Harvalik, a professional physicist recently retired from his post as scientific adviser to the U.S. Army's Advanced Material Concepts Agency to devote himself to private research, has turned his attention to the dowsing phenomenon and to how physical theory might help to explain it. As chief of the research committee of the American Society of Dowsers, Harvalik is helping to break down fifty years of prejudice in official circles against dowsing as a "quack art."

At his home on the banks of the Potomac River in Lorton, Virginia, Harvalik has made meticulous tests to reveal for the first time that dowsers react with varying degrees of sensitivity to polarized electromagnetic radiation, artificial alternating magnetic fields in a frequency range from one to one million cycles per second and to DC magnetic fields. Harvalik is convinced that dowsers pick up magnetic field gradients whether they are trying to find water, underground pipes, wires, tunnels, or geological anomalies.

Dowsing, however, appears to extend far beyond the detection of flowing water or the magnetic field gradients thought to be associated with water currents. In its broadest definition it is simply *searching*—for anything. The former president of the American Society of Dowsers, John Shelley, before his premature death in 1972, amazed his fellow naval reserve officers when at the end of a training session at the Pensacola, Florida, Naval Air Station he was able, by using only a small dowsing rod, to locate his government salary check, which his colleagues had conspired with the help of the paymaster to hide somewhere in a huge two-story naval building with dozens of rooms branching out of its corridors.

Gordon MacLean, a research chemist for Pine State By-Products in Portland, Maine, who still works full time despite his eighty-odd years, will take any visitor out to the Coast Guard lighthouse at Portland Head and with his "divining" rod accurately predict when the next oil tanker on its way into Portland harbor will appear on the horizon and where.

Perhaps the most celebrated American dowser is Henry Gross, also of Maine, to whose feats Kenneth Roberts, the American historical novelist, devoted three books in the 1950s. Like the French abbots, Gross is an expert at dowsing from maps. Sitting at his kitchen table, he pinpointed on a map of the British-governed island of Bermuda, on which no source of water had been found, just those spots where he said drilling would produce it. To everyone's amazement, Gross was correct.

To physicists like Harvalik the forces at work in *map* dowsing, which do not appear to be related to the magnetic gradients operative in *field* dowsing, are totally inscrutable. Obviously a dowser is contacting some source of information which can provide accurate data on areas—or parts of space—far removed from his own physical location. Rexford Daniels, whose Interference Consultants Company of Concord, Massachusetts, has been pioneering the study for twenty-five years of how proliferating electromagnetic emissions interfere with one another and may work harmful environmental effects on man, states that he has become convinced that some overall force exists in the universe which is itself intelligent and provides answers. Daniels theorizes that this force operates through a whole spectrum of frequencies not necessarily linked to the electromagnetic spectrum and that human beings can mentally interact with it. To Daniels dowsing is simply an as yet imperfectly

defined though exceedingly useful communications system. In his eyes an important task confronting man now is to check out the system in all of its aspects.

The specific technique of dowsing food for freshness and vitality was learned by engineer Simoneton, now also in his eighties—though he looks like a successful French businessman in his sixties—from another extraordinary Frenchman, André Bovis, a fragile tinker who died in his native Nice during the Second World War. Bovis is most widely known for his experiments with pyramids built to the dimensions of the Great Pyramid of Cheops, which he found would mysteriously dehydrate and mummify dead animals without decomposing them, especially if they were placed in a pyramid at the relative height of the King's Chamber, or one third of the way from the base to the summit.

Basic to Bovis' theory is that the earth has positive magnetic currents running north to south, negative magnetic currents running east to west. He says that these currents are picked up by all bodies on the surface of the earth, and that *any* body placed in a north-south position will be more or less polarized, depending on its shape and consistency. In human bodies these telluric currents, both positive and negative, enter through one leg and go out through the opposite hand. At the same time cosmic currents from beyond the earth enter through the head and go out through the other hand and foot. The currents also go out through the open eyes.

All bodies containing water, says Bovis, accumulate these currents and can radiate them slowly. As the currents go out and act and react against other magnetic forces in objects, they affect the pendulum held by the dowser. Thus the human body, as a variable condenser, acts as a detector, selector and amplifier of short and ultra-short waves; it is a go-between for the animal electricity of Galvani and the inanimate electricity of Volta.

At the same time the pendulum, says Bovis, acts as a perfect lie detector in that if a person is frankly saying what he thinks about some subject, it will not affect the radiations and thus not affect the pendulum; but anyone saying something different from what he is thinking changes the wavelengths, making them shorter and negative.

Bovis developed a pendulum from a similar device which he says was used by the ancient Egyptians, made from crystal with a fixed metal point suspended on a double strand of red and violet silk. He called it "paradiamagnétique" because it is sensitive to objects which are either attracted or repelled by a magnet. Bodies which are attracted, such as iron, cobalt, nickel, magnesium, chrome, or titanium, he called paramagnetic; those which are repelled, such as copper, zinc, tin, lead, sulfur and bismuth, he called diamagnetic. By placing a small magnetic field in the form of a solenoid between the dowser and the pendulum he claimed to be able to pick up very faint currents such as those emanating from a nonfecundated egg. He explained the use of red and violet strands as increasing the sensitivity of his pendulum on the grounds that red light vibrations are the same as the atomic vibrations of iron, which are paramagnetic, and those of violet being the same as copper, which are diamagnetic.

Bovis found that with his pendulum he could tell the intrinsic vitality and relative freshness of different foods within their protective skins because of the power of their radiations. To measure with his pendulum the varying radiant frequencies produced by foods Bovis developed a *biomètre,* or simple ruler arbitrarily graduated in centimeters to indicate microns, which are thousandths of a millimeter, and angstroms, which are a hundred times smaller, covering a band between zero and ten thousand angstroms.

By placing a piece of fruit or vegetable, or any kind of food, at one end of the ruler, Bovis could watch his swinging pendulum change directions at a certain distance along the ruler, which gave him an indication of the degree of the food's vitality. According to Bovis the limit of any object's radiance is overcome at some point by the general telluric field surrounding it, and can thus be measured. Dowsers maintain that any two objects of the same material and size placed a yard or so apart will create two fields which will repel each other at a halfway mark easily noted with a pendulum. Increasing the size of one of the objects will cause its field to move closer to the smaller object.

Simoneton found that food which radiates 8,000 to 10,000 angstroms on Bovis' biomètre would also cause a pendulum to turn at the remarkable speed of 400 to 500 revolutions per minute in a radius of 80 millimeters. Foods which radiate between 6,000 and 8,000 spun it at a rate of 300 to 400, with a radius of 60 millimeters. Meats, pasteurized milk, and overcooked vegetables, which radiate less than 2,000 angstroms, have not sufficient energy to make the pendulum spin.

For those who might complain about the arbitrary selection of angstroms for measuring the relative radiant vitality of objects, Louis Kervran, in a preface to Simoneton's book, *Radiations des Aliments,* points out that the angstrom is no more arbitrary than the calorie used in nutrition—a calorie being the quantity of heat required to raise the temperature of one gram of water one degree centigrade. All systems of measurement, says Kervran, are conventional; Bovis' angstrom merely made it easy to distinguish between the radiant value of fermented cheese, which reads at 1,500, and that of fresh olive oil, which reads at 8,500. In any case, Kervran adds, the wavelengths emitted by fruits and vegetables and other biochemical foodstuffs which are picked up with the pendulum are of totally unknown nature, apparently outside the electromagnetic spectrum. It is simply the fact that they are measurable by dowsing methods which remains of great practical value.

According to Bovis, wavelengths broadcast by an object are picked up by the nerves in a human arm and then amplified by means of a pendulum swinging at the end of a string. Impressive proof of this has been established in Montreal by Jan Merta, whose laboratory experiments clearly indicate that a minute muscular movement occurs in the area of the wrist a fraction of a second after a change in the encephalograph has been registered. Merta has also designed a dowsing device, which can be placed not only in the hands but on the arms, shoulders, head, legs, or feet, or any other part of the body where it can be balanced.

In line with Bovis and Lakhovsky, Simoneton reasoned that if human nerve cells can receive wavelengths they must also be transmitters: senders and receivers must be able to enter into resonant vibration with each other in order to pick up a transmission. Lakhovsky likened the system to two well-tuned pianos: when a note is struck on one it will cause the same note to vibrate on the other.

Some dowsers say that the prime sensor in the human body may be located in the area of the solar plexus. This appears to be borne out by Harvalik's most recent research. To shield parts of the human body from the effects of the ocean of magnetic forces surrounding it, Harvalik took an eight-foot-by-ten-inch strip of highly effective magnetic shielding (made from a Co-Netic AA Perfection Annealed sheet 0.025 inches thick, produced by the Magnetic Shield Division of the Perfection Mica Company) and rolled it into a two-layered cylinder which could be lowered around the body to shield head, shoulders, torso, or pelvic area.

With the shield covering his head, Harvalik walked blindfolded across a level area known to produce dowsing signals and obtained a strong reaction over each of three dowsing zones. The same reactions were obtained with his head exposed but his shoulders shielded. Gradually lowering the shield, Harvalik found that he could pick up dowsing signals until he reached an area between the 7th and 12th rib, that is to say from sternum to navel.

"These measurements," says Harvalik, "suggest that dowsing sensors must be located in the region of the solar plexus and that perhaps there are additional sensors in the head or brain."

Dr. J. A. Kopp of Ebikon, Switzerland, who for years has been working with dowsing techniques to locate geopathogenic zones that seem to be related to high incidences of cancer, reported in 1972 that a German engineer, in an experiment analogous to those of Harvalik, had himself carried horizontally on a stretcher over a dowsing zone. As his head passed the dowsing zone, the rod was undisturbed; when his solar plexus was above the same zone, the dowsing rod immediately reacted.

Using a pendulum to establish the relative radiance of different foods was a technique developed by Simoneton as a matter of life or death. During the First World War he underwent five operations. One dark night lying on a stretcher by a hospital train he overheard two medics whispering in the shadows cast by a kerosene lantern that he was so severely tubercular there was no chance of his recovery. A forced diet of rich food ruined his liver and gave him other unpleasant side effects. Barely surviving the ministrations of the medics, Simoneton discovered Bovis' system of selecting fresh and vital foods from poisonous fare. In

a short time he rid himself not only of the TB but of its side effects and became so healthy that years later, at sixty-six and sixty-eight he still fathered children, and at seventy was still playing tennis.

As a young engineer Simoneton had been drafted into the French army to work on the new science of radio, which, says Simoneton, was in those days at about the level that dowsing is today. During World War I Simoneton worked alongside such electrical luminaries as physicist Louis de Broglie, who was to establish that every particle, down to a photon of light, is associated with a specific wavelength.

With this background Simoneton had enough electrical engineering and radio knowledge not to dismiss Bovis as a quack, and was able to establish empirically that with Bovis' system he could measure specific wavelengths from foods that indicated both vitality and freshness. Milk, which he measured at 6.5 thousand angstroms when fresh, lost 40 percent of its radiation by the end of twelve hours and 90 percent by the end of twenty-four. As for pasteurization, Simoneton found that it killed the wavelengths dead. The same he found true of pasteurized fruit and vegetable juices. Garlic juice, when pasteurized, coagulated like dead human blood and its vibrations dropped from around eight thousand angstroms to zero.

On the other hand freezing fresh fruit and vegetables has the effect of prolonging their life; on defrosting they resume their radiance at almost the same level as when they were iced. Food placed in a refrigerator will deteriorate, but at a much slower pace. Unripe fruits and vegetables in a refrigerator may actually increase in radiance as they slowly mature.

Dehydrated fruit was found by experiment to retain its vitality; if soaked in "vitalized" water for twenty-four hours, even several months after drying, it would reradiate almost as strongly as when freshly picked. Canned fruits remained perfectly dead. Water turned out to be a very strange medium: normally unradiant, it was capable of being "vitalized" by association with minerals, human beings, or plants. Some waters, such as those at Lourdes, Bovis found, in 1926, to radiate as high as 156,000 angstroms. Eight years later some of the same water still registered 78,000 angstroms. The Czech-born psychic Jan Merta holds that the rind from apples, pears, and other fruits and vegetables, when left to soak in a glass of water overnight, releases healthful vibrations into the water which can then be drunk to provide better nourishment than the rind itself, which has little or no effect on Simoneton's pendulum.

To simplify life for readers of his book, Simoneton divided foods into four general classes. In the first he placed those foods whose radiant wavelength he found higher than the basic human wavelength of 6,500 angstroms, going up to 10,000 or higher. These include most fruits, which run between 8,000 and 10,000 at the peak of their maturity, and vegetables if eaten fresh from the garden. Simoneton noted that by the time most vegetables get to the market in town they have lost one-third of their potency; by the time they have been subjected to cooking, they have lost another third.

Simoneton says fruits are filled with solar radiation in the healthful light spectrum between the bands of infrared and ultraviolet, and that their radiance rises slowly to a peak while ripening, then gradually decreases to zero at putrefaction. The banana, which is healthily edible for about eight days out of a span of twenty-four between the time it is picked and when it starts to rot, gives off optimum vibrations when it is yellow, not so good when green, and very low when black.

Anyone who has lived in pineapple-growing areas of the world such as the Hawaiian islands knows that a pineapple picked and eaten at the precise time of its ripening—a period lasting no longer than a few hours—has a delicious taste which amazes people who have only eaten store-bought fruit picked long before they come to maturity.

Vegetables are most radiant if eaten raw, two raw carrots being better than a plateful of cooked ones. The potato, which has a radiance of only 2,000 angstroms when raw (perhaps because it grows underground hidden from the sun), mysteriously rises to 7,000 angstroms when boiled and all the way to a very healthy 9,000 when baked. The same applies to other tubers.

Legumes, such as peas, beans, lentils, or chickpeas, rate 7,000 to 8,000 when fresh. Dried they lose most of their radiance. They become heavy, indigestible, and hard on the liver, says Simoneton. To benefit from legumes they too should be eaten raw and freshly picked. Optimum

results, says Simoneton, come from their juices, especially if drunk at 10 A.M. and 5 P.M. when they are easily digested and do not tire the system but nourish it.

On Simoneton's scale wheat has a radiance of 8,500 angstroms; when cooked this rises to 9,000. He says wheat can and should be eaten in a variety of ways rather than simply in bread. Whole-wheat flour should be mixed into pies, tarts, and other pastries with butter, eggs, milk, fruits, and vegetables. Baked in a wood-burning oven, bread gives off even better radiations than if cooked with coal or gas.

Olive oil was found by Simoneton to have a high radiance of 8,500, and to be extremely long-lasting. Six years after pressing it still gives off around 7,500. Butter, which radiates about 8,000, is good for about ten days before it starts to fall off, reaching bottom in about twenty days.

Ocean fish and shellfish are good foods with a bright radiance from 8,500 to 9,000 especially if caught fresh and eaten raw. This includes crabs, oysters, clams, and other shellfish. Lobsters, says Simoneton, are best cut in half while live and broiled on a wood fire. Fresh water fish is much less radiant.

In Simoneton's second category he places foods radiating from 6,500 down to 3,000 angstroms. These include eggs, peanut oil, wine, boiled vegetables, cane sugar, and cooked fish. He rates a good red wine between 4,000 and 5,000, and says it is a better drink than devitalized city water, and certainly better than coffee, chocolate, liquor, or pasteurized fruit juices, which have virtually no radiance.

Echoing Nichols, Simoneton says that, whereas the juice of a fresh sugar beet gives 8,500 angstroms, refined beet sugar can fall as low as 1,000, and the white lumps that get wrapped in papers are down to zero.

Of meats, the only one that makes Simoneton's list of edible foods is freshly smoked ham. Freshly killed pork radiates at 6,500, as does all animal meat; but once it has been soaked in salt and hung over a wood fire its radiance rises to 9,500 or 10,000 angstroms. Other meats are almost pointless to eat; they are an exercise in tough digestion, which wears out rather than vitalizes the eater, requiring him to drink coffee to keep from falling asleep.

Cooked meats, sausages, and other innards are all in Simoneton's third category along with coffee, tea, chocolate, jams, fermented cheeses, and white bread. Because of their low radiation they do one little or no good, says Simoneton.

In his fourth category are margarines, preserves, alcohols, liquors, refined white sugar, and bleached white flour: all dead as far as radiations are concerned.

Applying his technique for measuring wavelengths directly to human beings, Simoneton found that the normal healthy person gives off a radiance of about 6,500 or a little higher, whereas the radiations given off by tobacco smokers, alcohol imbibers, and carrion eaters are uniformly lower. Bovis claimed that cancer patients give off a wavelength of 4,875, which, he noted, was the same wavelength as that of overrefined white French bread before the Second World War.

However, because a cancer victim will radiate this low level long before any overt symptom of his disease is in evidence, Bovis pointed out that it is possible to take remedial steps well before the ailment has made serious inroads into the body's cellular tissue.

It is Bovis and Simoneton's thesis that human beings should eat fruit, vegetables, nuts, and fresh fish that give off radiations higher than their own normal 6,500, if they wish to energize themselves and feel healthy. They believe that low-radiance foods, such as meats and bad bread, instead of bringing vitality to the body, sap the body of its existing vitality and that that is why one can feel heavy and devitalized from a meal one expected to replenish one's energy.

From the fact that most microbes read well below 6.5 thousand angstroms, Simoneton, like Lakhovsky, deduces that they can only affect a human being whose vitality has been lowered to a point where cells resonate at their wavelength, whereas a body with a healthy vitality remains immune to attack by microbes. This gives a *raison d'être* for deadly microbes in an ordered universe. The same principle, no doubt, explains why plants whose radiance has been reduced by chemical fertilizers are subject to attack by pests.

It struck Simoneton that the therapeutic marvels attributed since the dawn of history to herbs, flowers, roots, and barks might not be due simply to their chemical content, but the healthy wavelengths they radiate. Though the apothecary's shelves are still stocked with chemical

derivatives from plants and herbs, their curative powers no longer appear so miraculous. The secret of their potency seems to have been lost.

Old wives and hermits are still reputed to know and understand the mysterious healing powers of plants, but they must have acquired their knowledge by some extra sense, or the woods would be strewn with the corpses of accidented sages, poisoned by belladonna, deadly nightshade and a host of other noxious weeds.

Simoneton believes the day will soon come when vaccines are made not from the bodies or carcasses of animals but from the radiant juice of plants. To set the world right Simoneton envisages doctors with headphones like radio operators, able to diagnose by the frequencies they receive from patients just what ails them, able to broadcast to them just the frequencies required to set things right.

Perhaps the most informed doctor in the healing power of plants was Paracelsus, who acquired his lore from old European herbalists, from wise men of the East, but primarily from the direct study of nature. According to his "doctrine of sympathetic resemblances" all growing things reveal through their structure, form, color, and aroma, their peculiar usefulness to man. Paracelsus recommended that a physician sit quietly in a meadow, relax and soon notice "how the blossoms follow the motion of the planets, opening their petals according to the phases of the moon, by the cycle of the sun, or in response to distant stars."

A modern follower of Paracelsus who turned out to be an extraordinary wizard with herbs and plants was a young London doctor, Edward Bach, who gave up a handsome practice as a physician on Harley Street in the 1930s to take to the woods and fields in search of a better cure for his fellow human beings. Like Paracelsus who sought to restore health by natural means so that it would not be necessary for the sick first to recover from their ailment and then have to recover from the cure, Bach rebelled against the idea that medicine should be painful and unpleasant. Noting that in most hospitals in England the so-called remedies gave the patient great pain and often did him more harm than good, he was determined to find remedies in nature that would neither be harmful nor unpleasant. He sought a remedy that would be gentle, sure, and would result in healing of both mind and body.

Like Paracelsus and Goethe, Bach was convinced that true knowledge was to be gained not through man's intellect, but through his ability to see and accept the natural, simple truths of life. Paracelsus had asserted that the further you search the greater you will realize the simplicity of all creation, and advised physicians to search within themselves for the spiritual insight that would lead them to sense and recognize the energies of plants.

In the summer of 1930 Bach turned the key on his lucrative practice and took to the highway, wandering through the English countryside and into the wild mountains of Wales in search of the wildflowers he was convinced contained the secret to healing both the spiritual and physical ailments of aberrant mankind. Like Paracelsus he was convinced that disease of the body is due not primarily to physical causes, but to disturbing moods or states of mind which interfere with the normal happiness of the individual, moods which if allowed to continue lead to a disturbance of the functions of the bodily organs and tissues with resulting ill health.

With Paracelsus, Bach believed that everything that lives radiates, and with Simoneton, he realized that plants with high vibrations were able to raise the lowered vibrations of human beings. As he put it, "herbal remedies have the power to elevate our vibrations, and thus draw down spiritual power, which cleanses mind and body, and heals." Bach compared his remedies to that of beautiful music or arrangements of color, or any gloriously uplifting medium that gives inspiration; his cure was not to attack the disease, but to flood the body with beautiful vibrations from wild herbs and flowers, in the presence of which "disease would melt away as snow in the sunshine."

Myrna I. Lewis, coauthor with Robert N. Butler, M.D., of a new book, *Aging and Mental Health,* was amazed when recently taken by the Soviets on a visit to several sanitariums in the Black Sea city of Sochi to find aging Soviet citizens, afflicted with a variety of ills, both physical and mental, being treated not with drugs but with vibrations from flowers in greenhouses where they were led to smell specific blooms so many minutes a day. They were also being treated with music played in their rooms and the sound of the sea recorded on tapes.

Fundamentally, Bach maintains that it is up to the sick person to change his mind about his own illness, but that healthy aesthetic vibrations help him recover his desire to be well. Bach felt that a long bout of fear or worry could deplete an individual's vitality to the point where his body lost its natural resistance to disease, and was thus in a state to become the prey of any infection and any form of illness. "It is not the disease which needs the treatment," said Bach. "There are no diseases; only sick people."

Although he was convinced that plants with the right medical properties were to be found among the simple wildflowers of the countryside, Bach was out to find those with the greatest power, capable of being more than palliatives, actually able to restore health to mind and body.

The first flower he tested for its medicinal properties was the yellow-spired agrimony *(Agrimonia eupatoria),* a common wildflower which grows in abundance on the grassy verges of country roads and fields throughout England. Its small blooms are golden with many stamens of the same hue. Bach found an infusion of it to be a great remedy for worry, for the restless tormented state of mind so often hidden behind outward cheerfulness. Next he experimented with the striking blue flower of chicory, which he found a remedy for overconcern, especially for others, and discovered that it brought calmness and serenity. Bach's remedy for extreme fear was the administration of a dose of the elixir of rockrose. As his discoveries and ministrations progressed, Bach felt he was on the verge of discovering an entirely new system of medicine. On impulse or instinct he went to the Welsh wilderness, where he found two beautiful plants: the pale mauve impatiens, and the golden-flowered mimulus, growing in profusion near a mountain stream. Both turned out to be powerful medicines.

During his months in Wales, Bach felt his senses quickening, becoming more developed. Through a finely developed sense of touch he was able to feel the vibrations and power emitted by any plant he wished to test. Like Paracelsus, if he held a petal or bloom in the palm of his hand or placed it on his tongue he could feel in his body the effects of the properties within that plant. Some had a strengthening, vitalizing effect on his mind and body; others would give him pain, vomiting, fevers, rashes, and the like. His instinct told him that the best plants would be found blooming in the middle of the year, when the days are longest and the sun at the height of its power and strength. The plants he chose were the most perfect of their kind, their bloom beautiful in shape and hue, growing in profusion.

Perhaps Bach had read that Paracelsus on his estate at Hohenheim had captured dew on plates of glass, gathering the dew under various configurations of the heavenly bodies, believing the water to carry within it the energy of these planetary combinations, or perhaps he had a flash of intuition. At any rate, early one morning as he walked through a field upon which the dew still lay heavy, it struck Bach that each dewdrop must contain some of the properties of the plant upon which it rested; the heat of the sun, acting through the fluid, would serve to draw out these properties until each drop was magnetized with power. He realized that if he could obtain the medicinal properties of the plants he was seeking in this way, the resulting remedies would contain the full, perfect, and uncontaminated power of the plants, and they might heal as no medical preparations had been known to heal before. Collecting the dew from certain flowers before the sun had caused evaporation, he tried it on himself, shaking the drops from various flowering plants into small bottles, filling some with the dew from flowers which had been in full sunlight, some from those still in shade, although the latter never seemed as potent as the ones in the sun.

Though many of the flowers did not contain the healing properties he sought, Bach found the dew from each plant held a definite power of some kind, and deduced that the sun's radiation was essential to the process of extraction. As collecting sufficient dew from individual flowers could be laborious he decided to pick a few blooms from a chosen plant and place them in a glass bowl filled with water from a clear stream, leaving them standing in the field in the sunlight for several hours. To his delight he found that the water became impregnated with the vibrations and power of the plant and was very potent. To potentize his water Bach would choose a summer day with no clouds to obscure the sun's light and heat. Taking three small plain glass bowls filled with fresh water, he set them in a field where the flowering plants were growing, then selected the most perfect blossoms and placed them on the surface

of the water. To lift the blooms from the water without touching the fluid with his fingers he used two blades of grass. The water was then transferred by means of a small lipped phial to bottles. When half-full the rest of the bottle was filled with brandy designed to preserve the mixture. Before the next experiment Bach would destroy both bowls and phials.

Altogether Bach produced thirty-eight remedies and wrote a philosophic booklet to go with them. Thousands of patients throughout England and the world were to vouch for their efficacy, and many thousands still depend on this elixir of flowers to cure them of innumerable ailments.

The work of Maurice Mességué, a sophisticated Frenchman born of peasant stock in a remote section of Gascony known as the Gers, parallels that of Bach. Taught by his father, who took him as a child on herb-collecting trips all over the countryside, Mességué went on to become a famous herbal healer successfully treating hundreds of patients including such notables as the president of the French Republic, Edouard Herriot, and artist Jean Cocteau. Among the afflictions he cured were such baffling ones as a withered arm on a beautiful young girl and the apparent inability to talk in a child of twelve. Most of Mességué's cures were effected by having his patients soak their extremities in infusions of wild plants. Hounded into court on many occasions for practicing medicine without a medical degree, Mességué fought back because he felt he could not abandon the thousands of sufferers who pleaded for his assistance. An account of his life with many anecdotes about his encounters with world figures appears in three best-selling books he has written on the subject of plants.

Another sensitive who can feel the radiations from flowers has gone Bach and Mességué one better, saying he can transfer radiations direct from a blooming flower into a bowl of water without in any way harming the plant on which it grows.

A ruddy-cheeked Scotsman, very independent, Alick McInnes was born and lives on a sheep farm in the shadow of the castle of the Thane of Cawdor, surrounded by gently rolling hills and a fortune in peat bog —which he cannot dig or burn because by Scottish tradition it all belongs to the Thane. Blindfolded, McInnes can put his hand over a ripe bloom and tell from the wavelength of its radiation just what plant it is and what its medical properties may be. In India, where he spent thirty years working for the British Raj, McInnes got his first introduction to the fact that plants not only give off radiations which are sensible to humans, but are themselves sensitive to the radiations given off by humans; this he discovered when he visited the Bose Institute near Calcutta.

By the entrance to the Institute stands a luxuriant *Mimosa pudica*. Visitors are requested to pick a small frond from this compliant horticultural guinea pig and place it in one of Bose's complicated machines, which provides a schematic pattern of the vibrations of the plant on a sheet of paper. A visitor is then asked to place his wrist inside the machine and watch as a duplicate of the pattern is produced, demonstrating that mimosa is so sensitive it can pick up and faultlessly reflect individual human radiations.

As McInnes interprets the phenomenon of human and plant radiations, each individual member of either kingdom modifies or qualifies with his own wavelength the fundamental energy radiating through him. The same applies, says McInnes, down to the finest particle of matter: "Everything radiates wavelengths which can be identified as sound, color, form, movement, perfume, temperature and intelligence."

McInnes says the radiations from some flowers are circular, others go from left to right, others from right to left. Some go up and down; others down and up; some go diagonally from left to right; others in the opposite direction. Some feel cold; others warm. But the same flower species always gives off the same radiation. McInnes says he has found it possible to transfer flower radiations to water, where the radiations will stay more or less indefinitely. He has some bottles with radiations still effective after twenty years. Each flower species has a time when its radiations can best be transferred to water, usually, though not always, when the flowers are at the peak of their maturity, which is also usually near a full moon.

Potencies, as McInnes calls the radiations which are transferred to water, can be taken from the rose around midsummer, or June 21, and

from the dandelion around the Easter full moon. When conditions are right, transfer of the radiations is instantaneous, and McInnes, wrinkling his weatherbeaten lips into a wise smile, says the water can actually be seen to change, "an awe-inspiring experience never to be forgotten." Far from damaging the plant, McInnes says that just at that moment when its potency is transferred to water, other members of the same species for miles around brighten up and appear to grow more vigorously than before. The resulting potentized water McInnes calls an Exultation of Flowers, which he says is not a specific for the treatment of any diagnosable disease, but operates in a subtle way on the radiations coming through the human body, on animal or the soil, and in so doing raises the vitality of the person, animal, or soil concerned. When vitality is raised to the necessary level, says McInnes, illness disappears.

McInnes prescribes his Exultation to be taken by mouth, so many drops at a time for varying conditions, as a salve for cuts and burns and other problems of the skin, and as a tonic diluted in one's bath. He says that although he has been asked to do so he has never attempted to find individual flowers, or groups, that would be helpful in the treatment of a particular disease. He figures it more worthwhile to work on the concept that all illness has a common cause, and strives for a preparation that will, ultimately, bring results to every illness, no matter what the diagnosis. The decision as to whether potencies from any particular flower should be included in the forty-odd varieties in his Exultation has been made by McInnes by feeling the radiations emanating from the particular potency concerned. He finds that not all can be mixed successfully. Some seem to cancel each other out; others disturb the mixture; others upset the temper of the radiations already in the preparation. McInnes is amazed at how many differing radiations he has managed to combine in a harmonious whole.

As the radiations in Exultation of Flowers are not identifiable by ordinary methods of analysis based on the identification of chemical ingredients, and as so far the impulses cannot be identified by any measuring instrument available in Britain, McInnes has been obliged by a court action instituted by the Scottish health authorities to label his bottles "Guaranteed Chemical Composition—100% water, without herbal or chemical ingredients." Pointing out that magnetized steel and ordinary steel show the same chemical ingredients but are obviously quite different from each other, McInnes still hopes some new method will be devised to identify the radiations.

McInnes says his Exultation is just as good for a cow with milk fever in Scotland as it is for a man with asthma in California or a woman stung by a wasp in New Zealand. It can be used on a baby with a stomach ache, on a hive of bees with "foul brood," on strawberry plants with "June yellows" or on hens which have eaten poisoned grain. Sprayed onto the soil McInnes says it increases the activity and quality of soil bacteria. But he warns that gardens which have been treated with chemical fertilizers will take longer to respond "because the whole polarity of the soil has been geared to decay." He says the vibrations of his Exultation channel fresh energy into the soil which counteracts disease, blight, and pests.

In the more than sixteen years since Exultation of Flowers was first offered to the public, many thousands of letters have been received reporting success in the treatment of pretty well every diagnosable disease. Philosophically McInnes believes that all forms of life are created to live in harmony, but mankind has so misused this dominion over created things that there is now disharmony everywhere, which is expressed in physical disease in human, animal, and plant life, the life forces coming from the Source of Creation becoming more and more distorted. Believing that in the Golden Age the lion would lie down with the lamb, he describes how, when he lived in Uganda, he would watch hundreds of animals making tracks through the elephant grass toward the salt licks, with carnivores such as leopards and panthers trotting alongside tiny timorous deer that in other circumstances would tremble and run away.

In South India, where McInnes spent a couple of weeks as the guest of Ramana Mohan Maharshi at his ashram at the foot of the holy hill Arunachalam, famed in Hindu mythology for many centuries, every evening when the Maharshi would go out for a walk, within seconds of his crossing the threshold of his residence, cattle tied up in stalls in the nearby village, about half a mile away, would struggle to get out of their

bonds. Released by the villagers they careered along the road to accompany the old man on his walk, followed by all the dogs and children of the village.

Before the procession had gone very far wild animals, says McInnes, joined it from the jungle, including several varieties of snakes. Thousands of birds appeared, almost blotting out the sky, including tiny tits, huge kites and other birds of prey, heavy-winged vultures, all flying in harmony around the Maharshi on his walk. When he returned to his room, said McInnes, all the birds, animals, and children would quietly disappear. To achieve such an atmosphere worldwide, McInnes realizes, would be quite a feat. His Exultation would have to help produce vegetation of such an improved nutritive quality that the lion could feed on it before he would happily lie down with the lamb. McInnes sees no reason such a food plant could not be encouraged by some new Burbank to grow in abundance.

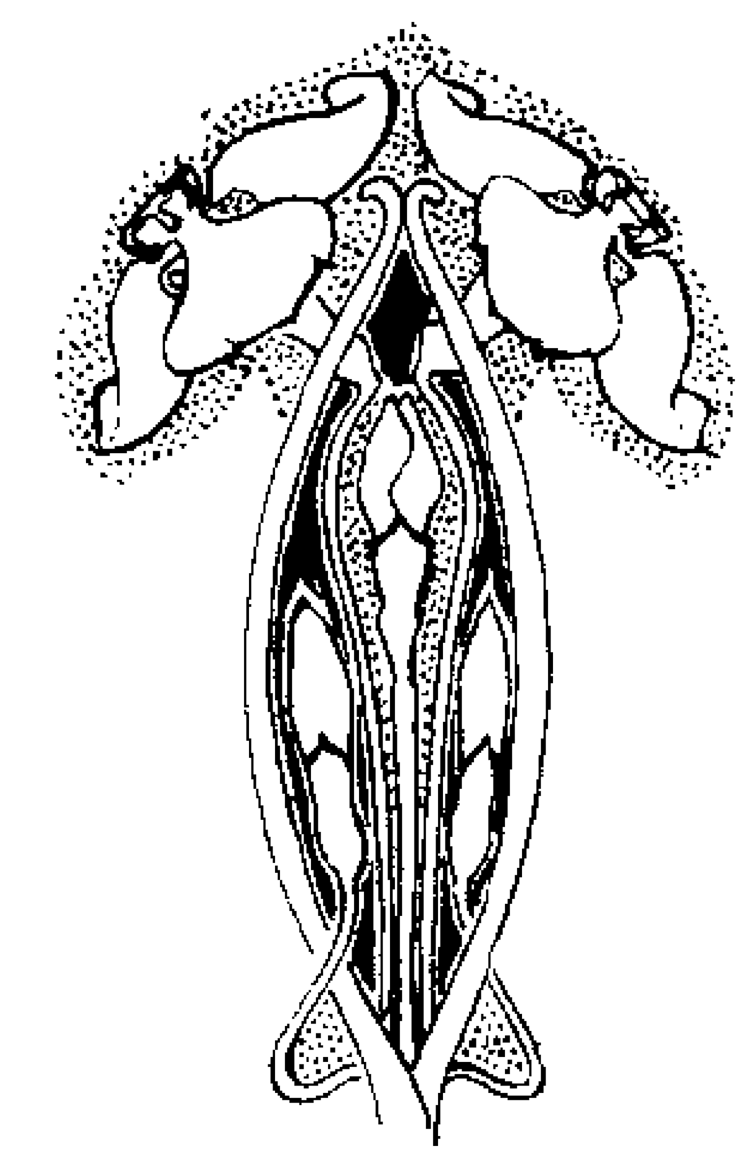
There will also have to be an increase in the sensitivity of humanity, says McInnes, to the point where the sacrifice of animals to sport becomes wholly intolerable, as well as the mass slaughter of animals in total terror in abattoirs. Better food must be more easily obtainable in such abundance that half-starved and semi-brutalized men no longer need to eat meat or demand work of half-dead, diseased, and suffering animals; in other words, we must cease to be a planet of jailors and chain-gang drivers.

As everything created is interdependent, says McInnes, it follows that what affects one form of life must affect all other forms as well. "If we deliberately cause suffering and disease in other lives, we increase our own suffering and disease." All creation, says McInnes, is affected by the disease inflicted on laboratory animals in what he believes to be a futile and foredoomed attempt to combat illness. All creation is tormented through the ghastly agonies which the vivisectionist inflicts on helpless creatures. Any relief of illness supposed to be removed by knowledge gained at the expense of such agonies will, says McInnes, be paid for many times over in increased suffering in some other part of the Whole. All creation suffers when plants in their millions are burnt by chemical weed killers.

Just as every created thing takes a knock for every victim of war or every inmate tortured in a concentration camp, so every created thing takes a knock when a rabbit dies of human-induced myxomatosis, or a plant dies in agony, deliberately diseased with toxic chemicals. "All of life," says McInnes, "is one. There is no exception."

CHAPTER 19

Radionic Pesticides



Simoneton's dream that doctors with earphones would one day diagnose patients simply by tuning in to the frequencies given off by their ailing organs and then be able to cure them by broadcasting to the organs more healthful vibrations has turned out to be closer to fact than fiction. However, because the mechanism appears to be as explosive as TNT and as amenable to the spread of death and disease as it is to the spread of life, the findings have been discreetly scotched by both the political and scientific establishments.

At the end of the nineteenth century Dr. Albert Abrams, the son of a successful San Francisco merchant from whom he had inherited a vast fortune, traveled to Heidelberg to study advanced medicine. In Naples young Abrams watched the famous Italian tenor Enrico Caruso flick a wine glass with his finger to produce a pure tone, then step back and by singing the same note shatter the glass. This impressive feat awoke in Abrams the idea that he might have stumbled on a fundamental principle which could be tied into medical diagnosis and healing.

At the University of Heidelberg's medical school, from which he was to receive top honors and the gold medal, Abrams met a Professor de Sauer, who was engaged—many years before Gurwitsch had happened on "mitogenetic radiation"—in a bizarre series of experiments with plants. De Sauer told Abrams that, while transplanting onion seedlings, he had inadvertently left some of the uprooted onions next to those still growing in one of several flats. Two days later he noticed that the seedlings growing on the side of the flat next to the dying plants were different in appearance from those on the opposite side. De Sauer could not explain the reason for the difference but Abrams was convinced that the onion roots were emitting some strange form of radiation and linked this in his mind with the resonance phenomenon behind Caruso's voice-shattered glass.

Abrams returned to the United States to teach pathology at Stanford University's medical school, of which he was later to become director of medical studies. A superb diagnostician and master of the art of percussion, he would tap the body of a patient to produce resonating sounds, which became clues to whatever ills might be afflicting the patient. One day Abrams noticed that when a nearby X-ray apparatus was switched on without warning it dulled the resonant note he was getting from his tapping. Perplexed, Abrams rotated his patient and discovered that the strange dulling occurred only while the man faced east and west, but that when he was aligned north and south the percussion note was continuously resonant. There seemed to be a relationship between the geomagnetic field and—as with the grains researched by Pittman in Alberta—the electromagnetic fields of individuals. Abrams later discovered a similar effect was produced by a man with a cancerous ulcer of the lip, even when the X-ray machine was not operating.

After several months of experimentation with persons afflicted with various maladies, Abrams concluded that nerve fibers in the epigastric region not only react by contracting to the stimulus of X-rays generated from a machine several yards distant, but appear to be in a state of permanent contraction in the case of a patient suffering from cancer, except when the patient is oriented in a north-south direction. Because of this similarity, Abrams concluded that the contractions, due in the first case to radiant energy rippling from an X-ray instrument, were in the second case taking place in response to vibrating molecules which were collectively forming the cancerous growth.

Abrams asked his houseboy, Ivor, who had accompanied him to class, to step onto the lecture platform, strip to the waist, and face west. As he tapped the boy just above the navel, Abrams told his students to listen carefully to the hollow, resonant quality of the note he was obtaining. He then asked one young doctor to hold a specimen of cancerous tissue in light contact with Ivor's forehead, applying it for a few seconds, removing it, and applying it again. As Abrams continuously percussed the abdomen, the class was amazed to hear the note change from resonance to dullness each time the specimen was placed on Ivor's forehead, apparently because of a contraction of muscle fibers. When Abrams substituted a tuberculous specimen for the cancerous one, the resonance of the note did not change. But when he began tapping an area just below the navel, the same effect was produced. Abrams was forced to the conclusion that unknown waves from diseased specimens could be received and recorded by a healthy human body and that they somehow altered the character of its tissues.

After months of work, Abrams was able to show that a series of what he called "electronic reactions," varying from cancerous and tuberculer to malarial and streptococcal, could be pinpointed on different areas of the trunk of a healthy person like Ivor. This led him to proclaim that the time-honored idea that disease was of cellular origin was out of date and must be discarded. Instead, he maintained it was because the molecular constituents of cells undergo a structural alteration, specifically a change in the number and arrangement of their electrons, that they develop characteristics which only later become visible at the microscope. Exactly what caused the alteration Abrams did not know, nor does anyone today. He nevertheless suspected that forces could be discovered for correcting what he considered to be intramolecular aberrations, and even for preventing their occurrence.

Abrams next found that the radiation from a pathological specimen could be transmitted, like electricity, over a six-foot wire. When a skeptical doctor challenged Abrams to find the exact location of a tuberculosis infection in his lung for which he had been receiving treatment in a sanitarium, Abrams immediately had the man hold one disc against his forehead and got another student to pass the second disc over the subject's chest until the percussing note changed in tone. The baffled man admitted Abrams had located the infection within centimeters.

Since one spot on the trunk of a healthy subject reacted to not just one but several pathological specimens, Abrams next began to conceive of an instrument which might differentiate between the wavelengths of all specifically diseased tissues. After months of research, he worked out what he called a "reflexophone," an instrument very much like the rheostat—a continuously variable electrical resistor used to regulate current—that could emit sounds varying in pitch and thus obviate the necessity of having to tap a specific point on a body.

Different diseases could now be read from the dial: 55 for a syphilitic specimen, 58 for sarcomatous tissue, and so on. Abrams asked his assistant to mix up the specimens and found he could infallibly select or "diagnose," by checking the readings on his indicator.

Abrams' developments to this point ran not only decades ahead of, but directly counter to, the prevailing medical philosophy of his day. His statement that "as physicians we dare not stand aloof from the progress made in physical science and segregate the human entity from other entities of the physical universe" was as incomprehensible to most of his medical colleagues as were the later pronouncements of Lakhovsky and Crile.

An even more fantastic revelation came when Abrams found he could diagnose the ills of the human body with his instrument from a single drop of the body's blood. Furthermore, by apparently inducting the

effect from one reflexophone to another which contained three rheostats calibrated in units of 10, 1 and 1/25, he was able to determine not only from what disease a person was suffering but *to what stage it had advanced.*

Even more fantastic, Abrams found that if a woman was afflicted with a breast cancer, he could determine from her blood spot alone in which breast the cancer was located, merely by having a healthy percussed subject point with his fingertips to his own breasts. In exactly the same way, Abrams could reveal the exact site of tubercular or any other diseased condition whether focused in the lungs, bowel, bladder, one of the vertebrae; in fact, wherever in the body.

One day while Abrams was demonstrating to a class the reaction induced by the blood of a malarial patient, he suddenly turned and said, "Well, there are upwards of forty of you physicians present, and probably all of you would prescribe quinine to a patient suffering from this disease, but can any one of you offer any scientific reason for so doing?" There being no reply, Abrams took out a few grains of sulfate of quinine and put them where the blood drop had been in the device. It produced exactly the same percussion note as malaria. He then placed the malarial material in the container *together* with a grain or so of quinine wrapped in tissue paper. Now the percussion which had produced a dull sound indicating malaria gave a resonant sound. To his amazed class Abrams put forward the suggestion that radiations emitted by quinine molecules *exactly canceled* those from malarial molecules, that the effect on malaria of quinine was due to an unsuspected electrical law which should become the subject of intensive research. Various other known antidotes behaved similarly—mercury against syphilis, to cite but one example.

Abrams knew that if he could devise a wave-emitting instrument, similar to a wireless broadcasting station, which could alter the character of the waves transmitted by malarial or syphilitic tissue, he might cancel them out as effectively as did quinine or mercury.

Though at first he believed "this was beyond the wit of man," he eventually built an "oscilloclast" with the help of a friend, Samuel O. Hoffman, a distinguished radio research engineer who had achieved fame in World War I by devising a unique method for detecting German zeppelins approaching the U.S. coast even at a great distance. This oscilloclast or "wave breaker" could emit specific waves capable of curing human afflictions by apparently altering or canceling out radiations emitted by various diseases. By 1919 Abrams began teaching its use to physicians, who, because neither they nor Abrams could exactly explain how it effected cures, regarded it as nothing short of miraculous.

In 1922, Abrams reported in the *Physico-Clinical Journal* that for the first time he had effected over telephone wires the diagnosis of a patient miles away from his office, using nothing more than a drop of blood from the patient and analysis of its vibratory rates by his instruments. This somewhat eerie claim finally aroused the ire of the AMA, which published a defamatory article impugning Abrams in its journal as a quack, an article which was parroted in England in the *British Medical Journal.* This caused Sir James Barr, past president of the British Medical Association, who had been successfully using Abrams' methods in his own practice, to write in reply: "You very seldom quote from the *Journal of the American Medical Association* and one might have expected that when you did you would have chosen a more serious subject than an ignorant tirade against an eminent medical man, against, in my opinion, the greatest genius in the medical profession." Barr concluded that one day "medical editors and medical men will begin to perceive that there was more to Abrams' vibrations than was dreamt of in their philosophy."

Abrams' greatest discoveries were that all matter is radioactive and that the generated waves can be picked up across space by using human reflexes as detectors; also, that in many conditions of disease dull patches are consistently found at specific spots on afflicted patients' bodies.

When Abrams died in 1924, the vilification against him continued in the United States in eighteen separate and consecutive issues of *Scientific American.* One of the worst insinuations was that the "Abrams box" had been devised for no other purpose than to make a financial killing by selling it to naïve physicians and an unsuspecting public. No one noted that Abrams, a millionaire in his own right, had written to Upton Sinclair, one of his American defenders, that he would donate his devices to, and work unremunerated for, any institute which would develop the "Abrams box" in the interests of humanity.

The sanctions against Abrams and his work scared off all but a small minority of American doctors, most of whom were independent-minded chiropractors or, as they like to be called, "drugless physicians."

But a generation after Abrams' death one of these, living in the San Francisco Bay area, was visited by Curtis P. Upton, a Princeton-trained civil engineer whose father was a partner of Thomas Alva Edison. Upton's engineering mind led him to wonder whether the strange device used to cure human affliction might not be applied to pest control for agriculture. In the summer of 1951 he and his Princeton classmate William J. Knuth, an electronics expert from Corpus Christi, Texas, drove into the cotton fields of the thirty-thousand-acre Cortaro-Marana tract near Tucson, Arizona. Together they unloaded from the back of their truck a mysterious boxlike instrument about the size of a portable radio, complete with dials and a stick antenna. Only this time they went one better than Simoneton and McInnes. They would attempt to affect the field not directly but through the medium of photographs.

An aerial photograph of the field was placed on a "collector plate" attached to the base of the instrument, together with a reagent known to be poisonous to cotton pests. The dials were set in a specific manner. The object of the exercise was to clear the field of pests without recourse to chemical insecticides. The theory behind the system—as "way out" as anything so far reported on the nature of plants—held that the molecular and atomic makeup of the emulsion on the photograph would be resonating at the identical frequencies of the objects they represented pictorially. Though the American engineers did not know it, the same discovery had been made by Bovis in the 1930s. By affecting the photograph with a reagent known to be poisonous to cotton pests the Americans believed the cotton plants in the field could be immunized against the pests. Because the amount of poisonous reagent used was infinitesimal compared to the number of acres photographed, the reagent was thought to act in the same way that trace dosages of dilution function in Homeopathic Medicine.

Homeopathy is a method of treatment founded by Christian Samuel Hahnemann, a physician of note born in Meissen in Saxony in 1755. Hahnemann, who was also a chemist, a linguist, a translator of medical works, and the author of a comprehensive apothecaries' lexicon, got himself into serious trouble with the then equivalent of the FDA by his discovery that small doses of what can cause the symptoms of a disease in human beings can also cure them. The original discovery was made by chance when the Countess of Cinchon, wife of the Spanish Viceroy to Peru, was relieved of malaria with an infusion of bark from a local tree which produced symptoms in her identical with those of malaria. Thereafter known as "cinchon bark," the remedy was sold by monks in Spain to the rich for its weight in gold and given to the poor for nothing.

Spurred by this novel approach to medicine, Hahnemann made a methodical search for plants, herbs, barks, or any substance, including snake venom, which could produce symptoms similar to those of a known disease, and by administering them in small doses produced some near miracle cures. He found belladonna to be a remedy against scarlet fever, pulsatilla against measles, and gelsemium against influenza. Quite as extraordinary as Hahnemann's cures was his next discovery, that the more he diluted a remedy the more potent and effective it became, even if diluted to an infinitesimal one million to one. Rudolf Hauschka explains the phenomenon by suggesting that if matter is a condensation or a crystallization of cosmic forces, these forces would naturally revert to being more powerful as they were liberated from their material casing like jinns from a bottle.

A careful chemist, Hahnemann would start by diluting the tincture of some bark, root, resin, seed, or gum with ninety-nine parts of pure alcohol. This would give him what he called a one-centesimal potency. He would then dilute one part of this liquid into ninety-nine parts of a diluent. The third time round he would have a tincture that was only one millionth part of the diluent. The result, for some even to him mysterious reason, was far more potent. Hauschka explains part of Hahnemann's secret as being in the rhythmic, mathematical fashion in which he shook his dilutions, rhythm having the same effect it has on humans of freeing the spirit from the clutches of the body.

But the authorities made short shrift of Hahnemann. Already in bad odor with his fellow physicians because he considered bleeding and cupping his patients to be a crime, Hahnemann next incurred the wrath

of his fellow apothecaries when they saw the threat to their profits from the sale of drugs in such minute quantities. The moment Hahnemann's discovery was given to the public in the journal of Goethe's personal physician, Dr. Hufeland, the Guild of Apothecaries (forerunners of today's pharmacists and the "detail men" who each year press hundreds of new pills on doctors) saw to it that Hahnemann was brought before a court, found guilty, forbidden to dispense medicine, and compelled to leave town.

In Tucson in 1951, it would have been hard to find a scientist who would bet the small change in his pocket that Upton and Knuth's protective process could offer them any safeguards against marauding pests. Yet the two engineers pursued their course, repeating the process with aerial photographs covering the entire four thousand acres owned by the Cortaro Management Company, one of Arizona's biggest cotton growers. The company executives were gambling that, if the twelve varieties of pests that normally attacked their million-dollar crop could be kept at bay with so simple a device, they could save up to $30,000 a year in operating costs by eliminating the use of insecticide sprays.

In the fall, the Tucson *Weekend-Reporter* ran an illustrated two-page spread headlined: "Million Dollar Gamble Pays Off for Cotton Man." The article stated that a "Buck Rogers type of electronic pest control" had allowed Cortaro to achieve an almost 25 percent increase in per-acre yield of cotton over the state average. W. S. Nichols, president of the Cortaro Management Company, stated in an affidavit that the treated cotton also seemed to have approximately 20 percent more seed: "This may possibly be the result of not destroying the bees, upon which the radionic process seems to have no effect." Nichols further remarked that his hoe hands had noted an almost complete absence of snakes in the areas subjected to the strange treatment.

On the East Coast of the United States, one of Upton's Princeton classmates, Howard Armstrong, who had become an industrial chemist with many inventions to his credit, decided to try his friend's method in Pennsylvania. After taking an aerial photograph of a cornfield under attack by Japanese beetles, he cut one corner off the photo with a pair of scissors and laid the remainder together with a small amount of rotenone, a beetle poison, extracted from the roots of a woody Asian vine which the Japanese call "roten," on the collector plate of one of Upton's radionic devices.

After several five- to ten-minute treatments with the machine's dials set to specific readings, a meticulous count of beetles revealed that 80–90 percent of them had died or disappeared from the corn plants treated through the photo. The untreated plants in the corner cut away from the photo remained 100 percent infested.

After witnessing this experiment, B. A. Rockwell, director of research for the Pennsylvania Farm Bureau Cooperative Association in Harrisburg, wrote: "To control insect pests at a distance of thirty miles with no danger to man, plants or animals would perhaps be an accomplishment heretofore unrivaled in the scientific control of insects injurious to vegetation. To an individual with 19 years experience in the research field this feat appeared unreal, impossible, fantastic, and crazy. Yet careful counts by the writer of the treated corn plants and untreated corn plants indicated definitely that the kill ratio was 10 to 1 in favor of the treated plants."

Upton, Knuth, and Armstrong combined their talents and the first letters of their names to form UKACO, Inc. The new company's goal was to relieve farmers of unwanted pests by the new method, as scientifically inexplicable as it was simple and inexpensive. The company received the backing of General Henry M. Gross, one of Harrisburg's most distinguished citizens, head of the Selective Service Board for the State of Pennsylvania.

In the West, Upton and Knuth contracted with forty-four artichoke growers to treat their crop against plume moths. The contracts were written on the basis of "no control—no pay." All the growers paid the service charge of one dollar an acre, a tiny fraction of the costs of conventional spraying. In Pennsylvania Rockwell stated: "Since farmers usually do not pay for a service unless there is value received, this is the best testimonial for the UKACO process which has come to my attention."

Convinced that a radical new development for controlling pests was in the offing, Rockwell arranged contracts with his fellow farmers to run

a long series of experiments under his supervision. In 1949 at the cooperative's "Camp Potato" in Potter County, and at the Fairview farmstead in Easton, potato crops treated by the UKACO process yielded 30 percent more than those fields sprayed seven times with conventional insecticides, the saving in chemicals also greatly adding to the value of the crop.

The following year the Farm Bureau's research division operatives, having learned to operate the UKACO equipment themselves, got yields 22 percent greater than in the insecticide-treated fields. In tests at Hershey Estates Farm No. 40, and the bureau's own poultry farm, a pair of cornfields showed, by actual count of cornstalks, 65 percent control of second-brood European corn borer, an efficiency never approached with any other treatment.

In Eatonville, Florida, the director of agriculture for the Hungerford School for Boys, a graduate in agriculture from Tallahassee University, also successfully used the UKACO method to eliminate pestilent worms from the school's cabbage patch and flea beetles from its turnip plants.

At this point, the new insecticideless method of treating crops piqued the curiosity of the United States Department of Agriculture's research station at Beltsville, Maryland, one of whose officials, Dr. Truman Hienton, called General Gross to say that he would like to find out exactly how UKACO was achieving its results. When Hienton and two of his Ph.D. colleagues arrived in Harrisburg, they were informed that the principle behind the machine seemed somehow to be related to that of radio broadcasting. But when UKACO's Howard Armstrong was asked at what wavelength he was broadcasting his treatments, he could only say he did not know. The mystified scientists shook their heads dubiously and returned to Beltsville.

In the summer of 1951 Armstrong traveled through the Cumberland Valley treating corn and anything else the farmers wanted him to treat. He was so successful that when insecticide salesmen visited the farms under treatment they were informed their products were no longer needed. The farmers themselves operated many of the treating devices which were left by Armstrong on their farms. This evidently raised the hackles of the American insecticide industry, which responded that winter to UKACO's new technology in the same way that the British fertilizer industry had to Sir Albert Howard's recommendations. *Agricultural Chemicals*, the industry's mouthpiece, printed an article in its January, 1952, issue, panning the UKACO process as fraudulent. When asked about the article's claim that his test results could not be duplicated by "disinterested agencies," the Pennsylvania farm bureau's Rockwell replied: "I've studied enough science to know a dead Japanese beetle when I see one."

In March of 1952, fifty York County agricultural leaders assembled, with a skeptical glint in their eyes, to hear R. M. Benjamin, executive secretary of the Pennsylvania Farm Bureau, tell them during a two-hour meeting how they could kill or chase away various insect pests by what seemed to be remote electronic control. Benjamin supplied testimonials to back up his story, one of them signed by the Secretary of Agriculture for Pennsylvania, Miles Horst, who reported highly effective results on a rose-of-Sharon bush in his garden which had been infested by Japanese beetles. Though many in the audience at first heckled Benjamin, and one jeeringly remarked that perhaps the cornfields should be injected with "a dose of faith," before the end of the meeting all present became convinced that the new methods should be given a trial the following summer.

When the York *Dispatch*, which had printed an account of the meeting, requested an opinion on the UKACO process from the U.S. Department of Agriculture in Washington, it was surprised to learn that the department put no faith in the process. F. C. Bishopp, assistant chief of the Agricultural Research Administration's Bureau of Entomology and Plant Quarantine, claimed in a letter that one of the bureau's field men had observed the experiments run by Knuth and Upton in the Southwest and found that the insects were *not controlled*. Bishopp added that "though we have not had an opportunity to carefully examine the device, or conduct any properly designed tests of it . . . a number of adverse reports on tests set up by the company have also reached us." He cited an article in the *Arizona Farmer* headlined "Electronic De-Bugger Flops—Promoter of Magic Black Box Leaves Texas Panhandle When Cotton Farmers Find It Didn't Work."

A week later, Bishopp, realizing that tests planned for the summer of 1952 were to proceed as scheduled and, evidently feeling that he had not made his point convincingly, wrote a second letter to the York *Dispatch*, in which he stated in part: "From our limited knowledge of the use of radiation in control of insects we frankly feel that the claims of this company are exaggerated. The question naturally arises as to why the company should proceed with large-scale tests without having competent authorities evaluate the method. We are anxious that unsound methods not be permitted to divert the farmer's attention, at this critical time, from recognized sound insect control practices." Bishopp's aim was evidently to use his authoritative position to prejudge and condemn a process of which he admitted he had no firsthand knowledge.

Rockwell never denied that the radionic process was *not always* successful. He himself stated plainly to the newspaper that certain tests could fail because of interference from standing irrigation pipes, high-tension wires, leaky transformers, wire fences, radar, plant pots, and various soil conditions, and added that, because the patents for UKACO devices had not yet been granted, he was not at liberty to turn one over to the Beltsville research center.

The same spring, the three UKACO partners and General Gross organized a nonprofit foundation to carry on their pest-control work. Because of the homeopathic quality of the reagents used, the nonprofit entity was called the Homeotronic Foundation, at the suggestion of Dr. William J. Hale, former chief of research in organic chemistry for the Dow Chemical Corporation.

In the meantime, despite Bishopp's statements, the USDA's Dr. Hienton again called General Gross to say that he had heard extremely favorable reports on Armstrong's work in the Cumberland Valley the previous year and wondered what his Beltsville agricultural research station could do to assist UKACO's further efforts. Gross suggested that the government research body send five representatives to work all summer with five UKACO operatives, each one of whom was to treat fields in a separate Pennsylvania county. By constant observation of the method of treatment and results obtained, they should be able to determine firsthand whether the UKACO work was all that it claimed to be.

Instead of accepting Gross's offer, Hienton decided to commission a USDA field worker in New Jersey, Dr. E. W. Seigler, and an assistant to oversee the UKACO operations on a sporadic basis.

During the 1952 growing season field corn was treated on 1,420 acres belonging to 61 farmers on 81 separate holdings in five counties; 78,360 individual corn stalks were examined. Officers of the new Homeotronic Foundation worked with several Pennsylvania Farm Bureau officials and one from the Farm Bureau Association of the State of Ohio.

The USDA officials finally put in an appearance on August 7. Dr. Seigler randomly selected one cornfield in York County owned by the Bittinger Cannery and checked the treated corn against the untreated. In four rows totaling 400 plants he found 346 silks damaged by beetles in the untreated section but only 65 silks damaged in the treated section. In another field, owned by the Pennsylvania Farm Bureau poultry farm cooperative, results were 339 and 64. Checks in other areas also testified to the success of the new methods, with the exception of one field where the process inexplicably did not seem to work. Overall results indicated that 92 percent success in the control of Japanese beetles, and 58 percent for corn borers was achieved.

The UKACO team was happy that the results had now been checked by the United States agricultural authorities. But the USDA's Dr. Seigler asked UKACO to refrain from publishing any results in the *Pennsylvania Farm Bureau Journal* until Beltsville had had time to issue their own report. When, after a number of weeks, no report was forthcoming from the USDA research station, General Gross called Beltsville to ask for thirty copies. Instead of mailing them, Bishopp sent a curt letter to Rockwell stating that, since no count had been made *before* the treatment had begun, the reports sent back from Pennsylvania by his own research men were valueless.

As the Pennsylvanians knew that Beltsville was well aware that the pictures had been taken and treatment started long before there was any appearance of either corn ears or Japanese beetles, they found the attitude of the USDA surprising. It seemed that the USDA was intent on killing the UKACO process in the bud. When several very large prospective customers called Beltsville for an opinion about it, they were

informed that the whole thing was a fake that had produced no results whatsoever.

Armstrong next learned from the West Coast that representatives of insecticide companies in concert with USDA employees had been visiting farmers who used the UKACO process and telling them it was an outright fraud. The UKACO team came to the conclusion that Beltsville was directly and intentionally preventing them from proceeding with their work and that lobbyists of the insecticide industry in Washington were putting extreme pressure on the government to stamp out the new pest-control methods which were so dangerously threatening to put them out of business. So effective was the campaign that UKACO had difficulty soliciting new clients among farmers, who were becoming convinced by an army of USDA agents that there was nothing to the Upton-Knuth-Armstrong treatments.

Meanwhile Upton, whose patent application had been rejected for "lack of convincing evidence in the record from qualified experts with scientific backgrounds," submitted a twenty-two-page addendum to support his claim. The addendum pleaded that "it is difficult to precisely define the nature and mechanism of the novel methods" and postulated that the process "comprehends the study and use of certain fundamental energy sources capable of affecting molecules, atoms and electrons through their characteristic harmonic potency resonance frequencies in which every particle of matter exhibits its own characteristic frequency under a controlled polarity in a magnetic field of motion."

In support of their allegations, the inventors cited the work of Dr. Edward Purcell, co-winner with Dr. Felix Bloch of a 1952 Nobel Prize in physics, who published an article in the November 15 issue of *Science News Letter* on the characteristic resonant frequency of elements when resonated in selected magnetic fields, and a report on the work of Dr. Bloch, wherein he succeeded, by a process he designated "nuclear induction," in turning atomic particles into what, in effect, were infinitesimal radio transmitters, whose broadcasts, if highly amplified, could be detected in loudspeakers. There was little doubt in Upton's mind that his "radiotonic treatment," as he called it, made use of the type of energy involved in the Bloch study, which, as Upton wrote, had "not heretofore been recognized by science—particularly in its applications to molecular structures of the complex nature of plant and animal life."

Holding that the work of electronic experts and the detection of potentials by means of delicate apparatus had long since proven the existence and the measurability of various amplitudes of electrical potentials in living creatures, Upton referred to the writings of Drs. George Washington Crile and Harold Saxton Burr.

When all this failed to get the patent accepted, General Gross brought into play his contacts on the boards of some of the nation's largest industrial companies and was able to introduce the process to the consideration of important scientists in the U.S Government, including Vannevar Bush, science adviser to President Eisenhower. When Gross explained to them UKACO's accomplishments and said they were based on the idea that every particle has its own generic frequency, as Dr. Crile had so stoutly maintained, the scientists responded heatedly that the UKACO-obtained results were impossible.

Though Gross politely suggested that the scientists come to Harrisburg and talk with Rockwell and the farmers whose crops had been "radiotonically" protected and see the results for themselves, they declined his invitation. Gross had no more success with the director of the Carnegie Institution in Washington, who flatly told him that there was nothing in the science of electronics to suggest that the UKACO process could work.

Dr. Willard F. Libby, who devised the carbon-14 dating technique, and who was soon to win the Nobel Prize in chemistry, after hearing Gross out, discouragingly yet perhaps accurately told him that it would take more than a million dollars to research the "box."

What also may have alarmed the government was the idea that if a host of insects could be affected, even killed, simply by radiating a poison at them via a picture of the plants which they were attacking, then the same technique could be militarily applied to concentrations of troops or even the populations of whole cities in wartime. All this discouragement, added to the studied and seemingly successful efforts of governmental and industrial moguls to wean farmers away from the new approach to insect control, finally forced UKACO to close its doors. But the story of what came to be called "radionics" was only beginning.

Thirty years before the demise of the UKACO enterprise, a young engineer for the Kansas City Power and Light Company, T. Galen Hieronymus, who was one of the first to be granted an amateur radio operator's license before World War I, was asked by one of his neighbors, a Dr. Planck, to machine various parts for some instrumentation which required precise components, such as strips of silver plate, cut to exact proportions down to the millimeter, and carefully wound coils. Beyond referring to a mysterious medical genius in San Francisco with whom he had studied fantastic new techniques to treat disease, Planck did not enlighten his young machinist as to the purpose of the new instruments he was helping to build. It was only after Planck died and his wife asked Hieronymus to come to the house to look over a workroom full of strange equipment and, because she had no use for it, select whatever he wanted, that Hieronymus learned the real purpose of the equipment he had been machining, and that the name of the unknown surgeon was Albert Abrams.

Meanwhile a vivacious young Los Angeles chiropractor, Dr. Ruth Drown, was also making refinements on Abrams' devices. Drown's most startling accomplishment was her development of a camera which could be used to take pictures of organs and tissues of patients using nothing but a drop of their blood, even when the patients were hundreds or thousands of miles from her office. Even more startling, she could take pictures in "cross-section," which cannot be done with X-rays. Though she received a British patent for this twenty-first-century apparatus, Dr. Drown's claim was relegated by FDA authorities to the realm of science fiction and her equipment was confiscated in the early 1940s. To make sure that her plight was suitably publicized, the same authorities saw to it that reporters from *Life* magazine were on the scene. After the *Life* story presented her as a charlatan, Dr. Ruth Drown died of grief—an unrecognized genius.

While Drown was working in California, still another of Abrams' followers, a Chicago doctor, G. W. Wiggelsworth, with the help of his brother, an electronics engineer who at first looked upon the oscilloclast as an outright fraud but finally became convinced of its efficacy, went on to improve the "Abrams box" by substituting for resistance coils variable condensers, a change which he found vastly improved the tuning. Wiggelsworth christened his new device a "pathoclast" or disease breaker, the users of which banded together into a Pathometric Association.

In the 1930s Glen Wills, an Arkansas chiropractor, successful businessman, and promoter, who pioneered the method of raising broiling chickens in cages or "batteries," heard Hieronymus lecture on electronic theory before the Pathometric Association. Wills bought out Wiggelsworth's Pathometric Association and asked Hieronymus if he could build a modified and more complex version of the pathoclast.

Hieronymus had earlier made a detailed study of his own of strange energies emitted, not from healthy or diseased tissues, but from metals. Working on his theory, he took sterling-silver objects, such as broken spoons, pepper-and-salt shakers, and anything else he could steal from his wife, and buried them in the Kansas prairie.

Knowing the location of the hidden silver, Hieronymus then "worked backward," as he says, trying to find the emanations from it. To his surprise, he discovered that every so often he could find *no energy* emanating from the silver, and wondered if someone might have dug up his hoard. A few hours later the energy would be radiating as strongly as ever.

Hieronymus' eclectic mind next wondered whether the energy was undetectable at given times because it was radiating not upward out of the earth but downward toward the earth's center. To find out, he took an eight-foot copper-clad steel ground rod and sledge-hammered it at an angle into the ground so that it would extend below the silver hoard. When the rod was at the level of the silver or below it, his device, to which the rod was attached, indicated a surge of energy; when he pulled the rod some distance above the silver, no energy was registered.

By repeatedly taking measurements over weeks, Hieronymus found that the energy from the silver seemed to be diverted downward for a few hours every two and a half days. Checking in an almanac he discovered that the cycle of diversions in some ways correlated with phases of the moon. What Pfeiffer had discovered about lunar influence with respect to plants seemed also to be applicable to metals.

Further work with buried metal also convinced Hieronymus that

these energies were, like those in Abrams' experiments, strongly influenced by magnetic attraction. Thus, at least two twentieth-century researchers, one a medical man, like Mesmer, the other a laboratory researcher, like Reichenbach, appeared to have rediscovered the link between mineral magnetism on the one hand and "animal magnetism" on the other.

Hieronymus suspected that the unknown energy emitted from metals might be somehow linked to sunlight; since it could be transmitted over wires, it might have an effect on the growth of plants.

To find out, Hieronymus placed some aluminum-lined boxes in the pitch-dark cellar of his Kansas City house. Some boxes he grounded to a water pipe and connected by separate copper wires to metal plates on the outside of the house exposed to full sunlight. Other boxes were left unconnected. In all of them Hieronymus planted seed grain. In the connected boxes the seeds grew into sturdy green plants. The seeds in the unconnected boxes had no trace of green and were anemic and drooping.

This brought Hieronymus to the revolutionary conclusion that whatever caused the development of chlorophyll in plants could not be sunlight itself but something associated with it, which, unlike light, was transmittable over wires. He had no idea at what frequency this energy might be located on the electromagnetic spectrum, or even if it was related to it.

As Hieronymus continued to build instruments for the doctors, and to experiment with them, he grew more and more convinced that the energy being modulated by the devices had little to do with electromagnetism. This notion became a certainty when he found the device itself was short-circuited if bathed in light rays from the sun just as electrical circuits in a radio are shorted by being plunged into a bath of water.

Hieronymus next designed a special analyzer, first with lenses, finally with a prism, by means of which he could identify, from the radiations they emitted, many of the elements on Mendeleyev's periodic chart. He found that the energy, when refracted through a prism, behaved in the same manner as light, except that the angles of refraction were much more acute, and that the energy from various elements came through at angles of refraction in the same order as the contents of their nuclei. His ability to detect a substance from its radiation alone convinced Hieronymus that disease was destroyed by the Abrams device and its descendants "through a radiative attack on the binding energy which holds molecular structures together."

The frequency of emanation, or angle of refraction, is in exact proportion to the number of particles in the nucleus of an element, says Hieronymus. The range of frequencies or angles of refraction from complex substances can thus be used to disclose what they contain. The energy emitted does not, like electromagnetic energy, attenuate inversely as the square of the distance from its source. It radiates out only a certain distance depending on the object from which it is emitted, on the direction it takes, and even on the time of day of its measurement. Something varies the amount of radiation emitted in the same way that fog, smoke or other materials altering the density of the air in our atmosphere vary the intensity of light from whatever source.

Trying to describe this radiation Hieronymus first came up with the cumbersome explanation: "Energy obeying some of the laws of *electricity* but not all of them, and some of the laws of *optics*, but not all of them." To obviate the repetition he finally coined the term *"eloptic energy."*

This energy, he concluded, though independent of, was somehow affiliated with, electromagnetic energy. Because of the difference, Hieronymus inferred that their spectra of frequencies were necessarily related. He decided to refer to eloptic energy in all its wavelengths as a *fine medium* which, as he wrote, "might be the same as that which used to be described by electronic engineers and physicists as 'the ether' put in action at higher harmonics than so far experienced."

In the early 1940s Hieronymus applied for a patent. The invention to which he put claim was basically a method and an apparatus "relating to the art of detecting the presence of, and measuring the intensity or quantity of, any known element of material matter, singly or in combination, whether in solid, fluid or gaseous form." For those who might rush to duplicate his idea, there was an important qualification in the application which stated that the *"apparatus preferably relies upon the element of touch and, therefore, the skill of the operator."*

This was because the operator had to stroke a detector which, substituting for the abdomen of Abrams' subject, was, in the abstruse language required by the patent office: "preferably an electrical conductor coated with a material having such characteristics that under influence of energy flowing through the conducting portion, the coating will change its surface tension or viscosity, or in some manner give evidence of the presence of the energy flowing through the conducting portion by producing a greater drag or resistance to the movement of any part of the body of the operators thereover, such as the hand or fingers."

What actually happened at the detector, to increase and decrease its drag at the touch of the operator, was not understood, but, as the text lamely explained, "the apparatus functions . . . and, therefore, a positively acting analyzer for atomic radiations is produced even though the principle upon which it is based is not fully known."

When he was invited in 1946, less than a year after Hiroshima and Nagasaki had been blasted, to describe his new process over Kansas City's radio station WHAM, Hieronymus paid full tribute to Abrams. "About twenty years ago a discovery was made by a California man," he said, "that was so hard to believe and more especially by those who did not wish to believe it, that the world was set back by their disbelief for many years. There were a few of those following along who took the original idea to the point where today it is as important, in fact, more important to mankind than the atomic bomb because the latter means destruction of humanity and the other idea means the lengthening of life and the alleviation of disease."

The bacteriologist Otto Rahn, whose book on radiation from living things had so puzzled his colleagues ten years before, after examining Hieronymus' process and experiments, wrote to the inventor: "Since those radiations hold the secret of life, they also hold the secret of death. At present, very few people know about the possibilities, and very few know *all* the facts. It seems imperative that those few keep their knowledge to themselves, and divulge only as much as is necessary to perform the immediate applications to cure disease. Your discoveries open up great possibilities, as tremendous as those of the atom bomb, and just like atomic energy, these radiations may be used for the bad as well as for the good of humanity." In the meantime, the *Saturday Evening Post* published a rehash of the more than twenty-year-old *Scientific American* series in a snide article "The Wondrous Box of Dr. Abrams," authored by a Robert M. Yoder, who falsely claimed that Abrams had risen to "fame and fortune selling a sealed box."

Part of the motive for this hatchet job was revealed by Hieronymus in his answering letter to the *Post's* editor, Ben Hibbs. "This is a controversial subject," wrote Hieronymus, "only because it involves the pocketbook of a large group of people who might be harmed financially should the truth of the present day status of the little black box be made generally known to the public. The unfortunate part of the situation at the moment is that a large pressure group is still fighting tooth and nail to keep the known facts from being presented and I just wonder if the article in the *Saturday Evening Post* wasn't instigated by that group."

The letter appeared in a booklet, *The Truth about Radionics and Some of the Criticism made about it by its Enemies*, published by a group which, because it applied the new term "Radionics" to the therapies being practiced on the basis of Abrams' finding, called itself the International Radionics Association.

In 1949 Hieronymus was awarded United States patent number 2,482,773 for the "Detection of Emanations from Materials and Measurement of the Volumes Thereof." Other patents were later issued in the United Kingdom and Canada.

The story of UKACO and the Homeotronic Foundation is further complicated by the fact that, at one point during the work, Hieronymus went to Harrisburg to consult with and assist Armstrong and his collaborators. Hieronymus told the authors that the device incorporating the amplifier which he had built for Wills was used in Pennsylvania with almost 100 percent success. However, according to Hieronymus, the UKACO group could not understand his notion that a new "eloptic energy" might be involved and preferred to proceed on the theory that the device worked solely on electromagnetic or electronic principles.

When they made further adaptations on his device, says Hieronymus, they began to get less than perfect results. The lack of a perfect record, however, was more than overshadowed in Hieronymus' eyes by observations which shook him profoundly. At the Hershey farms, together with

a UKACO representative he selected three ears of corn on each of which a corn worm was munching.

Isolating the ears so that the worms could not escape, Hieronymus began to treat them with his radionic broadcaster. He states that, after three days of treatment for ten minutes per hour round the clock, two of the corn worms were reduced to mush but the third was still wobblily intact. Another twenty-four hours of the same treatment and the stubborn worm was also mush. All that remained of the others was just "wet places" on the corn ears.

Hieronymus was so stunned by the lethal potential of the tuned radiation that he resolved never to reveal everything about the makeup of his devices or their operation until he could one day find serious researchers of impeccable character to help him elucidate the exact potentials of his discoveries.

Having for years measured the states of the human body and its organs radionically, Hieronymus and his wife, Louise, operator of the device, decided in 1968 to check the ongoing conditions of the first men ever to go on a trip to the moon.

They ordered photographs of the three astronauts from Washington and, after inserting them one at a time in their instrument, claimed they were not only able to track and monitor all physiological functions of the astronauts from the earth to the moon and back, but to determine that the transmitting energy could neither be shielded by the metal shell of the capsule nor affected by the great distance from Mother Earth or her satellite. They said they were also able to measure the effects of high "G" stress on the astronauts during take-off and re-entry as well as the effects of living in a weightless—zero "G"—environment for an extended period.

The Hieronymuses' most startling claim was the discovery of what they term a *lethal radiation belt round the moon*, which during the landing of Apollo 11 apparently extended from an altitude of roughly sixty-five miles down to approximately fifteen feet above the moon's surface. While the astronauts were traveling through or within this belt, Hieronymus noted a drop in the vitality as measured by his wife on the "box." But when two of the astronauts got out of the capsule and climbed down the ladder onto *luna firma,* he says the trends showed a spectacular turnaround.

In following later flights of the Apollo series, Hieronymus found that the lower level of the mysterious lethal atmosphere was as high as two miles above the moon's surface. Hieronymus believes further that its altitude may alter depending on a given time period or on its exact position above various spots on the moon's surface, or both, but states that extensive observations will be required to confirm this.

No less interesting was Hieronymus' confirmation that the energy he was picking up from the spacemen appeared not to be related to any of those on the electromagnetic spectrum. When the capsule was on the far side of the moon relative to the earth, no radio or other telemetered signals could be transmitted back to the Houston base. The astronauts were thus out of contact with their earthbound guides. Not so with Hieronymus, who says he was able to monitor them during this period on his analyzer. On the other hand, when the capsule was on the far side of the moon relative to the sun, i.e., in the moon's shadow, radio signals were easily sent to and received from earth, whereas Hieronymus' analyzer went "dead" and could pick up nothing. This seemed to confirm the idea, hit upon by Hieronymus when he was growing plants in his cellar, that the energy received by his analyzer was in close association, if not carried on, sunlight rays.

A German-born engineer, Rolf Schaffranke, working as a propulsion expert for American corporations contracting with NASA in Huntsville, Alabama, who as a young student watched the launching of the first man-made rocket, the V-2, from the secret German base at Peenemünde, wrote of Hieronymus' experiment: "Sounds absolutely crazy. Yet it really happened. Numerous observers are firmly convinced that the experiment is repeatable. Repeatable anywhere, any time, with as many witnesses present as desired."

Wondering whether eloptic energy could be carried not only on light rays from our sun but on those from all cosmic bodies including planets, Hieronymus took a ten-power telescope from an ordinary navigational sextant onto the roof of his house in Lakemont, Georgia, and fixed it so that it could be constantly directed at any spot in the heavens.

After focusing on Venus, he replaced the telescope's eyepiece with a metal disc penetrated by a hole, and soldered a wire to the edge of the disc to conduct what he believed was eloptic energy down into the house to the radionic device operated by his wife. Mrs. Hieronymus began to run tests similar to those which had measured the vitality rates of the astronauts' bodily parts and systems so as to see if there was anything that gave a similar response on the Venusian surface. Of the thirty-five wavelengths received from astronauts' organs and systems, half seemed to be tunable from Venus, the others not at all.

Perplexed by these findings, the Hieronymuses were suddenly struck that they might be receiving energies from parts, not of animals, but of plants. So they began running analyses on the organs of earthly plants *as if they were human beings.*

Checking three trees, a mango, a willow, and a pine, Hieronymus found that while they all had what appeared to be the equivalent of lungs, pineal, thymus, and pituitary glands, adrenals, thyroids, stomachs, a colon wall, a prostate, ovaries, and a nervous system, there were strange differences among them. The mango alone, for instance, seemed to have something akin to a lymphatic system, but, unlike both the willow and the pine, no duodenum or spleen.

Hieronymus next checked Bermuda grass, which he knew does not propagate by seeding itself but extends endlessly underground. Sure enough, no sex organs could be detected for the grass according to his readings, though a weed registered ovaries even when he had removed its seeds. Strangely, the Bermuda grass seemed to have the analog of an appendix.

The readings from Venus set on the tunings for each organ or system, for analog thereof, clearly indicated some structure on Venus similar to that of earthly plants. Hieronymus concludes that there may well be a form of Venusian plant life, though he has no idea what kind, or why the vitality of its organs seems to be more than twice that of the earth plants he has tested; nor has he any idea whether such "plants" may have no more than what occultists call etheric or astral bodies.

By the summer of 1973, as a result of the publication of a series of articles about him and his work in U.S. magazines devoted to the unexplained, Hieronymus began to attract wider interest; his correspondence mushroomed with letters and calls asking for further information.

Still keenly aware of Rahn's post-Hiroshima warning, and remembering with awe the corn borers reduced to no more than "wet spots," Hieronymus is still leery of revealing all he knows. As he stated to the authors: "While we are not intending to hold back scientific investigation, we are not going to broadcast complete information on our technology to the general public so that people can play around with it irresponsibly any more than we would advocate giving dynamite and matches to small children. If a group of responsible people will help us to run a proper and broad investigation of eloptic energy for the good of mankind, I will be glad to cooperate and tell them all I know."

CHAPTER 20

Mind Over Matter

About two decades before UKACO's efforts to help the farmers of Pennsylvania were put to rout by the chemical manufacturers and the USDA, a book appeared in the United Kingdom called *The Chain of Life* by the British surgeon Guyon Richards, who had built up wide experience in medical problems as physician in charge of an entire district for the Indian medical service.

He was stimulated by the theories of a colleague, Captain Sandes, who introduced him to the little-known benefits of ionization and its remarkable effects on the treatment of disease, a branch of science later developed in Germany and more particularly in the USSR, but almost wholly neglected in other countries. Richards became, as he put it, "electrically-minded," and proceeded to make detailed galvanometric studies of plants and people in health and disease. Of Abrams, Richards said it was a pity that the very invention of the oscilloclast had, because its curative properties could not be exactly explained, obscured from the medical profession the important issues which Abrams had raised.

Richards' book restimulated interest in radionics among a small coterie of imaginative British doctors who wanted to experiment with the new healing process. Looking for an engineer who could help them build the strange new equipment, they sought out an "English Hieronymus" and found him in the person of an Oxonian, George De La Warr, a psychically-gifted civil engineer.

Having built a series of instruments covered in black leather, which came to be known as "black boxes," about a year following the demise of UKACO, the work of which they had no inkling, De La Warr and his osteopath wife, Marjorie, found that they could affect the growth of diseased or undernourished plants by focusing "radionic" energy straight at them through a lens system, thus substantiating the claim of Hieronymus, of whom they were also unaware, that it was optically refractable. Like the UKACO partners, the De La Warrs found that they could obtain equally successful results either by directly radiating a plant or by beaming energy to it through one of its leaves or even its photograph. Why this should be so remained a mystery to the De La Warrs, who could only state: "It is still problematical whether it is the apparatus, the photographic emulsion or the presence of a specific operator that produces the effects—or a combination of all these factors."

De La Warr further theorized that in addition to radiations of light the emulsion on the negative receives from the subject other radiations, the precise nature of which was unknown. There was also evidence that a relationship perdured between a plant and a leaf detached from it, or the expressed juice of that plant, just as it existed between one of Abrams' patients and his blood spot.

"It would appear," wrote De La Warr, "that each molecule of matter is capable of producing a tiny electrical voltage that is specific to itself, and which 'transmits' rather like a tiny radio transmitter-receiver. A

collection of molecules, therefore, is capable of transmitting a generic pattern. This means that the signal from a plant or human is quite individual, and that each plant or person will receive a transmission on their own generic pattern. It is here that the photograph plays its part, as it is thought that the emulsion on the negative retains the generic pattern of the object photographed and can be induced to re-radiate as a carrier. Thus, with a photograph of a plant in circuit it is possible to affect that plant at a distance."

The theory was in no way airtight, but the results obtained by radionics were fantastic. Realizing that the presence of living organisms in the soil is a prerequisite to good husbandry, the De La Warrs wondered if they could treat the soil itself through the cells living within it by radiating energy patterns effectively equivalent to plant nutrients. To attempt this they determined to photograph the soil of garden plots, treat the photos radionically, then plant vegetables in the treated soil to see how they would fare.

They began with cabbages. Selecting two sites eighty feet apart, in the curtilage of their laboratory, they removed all the topsoil. This they thoroughly sieved and mixed to eliminate any possibility of soil variation, then spread it back on the sites, allowing it to settle for a week.

On the 27th of March, 1954, they began a month-long treatment of one site by radiating its photograph daily in their darkroom, leaving the other site untreated. This treatment accomplished, they planted four young cabbages, selected for their similarity, into the soil of each site. For two weeks no difference in the rate of growth was observable, causing them to have doubts about the procedure. Thenceforth to the end of June, the cabbages in the treated soil continued to grow larger than those left to grow normally. Photographs taken some four weeks before maturity revealed that the plants in the treated site were *three times larger* than those left to grow normally.

Encouraged by this success, the De La Warrs decided to repeat the experiment on a larger scale. They noticed that in one strip of garden three rows of peas thirty-seven feet long were growing so uniformly as to leave little doubt that the soil was of equal consistency throughout. The peas were uprooted and the site prepared for fresh planting. The strip was divided into fifteen plots, six of which were photographed from a bird's eye view and treated radionically every day for one month. Two plots were left untreated; seven others were used as buffers.

At the beginning of August, ninety-six Early English winter-resisting broccoli plants, all seven inches high, were set out, six to a plot. The radionically treated plots were rephotographed with the plants in them and irradiated daily until the experiment was concluded in mid-January, 1955, after snow and ice had apparently stopped all growth. Accurate weighing of the plants under the scrutiny of an expert from Oxford University's Department of Agriculture, Dr. E. W. Russell, who observed the experiment from beginning to end, revealed that an average 81 percent increase in total crop yield had been obtained for the treated plants compared to the nontreated controls.

After successfully experimenting with lettuces, suggested by Russell because they were fast-growing, the De La Warrs next decided to broadcast treatment from their laboratories to a garden at Old Boars Hill, two miles from Oxford. They laid out an equilateral plot, divided it into four squares, and planted broad-leaf beans in each square. A single square was photographed and irradiated from the beginning of May to the beginning of August, 1955. At the end of the test, the height of the bean plants grown in the treated square was 9½ inches greater than in any of the other squares, and the number of pods greater than for all the other plants combined.

Further to extend the distance between the soil treated and the laboratory, the De La Warrs cooperated with a carrot grower in Scotland. Soil samples taken from seventeen acres of a twenty-two-acre field were irradiated at Oxford each day throughout the growing season. When the carrots were pulled from the earth, those treated weighed out 20 percent heavier than the ones which were left alone. Pleased as they were with the astonishing results they were obtaining, the De La Warrs still had no idea why the radiation from their equipment affected the growth of various vegetables so favorably.

During the next growing season in 1956, they decided to ascertain whether an inert substance, if irradiated and mixed with soil, could reradiate the nutritive energy patterns to the seeds during germination

and growth. The substance they selected was "vermiculite," a micaceous silica sold by the building industry as an insulator, which was both chemically inert and insoluble in water. To treat it they blew it into the air for seven hours in front of a radionic apparatus normally used for therapeutic purposes on humans.

They then mixed the treated vermiculite with a grass-seed mixture containing rye, cocksfoot, and other varieties. The proportions were two parts vermiculite to one part grass seed by weight. The mix was sown in two boxes; an identical mixture, containing untreated vermiculite, was sown in two similar boxes. The soil was the same throughout. The results, as confirmed by a leading agricultural firm, showed that the treated vermiculite produced a crop 186 percent heavier in moist weight, with a protein content 270 percent higher, an extraordinary gain for any farmer.

Milford oats, seeded with treated vermiculite in a yard-square plot at a rate equivalent to 252 pounds to the acre, when harvested five months later produced at an estimated rate of *two tons to the acre* or a crop *270 percent larger* than that obtained from an untreated square. More uncannily, oat seeds grown in a beaker of nothing but distilled water containing not a single nutrient nevertheless grew luxuriously if treated vermiculite was added to the water.

At this point a nationally known plant-breeding establishment requested to perform tests with the treated vermiculite on various types of seed. Under the firm's rigid test conditions, the phenomenal increases in growth obtained by the De La Warrs were no longer apparent.

Instead of dejection, this news brought the De La Warrs to a stunning realization: perhaps the plants had been responding all along *not* to the radiations from their machines but indirectly to the human beings involved in the experiments!

To test this idea they called up the plant-breeding firm and obtained permission to run the very same tests the firm had performed on exactly the same plots. To the amazement of the establishment's horticultural staff, the De La Warrs were successful in increasing growth with treated vermiculite to a significant degree but, try as they would, the professional plant growers could not repeat the De La Warrs' success.

After three years of intense labor with plants, and out-of-pocket costs of some $20,000, the De La Warrs had at last stumbled onto the crux of the problem. A human factor of immense importance was confusing the issue. To determine the extent of this factor they again mixed vermiculite into the soil of potted oats. Their assistants, who daily poured measured quantities of water onto the seeds, were told which pots contained the treated substance, which the untreated. What they were *not* told was that none of the vermiculite used had in any way been irradiated and was as inert as when brought from the supplier.

Though every one of the oat seeds had received no nutrient energy other than that provided by the soil itself, the De La Warrs were excited to note that the seedlings in those pots which the assistants *believed* to contain treated vermiculite were coming up faster than the others. Human belief that a plant might grow faster was apparently acting as a nutrient to actually produce faster growth. Thought was a food!

De La Warr, who considered this experiment the most important he had ever run, found himself face to face with a shattering new reality with the most far-reaching implications: *the mind of a human being could affect cell formation!*

When De La Warr described this experiment to one of Great Britain's leading physicists and suggested that a universal energy could be evoked by the proper attunement of one's thoughts, he was told curtly: "I do not believe you, Mr. De La Warr. If you can affect the number of atoms in a growing plant by your thought process, we must revise our concept of what constitutes matter."

"Indeed we must," said De La Warr, "even if such revision poses a whole overhaul of existing knowledge. How, for instance, could this energy be incorporated into mathematical equations? What would happen to the law of the conservation of energy?"

When De La Warr realized that the real key to getting plants to flourish was simply asking them to do so, he published an article in his journal, *Mind and Matter,* entitled "Blessing Plants to Increase their Growth," asking readers to produce evidence to support his own experimental results, which were so at variance with accepted and current materialistic atomic theory.

One of the most crucial steps in a fifteen-step procedure outlined in the article was that in which the experimenter was to hold bean seeds in his hands and invoke a blessing, varying according to his faith or denomination, in a reverent and purposeful manner. Though warmly received by readers, the article evoked a harsh reply from officials of the Roman Catholic Church, who took umbrage because, as they pointed out, it was inadmissible for anyone below the rank of deacon to perform any act of blessing. Laymen were supposed only to ask the Creator to perform a blessing. To still the waters of protest, the De La Warrs renamed their experiment "Increasing the Rate of Plant Growth by the Mental Projection of an Undefined Energy."

Many of their readers reported success similar to that attained in America by the Reverend Franklin Loehr, whose 700 experiments on the effect of prayer on plants, conducted by 150 persons, using 27,000 seeds, under the auspices of Loehr's Religious Research Foundation in Los Angeles, are reported in his book *The Power of Prayer on Plants.* Loehr showed that the growth rate of plants could be accelerated as much as 20 percent when individuals singly or in concert visualized the plants as thriving under ideal conditions. Though their experiments seemed to be acceptable from the evidence and pictures presented, the results were ignored by scientists on the basis that Loehr and his assistants had no scientific training and used relatively crude methods to measure growth.

However, Dr. Robert N. Miller, an industrial research scientist and former professor of chemical engineering at Georgia Tech, began a series of experiments in 1967 with Ambrose and Olga Worrall, whose feats of healing have become celebrated in the United States. Using an extremely accurate method of measuring plant growth rates developed by Dr. H. H. Kleuter of the United States Department of Agriculture, with accuracies up to one thousandth of an inch per hour, Miller, working in Atlanta, Georgia, asked the Worralls to direct their thoughts at rye seedlings from Baltimore, some 600 miles away.

Whereas the growth rate of a new blade of rye grass had been observed by Miller to stabilize at 0.00625 inch per hour, after he asked the Worralls to think of the seedling at exactly 9 P.M., the trace on a graph indicating growth rate began immediately to deviate upward and by 8 A.M. the following morning the grass was growing at a rate 84 percent faster. Instead of growing the expected 1/16 inch in the interval, the seedling had sprouted more than ½ inch. Miller reported that the dramatic results of his experiment suggest that the sensitive experimental technique could be used to measure accurately the effect of mind over matter.

The mysteries of how the human mind may act through radionic devices such as those of UKACO, Hieronymus, or De La Warr are yet to be explained. In an amazing development, the late John Campbell, editor of *Astounding Science Fiction*—since become *Analog Science Fiction/Science Fact*—determined in the 1950s that a circuit diagram of Hieronymus' machine drawn in India ink worked as well as the machine itself. "Your electronic circuit," he wrote to Hieronymus, "represents a *pattern of relationships*. The electrical characteristics are unimportant and can be dropped out completely."

Voysey, an English dowser, corroborated the evidence by pointing out that if he traces a line with pencil on paper, thinking strongly that this mark will represent a certain metal, his pendulum will react to the drawn line exactly as if it were the metal.

After a prolonged study of radionic devices sponsored by the Foundation for the Study of Consciousness set up by Arthur M. Young, inventor of the Bell helicopter, Frances Farrelly, who ran her own college for medical laboratory technicians, also came to the conclusion that the devices were not necessary to achieve effects. While working in England with a Harley Street physician, she found she could walk toward a patient with her hands outstretched and feel within her own body where the patient had trouble. As she says: "I was beginning to run the instrument in my head, or mentally only." Since then, Farrelly has been able to make diagnoses of ills of individuals not only without a radionics device but without a blood spot or a photograph or anything at all. The mental image of a patient held in her mind is sufficient. She calls this a "resonating reflex phenomenon."

In the summer of 1973 Farrelly's talents were put to test in Prague when one of the participants in the First International Conference on

Psychotronics—a Czech logism for the effects of mental energy on matter—lost a wallet in the cavernous four-story Railway Workers' Building, site of the conference. Within minutes, Farrelly tracked it down, pinpointing its exact location inside a box at the back of a dark closet where a cleaning woman had placed it for safekeeping.

The following day she was confronted by a professor from the Czechoslovak Academy of Sciences who gave her a chip of mineralized rock and asked her before a large audience if she could state its origin and age. Rubbing the table before her to get a radionic type "stick," Farrelly, after putting a dozen questions to herself, stated that the mineral in question came from a meteor and was about 3,200,000 years old, answers which exactly matched the most considered conclusions of expert Czech minerologists.

During her stay in England, Farrelly was intrigued that the De La Warrs seemed to have radionically detected that every living plant has a critical rotational position (CRP), which is apparently established by the earth's magnetic field as the seed sprouts out of the ground. If the seedling is transplanted in such a way that it continues to grow in its CRP, it will thrive better than plants which have been transplanted out of that orientation. This phenomenon was also independently discovered by Hieronymus, who found that a reading on the dials of his radionic device was maximum when the plant was rotated in a given position with respect to a compass rose.

The De La Warrs had also found that, because of this apparent relationship with the geomagnetic field, a plant has a pattern of radiation around it. Nodal points within this pattern or web which seem to concentrate the field of radiation can be located by a portable detector with a probe and a rubbing plate similar to that on their radionics device.

In England Frances Farrelly found that with a simple dowsing pendulum she could locate on a tree and in the domelike geometric pattern around it nodal points of energy which could expose X-ray film.

This field of energy may be related in some way to a magnetic field, since both can be detected with dowsing methods. In Lorton, Virginia, the authors witnessed the incredible sensitivity to a magnetic field as displayed by Wilhelm de Boer, a *Rutenmeister*, or master dowser, who lives in the Hanseatic city of Bremen, West Germany. When Dr. Zaboj Harvalik asked de Boer to walk through a magnetic field which could be switched on or off, each time the field was on de Boer's tiny dowsing rod delicately held in his fingertips would revolve. When the field was off, the rod would not move.

With the same rod de Boer measures the auras of trees and people. First backing off from a large oak, he then advanced toward it until he was about twenty feet away, at which point the rod flipped downward. On a smaller tree de Boer had to approach more closely before there was any reaction from the rod.

"This energy coming out of a large oak can temporarily increase the strength of a human aura, or a person's vitality," said de Boer, demonstrating that it extended some nine to ten feet outward from Harvalik's chest but was double that length after Harvalik hugged a big oak for two minutes. De Boer related how the "Iron Chancellor" of Germany, Bismarck, at the advice of his personal physician, would put his arms around a tree for up to half an hour to recover from the fatigue of pressing duties.

Harvalik stated that the aura de Boer was measuring might not be the same as that seen around human beings by sensitives, to which the Britishers, Dr. Walter Kilner and Oscar Bagnall, devoted much attention, since it seemed to extend further from the body. As Harvalik put it: "We don't really know exactly what this extended aura is and we certainly have no way to analyze it in a physics laboratory, at least not yet."

Whether the auric field as measured by de Boer is the same as the one which contains the "nodal points" as revealed on film by Frances Farrelly is also as yet unanswerable. It appears that when the material substance with which the field is associated is broken up, the field goes with the individual parts which remain in contact even at a distance. This led the De La Warrs to wonder if a slip cut from a plant and rooted would benefit from the radiations emitted by its "mother" or pine away in the absence of such radiation. Incinerating a mother plant, roots and all, they found that its motherless children did not thrive as well as similar shoots taken from a mother which was permitted to continue growing.

Most incredible to J. I. Rodale, who successfully repeated the De La Warrs' experiment, was the allegation that the mother plant did not necessarily have to be growing near her children for them to benefit from her "protection." The mother could apparently be in the next city, the next country, across the ocean, or anywhere on earth. If so, suggested Rodale, it would tend to indicate that all living things, including human babies, get protective radiations from their mothers, that radiations might underlie "love at first sight" and that people with "green thumbs" are emitting radiations beneficial to their plants.

That an energy comes from the hands of a healer—as was claimed of Jesus Christ—and that this energy can increase the growth of plants seems to have been proved in a scientific experiment on sprouting seeds by Dr. Bernard Grad, a research biochemist at Allan Memorial Institute of Psychiatry of McGill University in Montreal. Taking the "healing controversy" into his laboratory, he performed some careful experiments with the cooperation of a retired Hungarian Army colonel, Oskar Estebany, who became aware of his own extraordinary healing powers during the Hungarian revolt against the Soviet occupation of his country in 1956.

Grad's meticulous experiments, written up in the *Journal of the Society for Psychical Research* and the *International Journal of Parapsychology*, indicated that the sprouting of grains and the total amount of green plant issuing therefrom could be significantly increased when compared to controls, by watering them with a solution sealed in bottles and exposed only to the healing energy of Estebany's hands.

In his first rigidly controlled experiments Grad convinced himself that by holding the cages of wounded mice, but not actually touching the animals themselves, Estebany could heal their wounds faster than if the mice were exposed to heat or left untreated. Estebany also could retard the growth of goiters produced in the mice by iodine-deficient diets and goitrogens and hasten their disappearance when the mice were returned to a normal diet.

Grad wondered what results might be obtained from subjects other than Estebany. From the many patients available at the institute he chose a twenty-six-year-old woman with a depressive neurotic reaction and a thirty-seven-year-old man with a psychotic depression. He also selected a psychiatrically normal man of fifty-two. What Grad sought to ascertain was whether a solution held for thirty minutes in the hands of a normal individual would cause plants to grow at a faster rate than a solution held for the same amount of time by neurotics and psychotics.

After the threesome had held sealed bottles of saline solution, their contents were poured on barley seeds embedded in soil. Grad found that the little plants watered by the saline solution held by the normal human being grew significantly faster than those held by the psychiatric patients, or by a control group left untreated. The plants treated by the psychotic grew the slowest. Contrary to Grad's expectations, the plants treated by the neurotic grew at a slightly higher rate than the controls.

Grad noticed that when the psychotic was given the sealed bottle to hold he expressed not the slightest reaction or emotion, whereas the neurotic immediately inquired about the reason for the procedure and, when told, responded with an expression of interest and what Grad termed a "brightening of mood." Grad also observed that she lovingly cradled the bottle in her lap as a mother would a child. Grad reached the conclusion that "the important fact for the purpose of the experiment was not the state of her general diagnosis but of her mood *at the time* she was holding the bottle." In his detailed account of the experiment Grad reported to the American Society for Psychical Research that it would seem that a negative mood, such as depression, anxiety, or hostility while treating the solutions would result in an inhibition of cell growth when plants were watered with that solution.

Grad saw the implications of his experiment to be far-reaching. If a person's mood could influence a saline solution held in the hands, it seemed natural to assume that a cook's or housewife's mood could influence the quality of food prepared for a meal. He recalled that in various countries menstruating milkmaids were not permitted in that part of the dairy where cheese was being prepared because of a presumed unfavorable effect on the bacterial cultures, and that during their menstrual periods women have been held to influence negatively the canning of perishables, the stiffening of egg white, and the survival of cut flowers. If Grad's experiments were correct, it was not the menstruation but the depression created by it in certain women that had the effect, a discovery

which removes from the realm of prejudice to the realm of science the biblical injunction against "unclean" women.

The whole subject of radionics and the part played by the action of the human mind—and whether it interacts with various radionics devices designed by De La Warr, Hieronymus, Drown, Abrams and others —stands on the very frontier of physics and metaphysics and the no-man's land which lies between them.

As Galen Hieronymus said to the authors: "Is the force and its manipulation basically in the realm of the psychic? We know that powerful psychics such as Frances Farrelly can produce results with no help whatsoever from a device. But others seem to be helped by a radionics instrument even when, like the De La Warrs, they have well-developed psychic powers."

Hieronymus has tried his best to separate the action of the human mind from whatever the various "boxes" do to interact with it. "I can take an ordinary empty cigar box and mount a tuning dial on top of it," he says. "By properly setting the dial at a given tuning, some psychics have been able to cure a given disease. I think they do this because they *believe* that they are *using* the box when, in reality, they are using only psychic ability.

"On the other hand, we are able without question to run analyses of ill persons and, having made our diagnoses, give information to third parties on how to set dials on healing instruments when those persons know nothing about radionics and are merely following instructions. The proper setting of the dials seems to have important effects. So there are two sides to the question which await resolution." Hieronymus says that a good friend, an Episcopal minister in Florida, received a hand-carved ebony cross from the family of an old Scottish vicar who had died in Great Britain. Touched, he replaced the metal cross which he normally wore around his neck with the ebony cross each time he offered holy services. A short time later he told Hieronymus that he felt exhaustingly depleted after each church service.

As a long-time "radionic detective," Hieronymus questioned his friend whether he had not done something different during the services which seemed so to fatigue him. When the clergyman remembered the substitution of crosses, Hieronymus tested his friend's vitality with and without the ebony rood around his neck. Whenever the black cross was worn, the minister's vitality dropped almost to the zero point on the device's dials.

Hieronymus suggested to his friend that he exorcise the gift cross. This accomplished, the minister no longer felt any debilitating effects. The two friends concluded that negative thoughts from the old vicar had lodged in the ebony cross and the energy therefrom was affecting its new owner.

The experiments run on certain strange figurines made of baked clay, stone, and bone discovered at Acámbaro in the Mexican state of Guanajuato by Waldemar Julsrud offer impressive evidence that matter can receive malevolent energy and store it for long periods of time, perhaps thousands of years.

Professor Charles H. Hapgood in his manuscript, *Reports from Acámbaro,* says of the huge Julsrud collection, numbering over 33,000 artifacts, that it cannot be identified with any of the known cultures of Mexico but suggests relationships not only with specific Indian tribes of the Western Hemisphere but also with peoples of the south Pacific and Africa. Researchers sponsored by Arthur M. Young's foundation selected a few examples which appeared to the eye as most evilly weird. After putting them individually in cages together with mice, they found that the tails of some of the mice turned black and fell off and that other animals died after only a night's exposure to the objects. There was evidently a malevolent energy—of a kind usually associated with voodoo—present in the evil-looking artifacts which was capable of destroying a mouse.

If mental intercession can act malevolently to destroy life, it is also clear, as the radionic process proves, that it can act benevolently to enhance life. In his unique paper, "Radionics, Radiesthesia and Physics," published by the Academy of Parapsychology and Medicine, Professor William A. Tiller, chairman of the Department of Material Science at Stanford University, who devoted part of a year-long stay in England to the study of radionics at the De La Warr laboratories, presents a model to explain how the process works.

> The basic idea in radionics [writes Tiller] is that each individual, organism, or material radiates and absorbs energy via a unique wave field which exhibits certain geometrical, frequency and radiation-type characteristics. This is an extended force field that exists around all forms of matter whether animate or inanimate. A useful analogy here is the physical atom that is continually radiating electromagnetic energy in the form of waves because of its oscillating electrical dipole movement and its thermal vibrations. The more complex the material, the more complex the wave form. Living things, like humans, emit a very complex wave spectrum of which parts are associated with the various organs and systems of the body.

Tiller holds that if the millions of new cells born in our bodies each day come into being in the presence of fields polarized by the radionic process, they tend to grow in a healthier configuration, which weakens the original field of an abnormal or diseased structure. Continued treatment eventually molds the healthy organ structure and the condition is healed.

Following Hindu Yoga philosophy, Tiller postulates further that there are seven principles operating in man, each of which constitutes a different type of substance that obeys a unique set of natural laws. These he lists as the *physical,* which most of us simply call the "body"; the *etheric,* or what the Russians have termed the "bioplasmic"; the *astral,* or emotional body, followed by three separate intuitive, intellectual, and spiritual *minds;* and finally *pure spirit* or divine mind.

"These substances are presumed to exist everywhere in nature and to interpenetrate with the human body, i.e., they all exist within the physical atom and organize themselves within the body," writes Tiller, who adds that if one thinks of seven transparent sheets containing seven different circuit patterns, each of a different color, and then overlays them, one can thus visualize the complete organization of the different levels of substance in the body. Although the different energy fields perturb each other only in a small way, they can be influenced to do so in a strong way, says Tiller, *by the agency of mind.*

Tiller points out that the seven endocrine centers of the physical body—the gonads, cells of Lydig, adrenals, thymus, thyroid, pineal, and pituitary—are paralleled in Hindu philosophy by seven energy vortices, or *chakras,* which are linked in the etheric body by a current of vitality. This current, says Tiller, is associated with the meridians of acupuncture and the points on them which, though known to the Chinese millennia ago, have only recently been detected with an instrument that measures electrical resistance.

> One of our goals [continues Tiller] is to arrange our etheric/physical system so as to deliver maximum power to the physical body from the environmental energy stream. One reason for wanting to tune the chakra/endocrine system relates to the transmitting of spiritual and healing qualities into the earth environment. These seven endocrine centers have been called our sacred centers and through them we radiate transmitting information of a quality (frequency) associated with that center.

Tiller offers the example of the thymus gland, the center supposed to control the quality of love in all its spectral range. He postulates that an entity radiates from this gland a field that is broadcast through space and is absorbed in the corresponding gland by another entity. This stimulates the gland and generates some biological activity within the organism. If the second entity radiates an in-phase vibration back to the first, then the love consciousness can form a bond between them. Most of us, in Tiller's view, are confined to expressing love in so limited a way that it is radiated at small power and has a restricted range of expression such that only a few individuals will receive the radiation and be aware of it. But, as Tiller puts it, "if the entity has built himself to radiate at large power and over a very broad band of the spectral distribution, then many, many entities will receive this radiation, be aware of this love and be nourished by it." Tiller's statement fits well with Rexford Daniels' idea that altruism has a higher, and perhaps more powerful, set of frequencies than egotism.

It also echoes the latest conclusions of Marcel Vogel:

> A thought is an act of creation. It is what we are here for, to create, to bring into being ourself by means of thinking. The way a thought can be observed and measured by a simple life form, a plant, shows a wonderful relationship between man and plant. When we love, we release our thought energy and transpose it to the recipient of our love. Our primary responsibility is to love.

Another researcher to accept the power of the mind is a neurologist and medical electronics expert, Dr. Andrija Puharich, who has recently reported some of the most awe-inspiring feats of psychic, or mental, power yet to confront physicists, psychologists, and other academicians. Author of *The Sacred Mushroom* (Doubleday, New York, 1959), which dealt with the effects of hallucinogenic plants, such as peyote, a decade before the world's younger generation became absorbed with mind-bending drugs, from marijuana to LSD, and of *Beyond Telepathy* (Darton, Longman and Todd, London, 1962) a decade before studies of direct idea transference from one human mind to another were considered anything but crazy by the "responsible" scientific community, Puharich has now discovered a truly remarkable psychic in the body of a young Israeli, Uri Geller, whose abilities have startled hundreds of audiences and left most open-minded scientists aghast at their implications.

Under rigorous test conditions, Geller has been able to unfailingly locate an iron ball or water hidden in one of ten identical sealed metal cans without touching the cans, to move solid objects at a distance without the use of any energy known to physics, to bend at a distance dense metal objects, such as a solid silver Mexican coin, as if they were plastic in his hands, to repair broken watches and get them running without having ever opened their cases, to shatter a set of watchmaker's screwdrivers made of a special alloyed steel, and even to cause objects to vanish from their locations and reappear somewhere else. Geller can also affect at will the material recorded on a magnetic tape, such as that used in television.

Puharich has now organized a multi-disciplinary international group of scientists to assess the abilities of Geller and of perhaps thousands of other people who would reveal similar gifts if they were taken seriously rather than considered freaks. A theoretical group which will take the results of the experiments and seek to mathematically provide physical constructs for them is being led by physicist Dr. Edward Bastin, member of the "Epiphany Philosophers" at Cambridge University in England and originator of the most advanced quantum theory.

The group will be asking such fundamental questions as: How can a coin disappear? What kind of space, or lack of it, is involved? What are the energetics which operate during Geller's transformations and vanishings?

As Puharich told Connie Best, author of an article on Geller, "The Man Who Bends Science":

> We're trying to develop a model to explain how all these atoms can be taken apart. There are theories of annihilation and so on in microphysics, but there is no theory in the world that can explain this on a macroscopic scale. How can you take all these atoms apart or infinitely compress them to the point where they are so tiny they are invisible, have the thing parked in some unknown space, and then get the atoms back reassembled?

Geller not only can miraculously affect the so-called inanimate world but the world of living things as well. Before reliable witnesses he has placed his hands over a rosebud for slightly longer than a quarter of a minute, then opened them to reveal the rose in full and radiant bloom. As Connie Best comments:

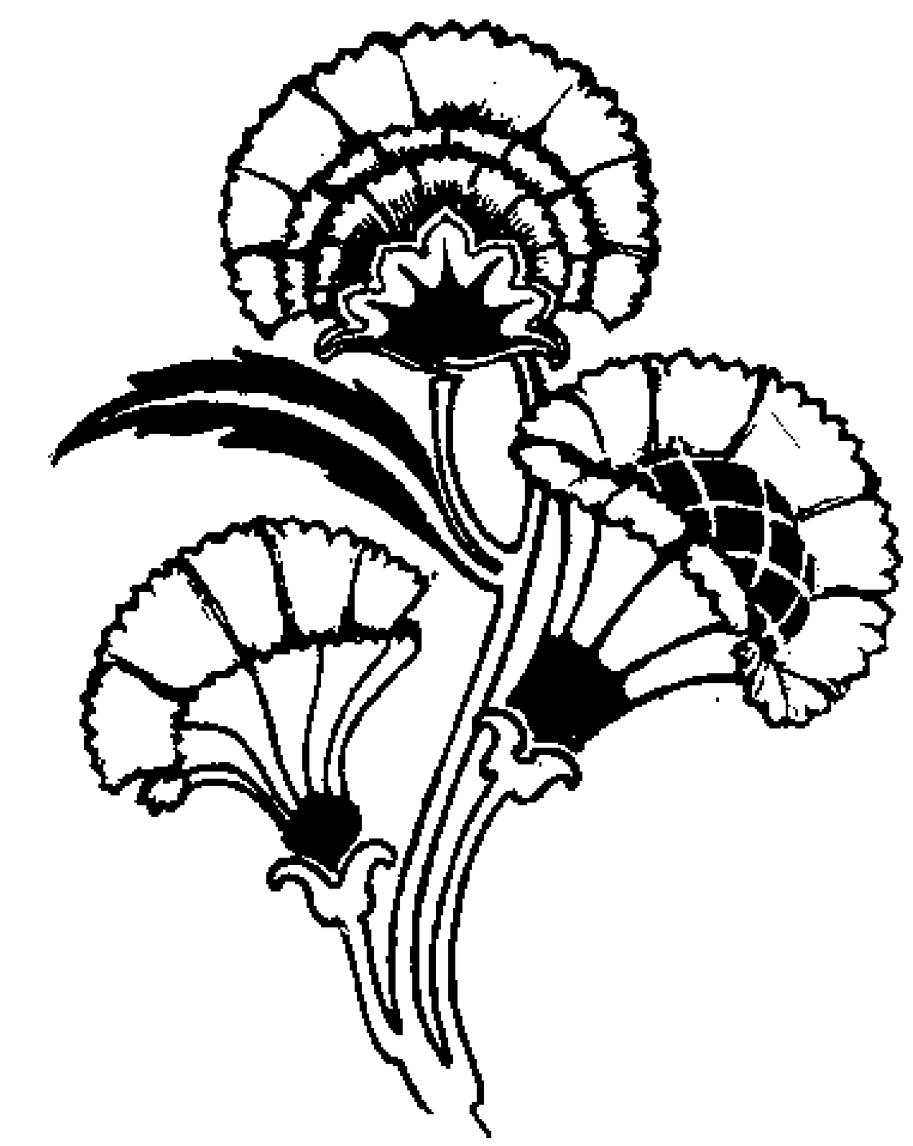
> Physics is precise, unbending. Yet Uri Geller is finding loopholes in science wide enough to pluck a rose out of. Uri Geller is bending physics, forcing it to take account of the so-called 'paranormal' powers of the mind. How much will physics have to change? If the readings of meters reflect the wishes of lab assistants, if the presence of an experimenter is enough to embarrass sub-atomic particles, how are we to know where we stand?

As the Serbian-born American inventor and genius, Nikola Tesla, stated before his death: "The day science begins to study nonphysical phenomena, it will make more progress in one decade than in all the previous centuries of its existence."

Perhaps that decade is upon us.

CHAPTER 21

Findhorn and the Garden of Eden



The most advanced experiment involving communication with plants has now developed in a remote corner of northern Scotland, with results more radiant than have been achieved by any other means. On a barren, wind-blown patch of gorse and sand overlooking the Firth of Moray, a seedling community has taken root which may flourish into a marvel of the Aquarian Age.

Three miles as the raven croaks from the battlements of Duncan's castle at Forres, and just south of the heath where the three witches prophesied to Macbeth that he would be Thane of Glamis and Cawdor, an ex-RAF squadron leader turned hotelkeeper decided to take up residence with his wife and three young sons in the derelict corner of a caravan park on Findhorn Bay—a rubbish heap of old tin cans, broken bottles, brambles, and gorse bushes.

Tall, ruddy, with the gentle manner of an English headmaster and the dress of a country squire, Peter Caddy, who once walked two thousand miles through the Himalayas, crossing Kashmir deep into Tibet, has been a follower since young manhood of a school of adepts whose object is to bring back beauty and wonder to this planet. Illumined by the dictates of his conscience, or as he chose to call it, the will of an all-powerful creative force revealed to him by his clairvoyant wife, Eileen, Caddy pulled up roots and moved to Findhorn one snowy November day in 1962. Accompanying the Caddys was another sensitive, Dorothy Maclean, who had left the Canadian Foreign Office to study Sufism.

For some time the Caddys had been intent upon radically changing their lives by turning away from mundane occupations and materialist pursuits in order to enter upon what Caddy calls a long period of training and preparation. During this period they planned to surrender everything, including all personal volition, to a being they term "Unlimited Power and Love," whose will is manifest to them through the guidance of a deceased Rosicrucian master whom they recognized in the flesh as Dr. G. A. Sullivan, and in the spirit as Aureolus, or St. Germain, or the Master of the Seventh Ray.

To be fair, the place in which the Caddys least expected to settle was the unsightly, overcrowded encampment of mobile houses known as Findhorn Caravan Park. For years they had hurried past it on their way to and from Forres. Now some mysterious force was overriding their aversion. Following what appeared to be crystal guidance, they wheeled an old caravan onto the site of their new home—less than half an acre in a hollow not far from the main cluster of trailers, a patch of land composed mainly of sand and gravel, constantly swept by gale-force winds, protected only partially by tufts of broom and quitch grass which kept the sand from blowing away, and shaded by a belt of spiny fir trees.

With winter coming it was a dismal prospect. Following the concept of the monks who used to build their monasteries by hand, putting love

and light into the fabric of the building with every stone they laid, the Caddys cleaned their rickety trailer from top to bottom and polished all the furniture, pouring in vibrations of love to cancel out the negative vibrations they considered to be inevitable in structures built by people interested only in money. Cleansing and hand painting the caravan was a first step toward the creation of their own center of light.

As none of the Findhorn pioneers was employed, and their meager resources would carry them through only one dark and clammy Scottish winter, they dreamed of springtime and establishing a garden, partly to increase the protective shield of light round them and partly as a source of healthy nourishment.

Short days and long nights Caddy pored over gardening books, which he found contradictory in their recommendations. Written for horticultural enthusiasts living mostly on the mild southern coast of England, they were irritatingly irrelevant. When Easter rolled around to herald a renaissance of the land, the arid, all but lifeless soil surrounding their caravan seemed hopeless for growing anything comestible. Caddy, who had never sown a vegetable seed in his life, felt like Noah when guided to build an ark where there was no water; but he dutifully persisted. Either guidance was to be followed to the letter or they might as well return to the world of business. His Rosicrucian masters had taught him one prime rule of life: "To love where I was, love whom I was with, and love what I was doing."

To receive the arcane guidance on which the infant community planned its every move, Eileen would rise regularly at midnight and meditate for several hours, bundling herself in an overcoat against the chill of the Scottish nights, taking refuge in the only place that could afford her absolute tranquillity, the trailer park's frigid toilet. Eileen had read in a book that everyone receives his spiritual name at some point in life and that only then can he begin his spiritual work in earnest. In 1953 she had felt the word Elixir branded on her forehead; so she adopted the name, and from then on her guidance was constant.

In her clairvoyant vision Elixir saw seven cedarwood bungalows clustered together, in the midst of a splendid garden, all trim and neat. How this vision was to materialize in the constricted squalor of the caravan site remained a mystery. Yet all were prepared to put their faith in her clairvoyance.

The prospect of creating a garden seemed a superhuman task. The ground was made of fine, dusty sand and gravel in which nothing grew but tough pointed grass. Elixir received guidance that each time you put a spade into the ground you put in your own vibrations, that the right vibrations acted as a magnet to draw in like vibrations. Peter Caddy cheerfully dug a strip of quitch turf three feet wide by nine feet long and laid it to one side. He then dug down eighteen inches, accumulating a pile of sand and gravel. In the clean trench he placed the strip of quitch turf upside down and broke it up with his spade. This was to insure that the turf would not sprout its way back up to the surface, but provide nourishment as it disintegrated.

Repeating the operation with two more trenches, Caddy had a garden nine feet by nine. His problem was to get water into the soil, a far more difficult job than he imagined. The sand was so fine the water poured onto it simply went into globules like quicksilver. Only by dint of the most assiduous patience, by spraying the surface over long periods with a very fine spray, was it possible to impregnate the soil sufficiently for it to hold the moisture. More stones and gravel had to be raked out; finally the plot was ready for seeding. According to the local agricultural experts and the available textbooks on gardening, nothing could be grown in the Findhorn soil except perhaps a few lettuces and radishes. Scanty fare for a family which had become accustomed at their hotel to daily steak or duck washed down with good red wine.

Fortunately Elixir had been warned by her guidance that man is eating the wrong food, drinking the wrong drink, thinking the wrong thoughts, and making his body gross instead of a body of light. They were to eat less dense food and begin to concentrate on making a real garden, the fruit and vegetables of which, combined with honey and wheat germ, would constitute the fare in the new age of refined bodies.

Conscientiously Caddy planted his lettuce seeds in an inch-deep furrow made with the handle of his spade, placing the seeds a foot apart, then raked them over. To sit in the sun and watch their garden grow the Findhorners needed a fence, to fend off the ever-present winds

blowing across the Moray Firth, and a level concrete patio. Sand they had in abundance, but no cement, nor any money for its purchase.

Lumber for a slatted fence appeared as if by miracle from a man who was dismantling his garage. As soon as the fence was up a neighbor ran over to say that some barely damaged bags of cement had fallen from a truck across the road. In a short while they had a fenced patio from which to admire—not thriving young lettuce, but stunted apparitions, attacked by wireworms.

What to do? Caddy had been warned by Elixir's guidance not to use chemical insecticides. A neighbor chanced to pass and informed him of a pile of seasoned soot just outside the entrance to the caravan park, an admirable antidote to wireworms.

Caddy spread it carefully, without taking into account the wind which that night blew it through the caravan, into hair, books, and clothing. Luckily it rained and the soot was washed into the soil. By the end of May they were eating luscious lettuces and radishes.

As Elixir's guidance informed them that chemical fertilizers were toxic to the human body, a compost heap was essential if they were to grow a greater variety of vegetables. Only, where to obtain the ingredients? A pile of rotting grass was donated by a neighbor. A nearby farmer, grateful for a rescued sheep, gave Caddy a large load of cow manure. A friend who owned a riding stable allowed them to follow his horses with bucket and shovel. A nearby distillery supplied them with free peat dross and cummings, a natural barley-germ fertilizer. Seaweed they gathered free from the beach. A bale of hay, dropped from a passing truck almost at the gate of the park as if from heaven, served to cover the piles of compost.

Relying on such "supermundane assistance," the Findhorners acted as if they were endowed. As one of them wrote: "We could have been negative and said the soil was useless—as it was. Instead we put hard work and positive thought into everything we did." Caddy began working from morning till night, putting sweat and radiations into the soil, his object to grow sufficient vegetables and salads to provide a large part of their diet in the months to come. Along with pure air, sunlight, sea bathing, and plenty of cold, pure water, they hoped gradually to purify their bodies and endow them with energy, on the theory that the more refined their bodies became the more they would be able to absorb cosmic energies and the less solid food they would need.

The Findhorners planted watercress, tomatoes, cucumbers, spinach, parsley, squash, and asparagus. As a living wall against an unruly Dalmatian they planted hedges of blackberries and raspberries round their garden, which began to spread beyond the caravan till it covered two acres of ground, every bit of soil of which had to be manufactured from old turf and new compost, every square inch manhandled several times in the process.

Within two months the results were stunning the neighbors, who, not knowing of the spirit in which the Caddys were going about their gardening, could not understand what was happening, especially when the Caddys' cabbages and Brussels sprouts were the only ones in the area to survive a plague of cabbage-root grubs which eat away at the roots of the plants, and their harvest of black currants grew healthily by the bushel, whereas the crop largely failed in the rest of the county.

Findhorn lunches began to consist of salads with over twenty ingredients; surplus quantities of lettuce, radishes, spinach, and parsley were disposed of round the county, which was suffering a shortage. Their evening meals included two or three vegetables from the garden, grown without fertilizer or insecticides, freshly picked and freshly cooked. Stews from garden vegetables consisted of onions, leeks, garlic, carrots, parsnips, rutabagas, turnips, artichokes, kohlrabi, celery, squash, potatoes, flavored with all kinds of herbs.

Elixir was told to let her mind dwell on each ingredient when making a salad, or a ratatouille, that her thoughts and feelings were important in the continuing cycle of life. She was to appreciate whatever she was doing, whether peeling a carrot or podding a pea, and to consider each pea or bean a living thing in her hands. Of the peelings and garbage nothing was to be wasted. All was to go back into the compost and the soil, constantly increasing the live vibrations. The only drawback to this life was that when they were obliged to go into town, or on a short holiday, they found it very difficult to support normal food. Elixir became so sensitive it was painful for her to go near the noxious vibrations of so-called civilization.

When midsummer came they were ready to preserve quantities of raspberries, blackberries, and strawberries, putting up altogether a hundred pounds of jam. They pickled fifteen pounds of red cabbage, and large quantities of cucumbers. In a newly built garage they stored potatoes, carrots, beets, and shelves full of shallots, garlic, and onions. During the winter they prepared the earth for the following season and planted more fruits, altogether some twenty species, including apples, pears, plums, greengages, cherries, apricots, loganberries, and boysenberries. By May of 1964 the fruit trees and bushes were bursting into bud.

When estimating the number of red cabbages the Findhorners would need for the following season Caddy calculated that with an average weight of three or four pounds they would require no more than eight. To the Findhorners' amazement, when the cabbages matured one of them weighed thirty-eight pounds and another forty-two. A sprouting broccoli, mistakenly planted as a cauliflower, grew to such enormous proportions that it provided vegetables for weeks; when eventually pulled out of the ground it was nearly too heavy to be lifted.

It began to dawn on Caddy that there might be some greater underlying purpose behind what was happening at Findhorn, that they must be involved in some mysterious pioneering venture, some larger experiment in group living, that the garden might be the nucleus of some larger experiment in New Age living, a sort of training course in the realization that Life is a Whole.

In June of 1964 when the county horticultural adviser came to take a sample of the soil for analysis, his first comment on arrival was that the soil would require a dressing of at least two ounces of sulfate of potash per square yard. Caddy replied that he did not believe in artificial fertilizers, that he was happy using compost and wood ash. The adviser said that would be totally inadequate.

Six weeks later, when the adviser returned bringing the results of the analysis which had been carried out in Aberdeen, he acknowledged with some bewilderment that the analysis had found no deficiencies in the soil sample. All necessary elements, including rare trace elements, were present. The adviser was so astonished by the results that he asked Caddy to take part in a broadcast about the garden in which the adviser would take the chair and an experienced gardener using conventional methods with chemical fertilizers would debate with Caddy. Caddy says that at the time he still did not feel it appropriate to expound to the public on the subject of the spiritual side of their endeavor and again he attributed the success solely to organic manure and compost.

By now they were growing sixty-five different kinds of vegetables, twenty-one fruits, and over forty herbs, both culinary and medicinal. For some time Dorothy Maclean had also been receiving extraordinary spiritual guidance of her own and had adopted the spiritual name of Divina. She learned from the aromatic plants in the garden that their unique wavelengths could serve special functions for humans, affecting different parts of human anatomy as well as the human psyche, some plants being good for wounds, others for eyesight, others for human emotions. She realized that by raising the quality of her own vibrations she might eventually open the doors to a whole new spiritual realm of plant life. It became clear to her that human thinking, human passion, human anger, human kindliness and affection, all have far-reaching effects on the world of plants, that they are most susceptible to human thoughts and emotions, which affect their energy. Poisonous and bad-tempered moods have as depressing an effect on plants as happy, uplifting frequencies have a beneficial effect. It occurred to her also that bad effects could come back to humans as they ate the produce they had infected with bad vibrations. Thus the whole cycle could become viciously descending, leading to more and more misery, pain, and disease, or hopefully ascending, leading to greater joy and greater light.

Divina says she realized that the most important contribution that man can make to a garden—even more important than water or compost—is the radiation he puts into the soil while cultivating it, such as love, and that every member of a group has something to contribute in the way of radiations—strength, happiness, and so on. Everything that comes into a human being through inspiration of one sort or another goes out again modified in wavelength, tone, and timber by the will of the person involved; he or she can improve the quality of what is sent out and increase the brilliance of its wavelength.

At the same time Divina realized that the soil and plants are constantly being affected by radiations from the earth itself and from the

cosmos, each of which contributes to its fertility, without which both soil and plants would be sterile; these radiations, she realized, were more fundamental than chemical elements or microbiotic organisms, radiations that are subject fundamentally to the mind of man. Man appeared to have the role of a demi-god; by cooperating with nature he might find no limit to what could be achieved on this planet.

In the spring of 1967 Elixir—who still received the overall policy guidance for the venture—was told that the garden was to be extended even further and made into a place of beauty with the planting of many kinds of flowers. The center was to be expanded and new bungalows built. The vision she had first received on arriving at Findhorn was now beginning to materialize. Money for neat cedarstrip bungalows turned up as if by miracle, and the bungalows were soon surrounded by impeccable flower gardens.

In 1968, when Findhorn was visited by a number of accomplished gardeners and agricultural experts, they were amazed at what they found, remarking they had never seen such a uniformly high standard in all sections of a garden. The growth and color of the flowers in the new herbaceous borders were so remarkable that the visitors were at a loss to explain the phenomena, considering the poverty of the soil and the rigorous northern climate. When Sir George Trevelyan, who for twenty-four years had run the famed Adult Education Foundation at Attingham, dropped in at Easter he was amazed by the quality of the daffodils and narcissi growing in beds crowded with shorter flowers, all as beautiful and large as he had ever seen, their brilliant colors of a scintillating quality. He found the root vegetables the best he had ever tasted, and was surprised to find fruit trees of all sorts in blossom, as well as a vigorous young chestnut standing eight feet high among broad-leaved trees and shrubs thriving on the landward slope of windswept dunes.

As a member of the Soil Association, with an interest in the organic method, Sir George said he had seen enough to know that compost and straw mulch alone mixed with poor and sandy soil were not enough to account for such a garden. There must, said he, be some Factor X to be taken into consideration, adding that if so much could be accomplished at Findhorn in such a short time the Sahara could be made to blossom.

In June of 1968, Miss Armine Wodehouse, of the Radionic Association, who ran a commercial truck garden in Wales for twenty years, visited Findhorn and was amazed at the lush crops she found, especially when she noted the pure sand thinly spread with compost and the powerful winds that swept uninterruptedly across the garden. She felt the strawberry plants would arouse the admiration of any gardener, and was surprised to find moisture-loving asters and primulas, which are notoriously thirsty, thriving in such soil.

Mrs. Elizabeth Murray, an independent organic gardener and member of the Soil Association, who visited Findhorn in July of 1968, felt that the radiant health of the trees, flowers, fruit, and vegetables was far beyond the ordinary. She felt the compost was of such poor quality when mixed with sand that it could not explain the superb produce, which for size, quality, and flavor was superior to anything she had ever seen anywhere. She too was sure that such results could not have been attained on such barren soil simply by good husbandry and compost.

Lady Mary Balfour, sister of Lady Eve, who describes herself as an "ordinary gardener of the organic school," spent twenty-four hours at Findhorn in September of 1968 and wrote: "The weather throughout was grey and at times wet. Yet in retrospect I can see that garden in brilliant sunshine without a cloud in the sky, which must be due to the extraordinary brilliance of the blooming flowers I saw there. The flower beds were all a compact mass of color."

Lady Cynthia Chance, a follower of Rudolf Steiner's Biodynamic farming methods, was astounded when Peter Caddy told her he did not need to apply Steiner's methods, that he had a more direct spiritual way of obtaining the same results. A United Nations agricultural expert and professor of agriculture at various universities, Professor R. Lindsay Robb, when he visited Findhorn just before Christmas went on record to say that "the vigor, health and bloom of the plants in the garden at midwinter on land which is almost a barren powdery sand cannot be explained by the moderate dressings of compost, nor indeed by the application of any known cultural methods of organic husbandry. There are other factors and they are vital ones."

At which point Peter Caddy broke down and let out to Sir George Trevelyan the secret of their success at Findhorn. He said that Dorothy Maclean, or Divina, had managed to get into direct contact with the devas or angelic creatures who control the nature spirits that are said by clairvoyants to be everywhere at work nurturing plant life. Sir George, an advanced student of the arcane, of astrology and the hermetic sciences, admitted he was aware that a number of sensitives claimed to be in touch with the devic world and to be working with it, that Rudolf Steiner had founded his Biodynamic methods on such knowledge. Far from scoffing at Caddy's explanation, he was prepared to give it credence and to validate it by suggesting that conscious investigation of such worlds is of the utmost importance to our understanding of life, and especially our understanding of the life of plants.

In short order Peter Caddy put out a series of pamphlets describing the true nature of the experiments at Findhorn. Divina contributed detailed descriptions of the messages she said she received directly from the devas, of which she described whole hierarchies responsible for every fruit and vegetable, for every flower and weed. Here was a Pandora's box more phenomenal than the one opened in New York by Backster.

Findhorn quickly developed into a community of over a hundred disciples. Young spiritual leaders turned up to preach the gospel of a New Age, and a college was founded in the community to teach the tenets of this New Age. What had started as a miraculous little garden appeared to be turning into a true center of light for the Aquarian Age, visited annually from every continent of the globe.

Parting the veil into other worlds and other vibrations beyond the limits of the electromagnetic spectrum may well go a long way to explain the mysteries which are incomprehensible to physicists who limit their looking to what they can see with their physical eyes and their instruments. In the more ethereal world of the clairvoyant, who claims to have mastered the art of etheric and astral vision, a whole new series of vistas opens up around plants and their relation to man, to the earth, and to the cosmos. The growth of seeds and plants, as Paracelsus intimated, may indeed be affected very strongly by the position of the moon, the positions of the planets, their relation to the sun and to the other stars of the firmament.

Fechner's animistic vision of plants being ensouled becomes less of a wild conceit, as does Goethe's concept of a prototype plant. Burbank's knowledge that whatever man wishes he can produce with the aid of nature or Carver's insistence that nature spirits abound in the woods and take part in the growth of plants may have to be reviewed in the light of the discoveries of the Theosophists and especially of such extraordinary seers of nature spirits as Geoffrey Hodson. The ancient wisdom, as detailed by seers like Mesdames Helena P. Blavatsky and Alice A. Bailey, throws quite another light on the energy of bodies, both of humans and of plants, as well as the relation of individual cells to the entire cosmos.

The secret behind Pfeiffer's Biodynamic compost, which has been proved so highly effective scientifically, turns out to be a homeopathic wonder based on a fairyland creation of Rudolf Steiner's organic brews made by burying cow horns filled with cow dung and deer bladders filled with nettles and camomile leaves. Steiner's anthroposophy, or Spiritual Science, throws such a light on plant life and agriculture as to make scientists root in their tracks.

Aesthetically, the world of the devas and the nature spirits turns out to be even more full of color and sound and perfume than the creations of Scriabin and Wagner, their gnomes, nymphs, and undines, their fire, water, earth, and air spirits closer to reality than the Holy Grail and the eternal quest it engendered. As Dr. Aubrey Westlake, author of *Pattern of Health,* describes our imprisoned state, we are locked in a "valley of materialistic concepts, refusing to believe there is anything other than the physical-material world of our five senses. For we, like the inhabitants of the country of the blind, reject those who claim to have 'seen' with their spiritual vision the greater supersensible world in which we are immersed, dismissing such claims as 'idle fancies' and advancing far 'saner' scientific explanations."

The attraction of the seer's supersensible world, or worlds within worlds, is too great to forgo, and the stakes too high, for they may include survival for the planet. Where the modern scientist is baffled by the secrets of the life of plants, the seer offers solutions which, however

incredible, make more sense than the dusty mouthings of academicians; what is more, they give philosophic meaning to the totality of life. This supersensible world of plants and man, only touched on in this volume, will be explored in another, *The Cosmic Life of Plants.*

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Index

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Exploring the world of plants and its relation to mankind as revealed by the latest discoveries of scientists, *The Secret Life of Plants* includes remarkable information about plants as lie detectors and plants as ecological sentinels; it describes their ability to adapt to human wishes, their response to music, their curative powers, and their ability to communicate with man. Authors Peter Tompkins and Christopher Bird suggest that the most far-reaching revolution of the twentieth century-one that could save or destroy the planet-may come from the bottom of your garden.

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This is indeed a cumulative effort, and I hope that my successors in pyramidal quests will be as lively and entertaining as have been my predecessors.

I have taken the book's 350 illustrations from the most disparate Medieval, Renaissance, Romantic, and Modern sources, from the 400 engravers of Napoleon's 20-volume *Description de l'Egypte* to the most recent archeological journals.

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INTRODUCTION

Does the Great Pyramid of Cheops enshrine a lost science? Was this last remaining of the Seven Wonders of the World, often described as the most sublime landmark in history, designed by mysterious architects who had a deeper knowledge of the secrets of this universe than those who followed them?

For centuries a debate has been waged between supporters of such a theory and its opponents, with eminent scientists and academicians lining up on either side. Though all agree that the Great Pyramid is at least four thousand years old, none can say for certain just when it was built, by whom, or why.

Till recently there was no proof that the inhabitants of Egypt of five thousand years ago were capable of the precise astronomical calculations and mathematical solutions required to locate, orient and build the pyramid where it stands.

It was attributed to chance that the foundations were almost perfectly oriented to true north, that its structure incorporated a value for π (the constant by which the diameter of a circle may be multiplied to give its true circumference) accurate to several decimals and in several distinct and unmistakable ways; that its main chamber incorporated the "sacred" 3–4–5 and 2–$\sqrt{5}$–3 triangles ($a^2 + b^2 = c^2$) which were to make Pythagoras famous, and which Plato in his *Timaeus* claimed as the building blocks of the cosmos. Chance was said to be responsible for the fact that the Pyramid's angles and slopes display an advanced understanding of trigonometric values, that its shape quite precisely incorporates the fundamental proportions of the "Golden Section," known today by the Greek letter φ (pronounced *phi*), revered equally by masters of the *çinquecento* and luminaries of modern architecture.

According to modern academicians the first rough use of π in Egypt was not till about 1700 B.C.—at least a millennium after the Pyramid; Pythagoras' theorem is attributed to the fifth century B.C.; and the development of trigonometry to Hipparchus in the second century before Christ. That is what the Egyptologists say, and that is what they put in their textbooks.

Now the whole subject has had to be reviewed.

Recent studies of ancient Egyptian hieroglyphs and the cuneiform mathematical tablets of the Babylonians and Sumerians have established that an advanced science did flourish in the Middle East at least three thousand years before Christ, and that Pythagoras, Eratosthenes, Hipparchus and other Greeks reputed to have originated mathematics on this planet merely picked up fragments of an ancient science evolved by remote and unknown predecessors.

The Great Pyramid, like most of the great temples of antiquity, was designed on the basis of a hermetic geometry known only to a restricted group of initiates, mere traces of which percolated to the Classical and Alexandrian Greeks.

These and other recent discoveries have made it possible to reanalyze the entire history of the Great Pyramid with a whole new set of references: the results are explosive. The common—and indeed authoritative—assumption that the Pyramid was just another tomb built to memorialize some vainglorious Pharaoh is proved to be false.

For a thousand years men from many occupations and many stations have labored to establish the true purpose of the Pyramid. Each in his own way has discovered some facet, each in its own way valid. Like Stonehenge and other megalithic calendars, the Pyramid has been shown to be an almanac by means of which the length of the year including its awkward .2422 fraction of a day could be measured as accurately as with a modern telescope. It has been shown to be a theodolite, or instrument for the surveyor, of great precision and simplicity, virtually indestructible. It is still a compass so finely oriented that modern compasses are adjusted to it, not vice versa.

It has also been established that the Great Pyramid is a carefully located geodetic marker, or fixed landmark, on which the geography of the ancient world was brilliantly constructed; that it served as a celestial observatory from which maps and tables of the stellar hemisphere could be accurately drawn; and that it incorporates in its sides and angles the means for creating a highly sophisticated map projection of the northern hemisphere. It is, in fact, a scale model of the hemisphere, correctly incorporating the geographical degrees of latitude and longitude.

The Pyramid may well be the repository of an ancient and possibly universal system of weights and measures, the model for the most sensible system of linear and temporal measurements available on earth, based on the polar axis of rotation, a system first postulated in modern times a century ago by the British astronomer Sir John Herschel, whose accuracy is now confirmed by the mensuration of orbiting satellites.

Whoever built the Great Pyramid, it is now quite clear, knew the precise circumference of the planet, and the length of the year to several decimals—data which were not rediscovered till the seventeenth century. Its architects may well have known the mean length of the earth's orbit round the sun, the specific density of the planet, the 26,000-year cycle of the equinoxes, the acceleration of gravity and the speed of light.

But to disentangle the authentic from the phony in what has been attributed to the builders of the Great Pyramid has required the technique of a Sherlock Holmes. To climax the story there is a mystery of detection to match the classic style of Sax Rohmer's Abu Hassan, complete with radiography by cosmic rays.

I. ANCIENT BACKGROUND

Ten miles west of the modern city of Cairo at the end of an acacia, tamarind and eucalyptus avenue stands a rocky plateau. A mile square, it dominates the luxuriant palm groves of the Nile Valley from a height of 130 feet. On this man-leveled plateau, called Giza* by the Arabs, stands the Great Pyramid of Cheops. To the west stretch the vast wastes of the Libyan desert.

The Pyramid's base covers 13 acres, or 7 midtown blocks of the city of New York. From this broad area, leveled to within a fraction of an inch, more than two-and-a-half *million* blocks of limestone and granite—weighing from 2 to 70 tons apiece—rise in 201 stepped tiers to the height of a modern forty-story building, etched against the cloudless blue of the Egyptian skies.

In terms of solid masonry, the structure contains more stone than all the cathedrals, churches and chapels built in England since the time of Christ; as a feat in masonry it was not to be matched till the construction of Boulder Dam. Modern engineers are astounded by both the enormity of the problems involved in the construction of the Pyramid and the optician's precision with which these problems were resolved. As originally designed, with its full mantle of polished limestone, the Pyramid must have been a dazzling sight. Unlike marble, which tends to become eroded with time and the weather, limestone becomes harder and more polished.

Near the Pyramid of Cheops stand two more pyramids, one, slightly smaller, attributed to Cheops' successor, Kephren, and another, smaller still, partly sheathed in red granite, attributed to Kephren's successor, Mykerinos. Together with six diminutive pyramids, supposedly built for Cheops' wives and daughters, they form what is known as the Giza complex. About a hundred more pyramidal structures of various sizes and in various stages of dilapidation follow the western bank of the Nile southward toward the Sudan, mostly within one degree of latitude, or 70 miles; but it is the Great Pyramid, unique in size and proportion, which is of paramount interest in this story.

The three large pyramids on the Giza plateau seen from across the Nile. The nearest of the three large pyramids is that of Cheops. Kephren's appears to be higher because it stands on higher ground. The third is that of Mykerinos. The two smallest pyramids are attributed to Cheops' wife and daughter.

* Most often spelt Giza, but transliterated by various authors as Djiseh or Jeeseh, the G is pronounced hard by the Egyptians and soft by other Arabs—as in *J* or *Dj*.

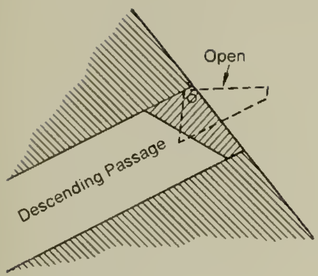
Reconstruction of a pyramid, showing the original polished limestone mantle which covered the entire structure.

What the Great Pyramid looked like when it was completed, or even for the first one or two millennia thereafter, is not recorded in history. No description of the Pyramid has survived in the Egyptian texts. Legends have it painted in various colors, marked with designs and inscribed with symbols. The thirteenth-century Arab historian, Abd-al-Latif, says the Pyramid was once inscribed with unintelligible characters in inscriptions so numerous they would fill ten thousand pages: his colleagues assumed them to be the graffiti of myriads of ancient tourists.

The first eyewitness descriptions from classical authors are pitifully sparse. Thales, the father of Greek geometry, who visited the Pyramid sometime in the sixth century B.C., is reputed to have astounded its Egyptian guardians with a correct computation of its height by measuring its shadow at the time of day when his own shadow was equal to his height. Unfortunately he left no detailed description of his visit.

The works of other classical authors known to have written about the Pyramid, such as Euhemerus, Duris of Samoa, Aristagoras, Antisthenes, Demetrius of Phaleron, Demoteles, Artemidorus of Ephesus, Dionysius of Halicarnassus, Alexander Polyhistor, Butoridas, and Apion are all lost, and survive only in fragmented quotation.

Herodotus, who saw the Pyramid about 440 B.C.—by which time it was as ancient to him as his period is to us—says that each of the structure's four perfectly triangular faces was still covered with a mantle of highly polished limestone, the joints so fine they could scarcely be seen. In his *History,* which contains the first comprehensive account of Egypt to have survived intact, Herodotus



Though no remains of a swivel door have been found at the Great Pyramid, Strabo's description fits the conditions; and a similar swivel door was found at the south pyramid of Dashur.

deals with other aspects of the Pyramid, but not all his information can be taken at face value.

Diodorus Siculus, the Greek historian who lived soon after the time of Christ, described the Great Pyramid's 22 acres of polished casing stones as being "complete and without the least decay." The Roman naturalist Pliny gives a report of natives gamboling up the polished sides to the delight of Roman tourists.

A man who may have had a lot to say about the Pyramids, in the forty-seven books of his *History,* was Strabo, the Pontine geographer who took a trip up the Nile in 24 B.C., but his history is lost: in the geographical appendix which survives he does little more than describe an entrance on the north face of the Great Pyramid made of a hinged stone which could be raised but which was indistinguishable from the surrounding masonry when it lay flush.

Strabo reports that this small opening gave onto a narrow and low passage, less than 4 feet by 4, which descended 374 feet into a damp, vermin-infested pit dug from the live bedrock 150 feet below the base of the Pyramid. That this pit was visited in Roman times was deduced from initials supposedly written with smoking torches on the rough ceilings by wealthy Greek and Roman tourists.

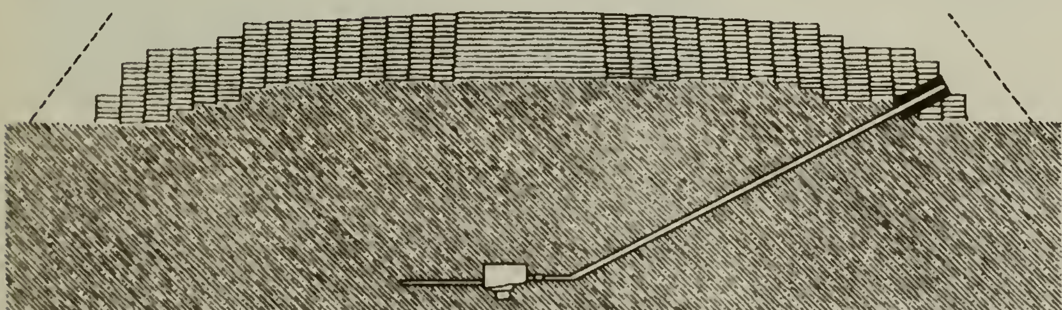
Sometime during the early centuries of the Christian era, the precise location of the movable door was lost. It was a period when information of all sorts began to grow scarce, when worldly learning came to be despised and denigrated. Christianized Egyptians were forbidden access to the ancient temples, which were either seized or razed by the Catholics; thousands of statues and inscriptions were disfigured; the hieroglyphs, whose meaning was already lost to most, became dead letters to the world to remain so for the next fifteen hundred years.

The great library of Alexandria, accidentally damaged by Julius Caesar and restored by Mark Anthony, was intentionally destroyed by a Christian mob on orders of the Christian emperor Theodosius in A.D. 389. All that was

From the original entrance a long passage descends into the heart of the Great Pyramid at an angle of 26 1/2°, or a slope of about 1 in 2. The passage is 3 feet 5 inches wide and 3 feet 11 1/2 inches high.

For the first 130 feet down, the passage is built into the masonry with beautifully finished sides of white limestone, perfectly straight and smooth. Thereafter it is cut equally smoothly through the bedrock of limestone on which the Pyramid is founded.

At 345 feet from the entrance, the passage levels out for 25 feet, then enters a roughly cut pit.



ancient was pagan, and therefore sinful. Those interested in mathematics and astronomy were persecuted and put to death for their inquisitiveness. Even women weren't spared, as with the lovely Hypatia, who was seized by an angry mob (incited by the monks under the control of St. Cyril, then Bishop of Alexandria), dragged into a church, stripped naked, and scraped to death with oyster shells. Her crime was to have been the daughter of the celebrated Alexandrian mathematician Theon, to have edited her father's works, taught mathematics, and become a leading philosopher in her own right, renowned for her beauty, modesty and learning.*

As the Dark Ages continued, little or nothing more was heard of the Great Pyramid of Cheops.

* Though her writings perished with the burning of the library of Alexandria, Hypatia is known from contemporary writings to have produced a commentary on the *Arithmetic* of Diophantus, one on the *Astronomical Canon* of Ptolemy, and one on the *Comics* of Appolonius of Perga. Synesius, Bishop of Ptolemais requested her assistance in the construction of an astrolabe and a hydroscope.

II. MEDIEVAL EXPLORATION

The first dawn of a renaissance came with the Arabs. When the followers of Mohammed swept into power in the Near East in the seventh century and captured Alexandria in A.D. 640, they found no library of any importance, but a city of four thousand palaces, four thousand baths and four hundred theaters. Impressed by the opulence of the city and the size of the Christian fleet, they decided to emulate both.

The Mohammedans' delight in navigation engendered a need for geography, which required astronomy and mathematics. The search for such data was to lead them to the secrets of the Pyramid. To broaden their knowledge, the Arabs set about translating into Arabic all they could lay hands on of ancient Greek and Sanskrit material, ransacking monasteries for rare copies of Euclid, Galen, Plato, Aristotle, and the Hindu sages. In the midst of otherwise Dark Ages, Mohammed's religious successors, the caliphs of Baghdad, were soon the most enlightened as well as the most powerful potentates. Under caliph Harun Al-Rashid, whose feats were to be celebrated in the *Arabian Nights,* translators were paid in gold by the weight of each manuscript.

Harun's young son Abdullah Al Mamun, who came to the throne in A.D. 813, founded universities, patronized literature and science, and turned Baghdad—known as Dar-al-Salam, or City of Peace—into a seat of academic learning, with its own library and astronomical observatory.

Described by Gibbon as "a prince of rare learning who could assist with pleasure and modesty at the assemblies and disputations of the learned," young Al Mamun was responsible for the translation into Arabic of Ptolemy's great astronomical treatise, the *Almagest.* This work contained astronomical and geographical data, including the earliest star catalogue which has survived, all of which knowledge had been lost to the West for centuries but was of great value to the Arabs in their growing empire.

Claiming that Aristotle had appeared to him in a dream, Al Mamun commissioned seventy scholars to produce an "image of the earth" and the first "stellar map in the world of Islam." (Though they have since disappeared, these maps were consulted by the Arab historian Al Masudi in the first half of the tenth century.) To check Ptolemy's

In the *Arabian Nights* the Great Pyramid was reputed to have magical qualities and to contain extraordinary treasures. E. W. Lane's picture illustrates his nineteenth-century translation of *The Thousand and One Nights*.

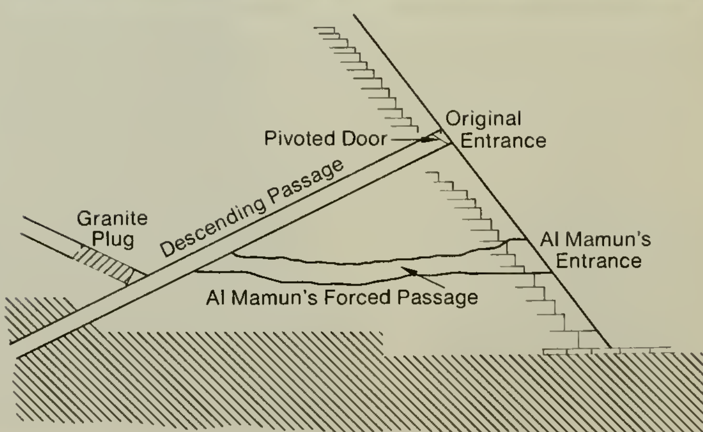
statement that the circumference of the earth was 18,000 miles, Al Mamun ordered his astronomers to measure the actual overland length of a degree of latitude across the adjacent plain of Palmyra, north of the Euphrates. From a central point the observers moved north and south till they noted by astronomical observation that the latitude had changed 1°; with wooden rods they measured across the sandy plain and obtained a degree of 56 2/3 Arabic miles, the equivalent of 64.39 English statute miles. This figure, which gave a circumference of 23,180 miles, was more precise than Ptolemy's, but the Arabs had no way of checking it: no one had yet circumnavigated the globe; indeed, most still argued that the world was flat!

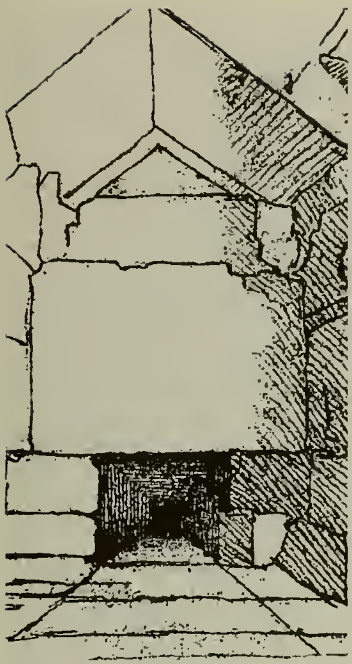
Al Mamun, who ran an up-to-date intelligence service under the direction of his postmaster-general employing as many as seventeen hundred old women as intelligence agents in Baghdad alone, was informed that the Great Pyramid was reputed to contain a secret chamber with maps and tables of the celestial and terrestrial spheres. Although they were said to have been made in the remote past, they were supposed to be of great accuracy. The chamber was also reported to contain vast treasures and such strange articles as "arms which would not rust" and "glass which might be bended and not break."

Arab historians, including one with the imposing name of Abu Abd Allah Mohammed ben Abdurakin Alkaisi, have recounted the tale of Al Mamun's attempts to enter the Pyramid. In 820 the young caliph collected a vast conglomeration of engineers, architects, builders and stonemasons to attack the Pyramid; for days they searched the steep polished surface of the northern slope for its secret entrance, but could find no trace of it.

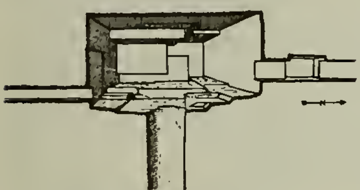
Not to be thwarted, so the story goes, Al Mamun decided to burrow straight into the solid rock of the structure in the hope of running across some passage within the interior. Hammer and chisel would not dent the huge blocks of limestone, no matter how many blacksmiths stood ready to sharpen them; so a more primitive but effective system was used: fires were built close to the blocks of masonry, and when these became red hot they were doused with cold vinegar until they cracked. Battering rams knocked out the fragmented stone.

Al Mamun forced his way into the Pyramid to the west of the main axis of the northern face, at the level of the seventh course of masonry. He misjudged the level of the original entrance by starting ten courses too low, and too far to the west.


Original
Entrance
Pivoted Door
Descending Passage
Granite
Plug
Al Mamun's
Entrance
Al Mamun's Forced Passage



Entrance to Descending Passage.



The subterranean pit cut deep into the bedrock is almost 600 feet directly below the apex of the Pyramid. It is 31 feet in the east-west direction but only 27 feet north-south.

Though its ceiling is relatively smooth, its floor is cut in several rough levels, the lowest being 11 feet 6 inches from the ceiling.

In the south wall, opposite the entrance, is a low passage which runs another 53 feet southward before coming to a blind end.

In the center of the floor is a square hole, which was 12 feet deep in 1838, but was dug deeper by the English explorer Howard-Vyse in the vain hope of finding an outlet for a further hidden chamber.

For over 100 feet Al Mamun's men tunneled into the solid core of the Pyramid, excavating a narrow passage that became hotter, dustier and more constricted. Illumination by candle or flare consumed oxygen and poisoned the air.

Al Mamun was on the point of giving up when a workman heard a muffled sound of something heavy falling somewhere within the Pyramid, east of the tunnel. Renewing their efforts and altering the direction of the bore, the workers broke into a hollow way "exceeding dark, dreadful to look at, and difficult to pass." It was a passage 3 1/2 feet wide by 3 feet 11 inches high, which sloped at a steep angle of 26°. On the floor lay a large prismatic stone which had been dislodged from the ceiling of the passage.

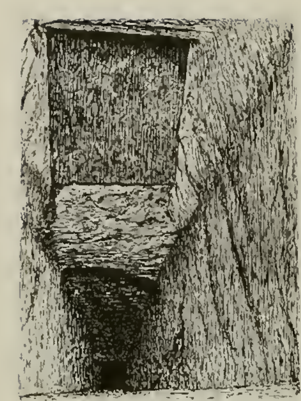
Struggling up the passage on all fours, the Arabs discovered the original secret entrance about 90 feet to the north. It had been placed 49 feet above the base of the Pyramid, ten courses higher than Al Mamun had guessed, and 24 feet east of the main axis of the north face of the Pyramid.

Retracing their steps, Al Mamun and his men groped down the low, slippery, Descending Passage, cut deep into the rock of the plateau. At the bottom they were disappointed to find nothing but the unfinished, roughly hewn chamber, or "pit," with an uneven floor, containing nothing but debris and dust. On the far side of it, an even narrower horizontal passage led 50 feet to a blank wall; in the floor a well shaft appeared to have been carved to a depth of 30 feet, leading nowhere.

From the torch marks on the ceiling, the Arabs deduced that the "pit" had been visited in classical times and that anything of interest it may have contained had long since been removed.

What now intrigued the Arabs was the large prismatic stone that had fallen from the ceiling of the Descending Passage. It had evidently covered the end of a large rectangular red-and-black granite plug which completely filled what looked like another passage sloping *up* into the body of the Pyramid. Of such a passage there had been no mention in the writings of Strabo or other classical authors; Al Mamun figured he might have stumbled onto a secret which had been kept since the original construction of the building.

The Arabs tried to chip or dislodge the granite plug, but it was tightly wedged, of indeterminate length, and it evidently weighed several tons. Spurred by the prospect of a new passage leading to some hidden treasure chamber, Al Mamun ordered his men to cut around the plug through

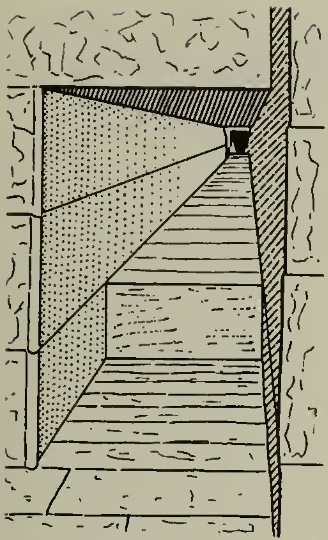


The granite plug in the ceiling, halfway down the descending passage, was of very hard quartz, mica and feldspar, which blunted the Arabs' chisels.

The Arabs dug a large cavity into the softer limestone blocks of the body of the Great Pyramid to the west of the Descending Passage. By means of this hole Al Mamun was able to circumvent the three impenetrable granite monoliths which barred his way to what appeared to be a passage leading upward into the Pyramid.

the softer limestone blocks of the surrounding walls. Even this turned out to be more of a job than expected. When the Arabs had bored beyond the first granite plug for over 6 feet, they encountered another granite plug, equally hard and equally tightly wedged. Beyond it lay yet a third. By now the Arabs had tunneled more than 16 feet. Beyond the third granite plug they came upon a passage filled with a limestone plug which could be cracked with chisels and removed piece by piece.

It is not recorded how many such plugs the Arabs encountered, but they may have had to clear a score or more before they could force their way into a narrow ascending passage, again less than 4 feet high and equally narrow. On their hands and knees, holding their torches low, Al Mamun and his men were obliged to scramble up 150 feet of dark, slippery passageway, at the same steep



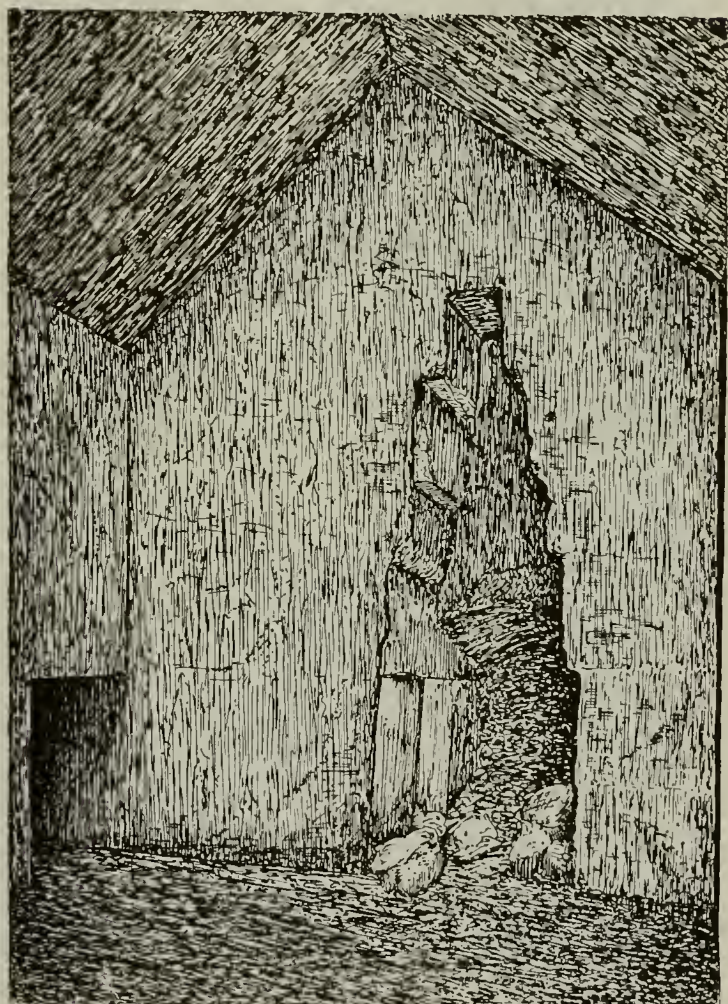
The first-level passage, at the top of the first long incline, is 127 feet long, 3 feet 9 inches high, and 3 feet 5 inches wide.
A sudden drop of 2 feet mysteriously appears in the passage.

slope of 26°, before they could raise their heads and stand on a level spot.

In front of them stretched another low horizontal passage, no higher than the one they had painfully ascended.

Inching their way to the end of this passage, they found themselves in a rectangular limestone room with a rough floor and a gabled limestone roof. Because of the custom among the Arabs of placing their women in tombs with gabled ceilings (as opposed to flat ones for men), this room came to be known as the "Queen's Chamber."

The bare room, 18 feet long, and almost square, had an empty niche in the east wall large enough to have contained an overlifesize statue. Thinking the niche might conceal the entrance to a second chamber, the Arabs hacked their way into its solid masonry for another yard before giving up.



Queen's Chamber, with niche, excavated by Arabs.

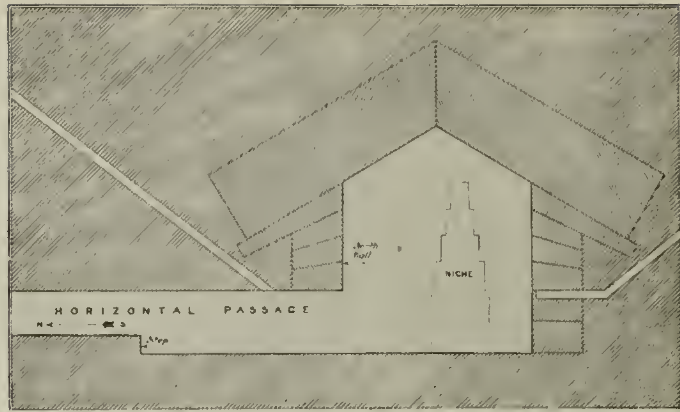
The name "Queen's Chamber" is considered a misnomer by Egyptologists, who claim that the Egyptians placed no queens in the pyramids of the Pharaohs.

The walls of the chamber are unblemished limestone blocks, beautifully finished, but early explorers found them mysteriously encrusted with salt as much as 1/2 inch thick.

Originally the niche was 3 feet 5 inches deep, but treasure seekers have hacked a passage through the back for several yards. The niche is just over 16 feet high. The sides have four corbeled courses, and are 61 3/4 inches (3 cubits) apart at the base and 20 1/4 inches (1 cubit) apart at the top.

The chamber, placed directly beneath the apex of the Pyramid, is almost square: 18 feet 10 inches from east to west and 17 feet 2 inches from north to south. It has a double-pitched ceiling, 20 feet 5 inches at its highest, formed by huge blocks of polished limestone at a slope of 30° 26′, which extend 10 feet beyond the supporting walls; there is no pressure, or arch thrust, at the apex, the center of gravity of each block being well behind the wall face.

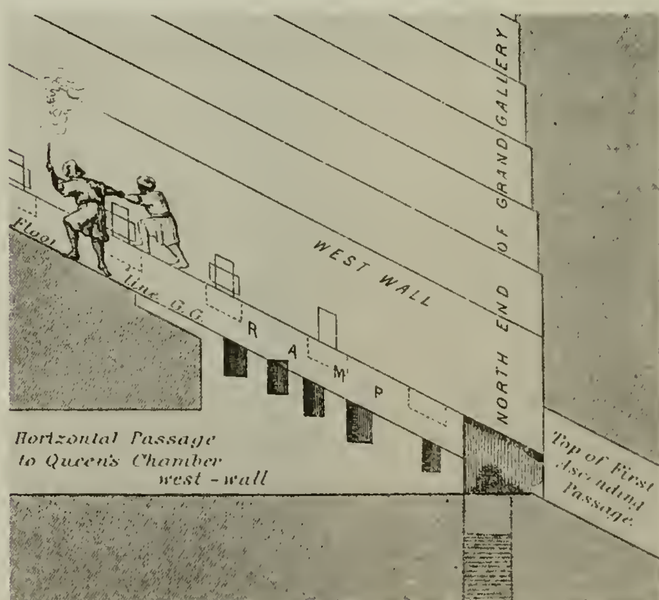
The floor of the chamber is of roughly dressed stones, and appears never to have been finished, as if another layer of polished stones were to be laid.



Retracing their steps to where they had left the low Ascending Passage, the Arabs raised their torches into an ominous void above them. In the side walls joist holes indicated that the floor of the Ascending Passage had once continued upwards, blocking and hiding the low passage to the Queen's Chamber.

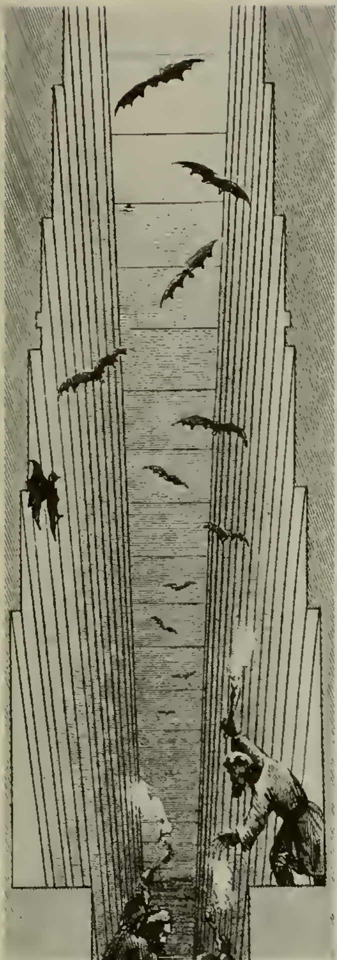
Climbing on each others' shoulders and raising their torches, the Arabs now saw that they were at the bottom of a narrow but grand gallery, about 28 feet high, which appeared to stretch upward at the same steep slope as the Ascending Passage into the black and mysterious heart of the Pyramid.

The center of this new passage was very slippery, but to either side of it were two narrow ramps slotted at regular intervals; they afforded a better foothold.



Holding their torches high, the Arabs proceeded to escalade these ramps. At the end of another 150-foot climb, they came upon a huge solid stone, raised 3 feet from the floor, which they had to clamber up in order to stand at the top of the gallery on a 6 × 8 foot platform.

Beyond this platform the floor continued level, but the



The overall length of the Grand Gallery, shown here, is 157 feet. It is inclined 26°, as is the Ascending Passage.

The walls are 28 feet high, rising vertically in seven courses of polished limestone, each corbeled 3 inches toward the center, making the gallery narrow from 62 inches at the base to 41 inches at the top. The first corbeling is 7 feet high.

On either side of the central 2-foot passage are two ramps 18 inches wide and 2 feet high; along the walls is a series of notches.

The gallery is considered an architectural masterpiece. Egyptologists have differed as to its function, and that of its ramps and notched holes.

At the top of the Grand Gallery lies a huge stone step, 6 feet wide, 3 feet high, which blocks the Ascending Passage and forms a platform 8 feet deep, now badly chipped and worn.

Beyond the Great Step there stretches another low, level passage 41 inches (or 2 cubits) square. A third of the way along this passage, it rises and widens into a sort of antechamber, the south, east and west walls of which are no longer of polished limestone but of polished red granite.

ceiling fell to a mere 41 inches, forming a sort of portcullis entrance to a small antechamber.

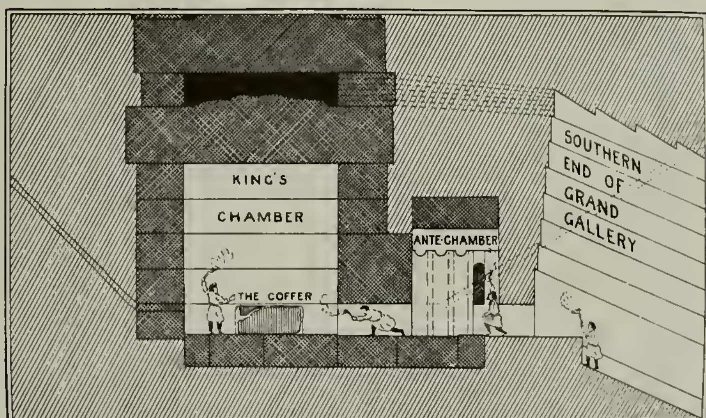
Past the portcullis, Al Mamun's men were again obliged to stoop along a short passage which led to yet another chamber.

Their torches revealed a great and well-proportioned room; the walls, floor and ceiling were all of beautifully wrought and polished red-granite blocks, squared and extremely finely jointed: "a right noble apartment, thirty-four feet long, seventeen broad, and nineteen high." Because of its flat ceiling, the Arabs named it the "King's Chamber."

Al Mamun's men frantically searched every cranny of the chamber but could find nothing of interest or value—there was no sign of any treasure, only a large lidless "sarcophagus" of highly polished, dark chocolate-colored granite.

Some Arabian authors have reported that Al Mamun found in the sarcophagus a stone statue in the shape of a man. They say that within the statue lay a body wearing a breastplate of gold set with precious stones, an invaluable sword on his chest, and a carbuncle ruby on his head the size of an egg, which shone as with the light of day. According to the storytellers the statue was inscribed with a mysterious writing that no one could decipher; but there is no historical evidence to support the tale.

To Al Mamun it appeared that either the vast mausoleum had been built about nothing but a single empty chest, or the whole place had previously been looted; though how and by whom it was hard to imagine, considering the enormous number of stone plugs the Arabs had been obliged to break up in order to make their entrance.



VERTICAL SECTION (LOOKING WEST) OF KINGS CHAMBER; ALSO OF ANTE-CHAMBER, AND SOUTH END OF GRAND GALLERY CROSSED LINES INDICATE GRANITE

The sole item within the King's Chamber is a lidless coffer cut from a solid block of chocolate-colored granite, whose granules of feldspar, quartz and mica are even harder than those of the chamber walls. They were fabled to have come not from the Egyptian quarries up the Nile at Syene but from the mythical Atlantis or even from America.

Because the coffer is 6 feet 6 inches long, 2 feet 3 inches wide and 3 feet deep and could comfortably accommodate a human body, it has been called a sarcophagus and is believed by Egyptologists to have been the tomb of the Pharaoh Cheops.

A ridge along the top edge of the coffer indicates it may have once had a sliding lid, though no trace of the lid has been found.

As the Arabs removed 22 acres of 100-inch-thick pure-limestone covering from the Great Pyramid, vast mounds of chips and refuse built up as high as 50 feet around the base.

In a fury of disappointment, the Arabs ripped up part of the floor and hacked at the beautiful granite walls, even burrowing a short tunnel into a corner of the room, all to no avail.

Legend has it that to pacify his disappointed men Al Mamun had a treasure of gold secreted in the Pyramid at night, amounting to just the wages due his men, and palmed off the coincidence on the wisdom and prescience of Allah.

For another four centuries the great pile lay undisturbed on the desert's edge, its outer casing virtually intact, its geometric shadows lengthening and shortening with the revolutions of each year. An Arab historian who saw the Pyramid in the early thirteenth century compared it to a great female breast rising from the bosom of Egypt. He remarked that it was still perfect except for the entrance carved in it by Al Mamun.

Subsequently a series of earthquakes demolished large parts of northern Egypt, and the descendents of Al Mamun's workers wreaked their revenge on the treasureless Pyramid by stripping it of its precious limestone casing to rebuild their new capital city El Kaherah, "The Victorious." In the course of several generations they managed to remove the entire 22 acres of 100-inch-thick covering of the Pyramid, and even built two bridges especially to drag the heavier stones across the river on camel trains to Cairo for the construction of a series of mosques and palaces.

The Mosque of Sultun Hasan in Cairo, built in 1356 with limestone blocks removed from the covering of the Great Pyramid.

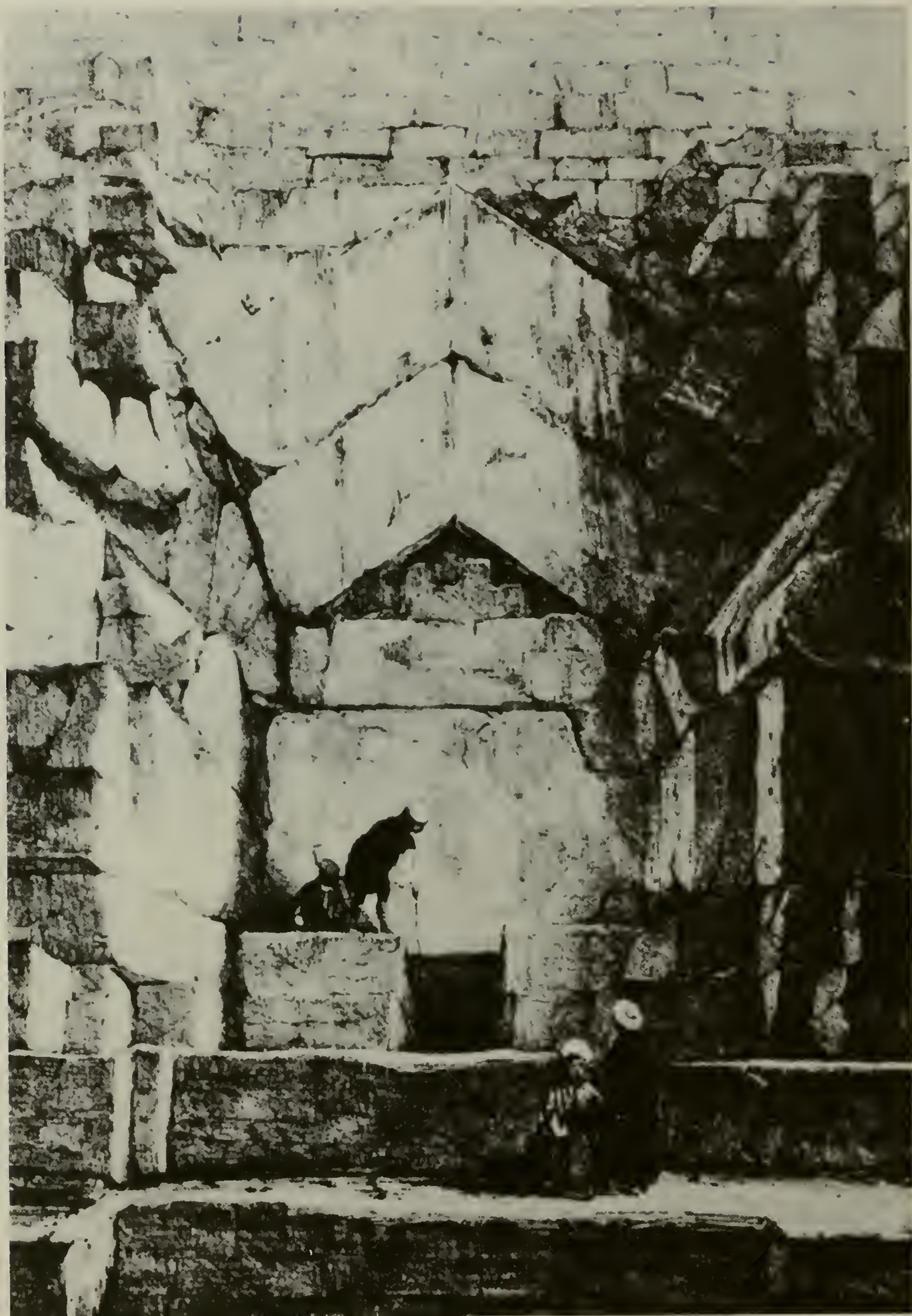
One of the more renowned of the several hundred minareted mosques in what came to be known as "Grand" Cairo was built in 1356 by Sultan Hasan almost entirely with stones removed from the Pyramid. Forty years later, in the reign of his successor Barluk, when the French Baron d'Anglure traveled to Egypt, he was able to see and report on the continued dismantling of casing stones by Arab stonemasons. D'Anglure was naïve enough to fall for the historical canard that the pyramids had been built as granaries by the biblical Joseph to store Pharaoh's grain in years of plenty; but his old French gives a vivid picture of the despoilers tumbling the massive blocks from the summit: ". . . *certain ouvriers massons qui à force desmuroient les grosses pierres taillés qui font la couverture de desdits greniers, et les laissoient devaller à val.*" ("Certain masons demolished the course of great casing stones which covered these granaries, and tumbled them into the valley.")

The stripping of the limestone left the core masonry exposed in a series of gradually ascending and receding steps to be weathered and worn by wind, sand and rain. Some of the underlying core blocks proved to be of pure limestone, others of nummulitic limestone containing large quantities of fossil shells resembling coins.

Around the stripped Pyramid, fragments of limestone and rubble were piled so high that they finally obliterated the entrance which Al Mamun had forced in the north face.

But the removal of the outer casing brought to light two huge transoms embedded in the masonry which formed a protective gable over the tiny gaping original entrance to the Descending Passage.

Only now, no one cared to reenter the Pyramid.



III. RENAISSANCE AND REVIVAL OF INTEREST

Superstition shrouded the ancient structure. It was said to be haunted by ghosts and to be alive with venomous vermin. According to the Arabs the Great Pyramid was haunted at noon and sunset by a naked woman with large teeth who seduced people into her power and then drove them insane.

When Rabbi Benjamin ben Jonah of Navarre, an adventurous twelfth-century traveler, reached the Giza plateau from Abyssinia he noted that "the Pyramids which are seen here are constructed by witchcraft."

Abd-al-Latif, who taught medicine as well as history in Baghdad, summoned the courage to enter the Great Pyramid shortly after Benjamin's visit but admitted that within its stifling interior he fainted from fear and came out more dead than alive.

The Pyramid's bad reputation spread so far afield that when the fabulous English explorer Sir John Mandeville is supposed to have visited Egypt in the fourteenth century, he is said to have complained he dared not enter the Pyramid because it was filled with serpents: but the serpents turned out to be as fabulous as his *Travels* which were produced by a notary in Liège who had never even left his native country.

Not till the Renaissance had swept away some of the cobwebs of medieval obscurantism, and revived man's interest in science, was there enough motive for Europeans to enter the Pyramid and rationally examine its interior.

In 1638 John Greaves, a 36-year-old mathematician and astronomer who had studied at Oxford and taught geometry in London, decided to set off for Egypt. His was no idle curiosity: like Al Mamun, he hoped to find in the Great Pyramid a datum that might help to establish the dimensions of the planet. Although the preceding century had spawned the great voyages of exploration, and Magellan's crew had circumnavigated the earth, the sciences of geography and astronomy were still so much in their infancy—to all appearances—that no one had improved on Ptolemy's or Al Mamun's geographical degree and hence no one knew the true circumference of the earth.

The Giza pyramids and Sphinx as depicted in 1610, showing European travelers.

A clue to a possible solution had been postulated by Girolamo Cardano, an astonishing Milanese physician and mathematician of the early sixteenth century and a close friend of Leonardo da Vinci's, who maintained that a body of exact science must have preexisted the Greeks. Cardano suspected that a degree of meridian (far more exact than that of Eratosthenes, Ptolemy or Al Mamum) must have been in existence hundreds if not thousands of years before the Alexandrians and that to find it one must search in Egypt. Pythagoras was said to have claimed that the measures of antiquity were derived from Egyptian standards, themselves copied from an invariable prototype taken from nature. It followed that the pyramids might have been built to record the dimensions of the earth and furnish an imperishable standard of linear measure.

Greaves had already traveled to Italy to measure its ancient buildings and statues in an attempt to establish the original standard of measure used by the Romans—which he concluded to be a foot somewhat shorter than a British foot by 28 thousandths.

John Greaves.

Statue of young Roman architect, Statilius Aper, in Vatican gardens, from which Greaves measured a Roman foot which was related to the circumference of the earth.

In the Vatican gardens Greaves found a statue commemorating a young architect of the first century A.D., T. Statilius Vol Aper, who had died in his twenty-third year. Portrayed in relief were Aper's architectural instruments, including a Roman foot. Greaves copied this foot and compared it to an English foot made of brass which he had divided in 2,000 parts. "I spent at least two hours," wrote

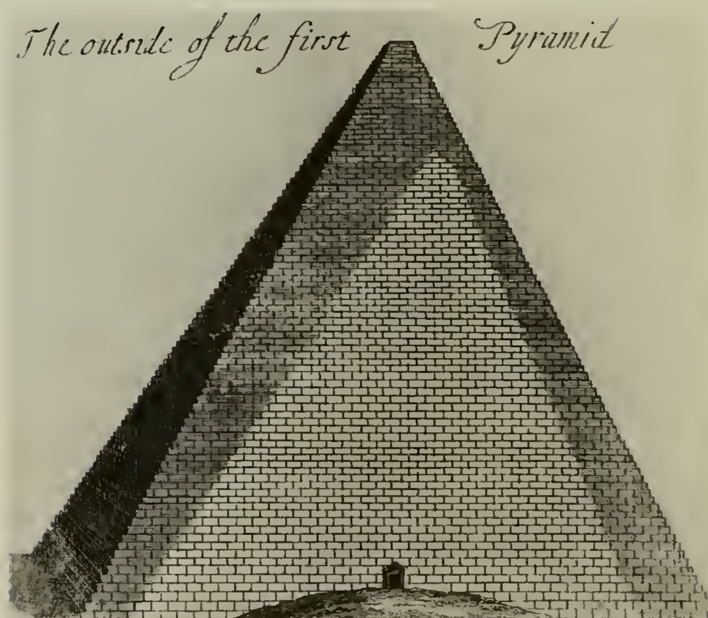
Greaves, explaining the diligence with which he performed the operation, "so often comparing the several divisions and digits of it respectively one with another, that I think more circumspection could not have been used."

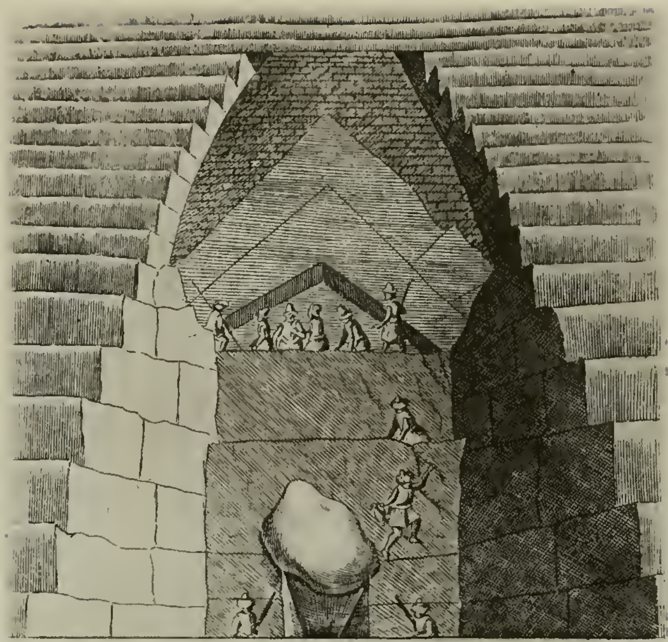
Greaves found that the Roman foot contained "1,944 such parts as the English foot contains 2,000." The interesting result of this measurement was the fact that it confirmed a Roman foot to be exactly 24/25ths of the Greek foot derived from the Parthenon—a foot of which there are 100 in the width and 225 in the length of the building.

Greaves's next problem was to establish the basic unit on which the Pyramid had been built—whether foot, pace, cubit (an arm's length), or palm.

To help defray his expenses, Greaves applied for the patronage and assistance of the magistrates of the City of London, but they turned him down. Luckily the Archbishop of Canterbury thought enough of Greaves, and was sufficiently interested in rare Arabic and Persian manuscripts which might be discovered in the East, to patronize him. Greaves was able to equip himself with instruments for measuring the inside and the outside of the Pyramid and for obtaining the declination and right ascension of the stars above it, and have enough money left over to spend a few weeks in Cairo.

Though a bookish mathematician and an ingrained antiquarian, Greaves was not without courage as an explorer. At the Pyramid he climbed onto the mound of rubbish 38 feet high which surrounded it and gingerly let himself into the Descending Passage, "creeping like a serpent," horrified to





Entrance to the Great Pyramid as depicted by John Greaves.

find himself in a storm of bats "so ugly and so large, exceeding a foot in length," such as he had never imagined.

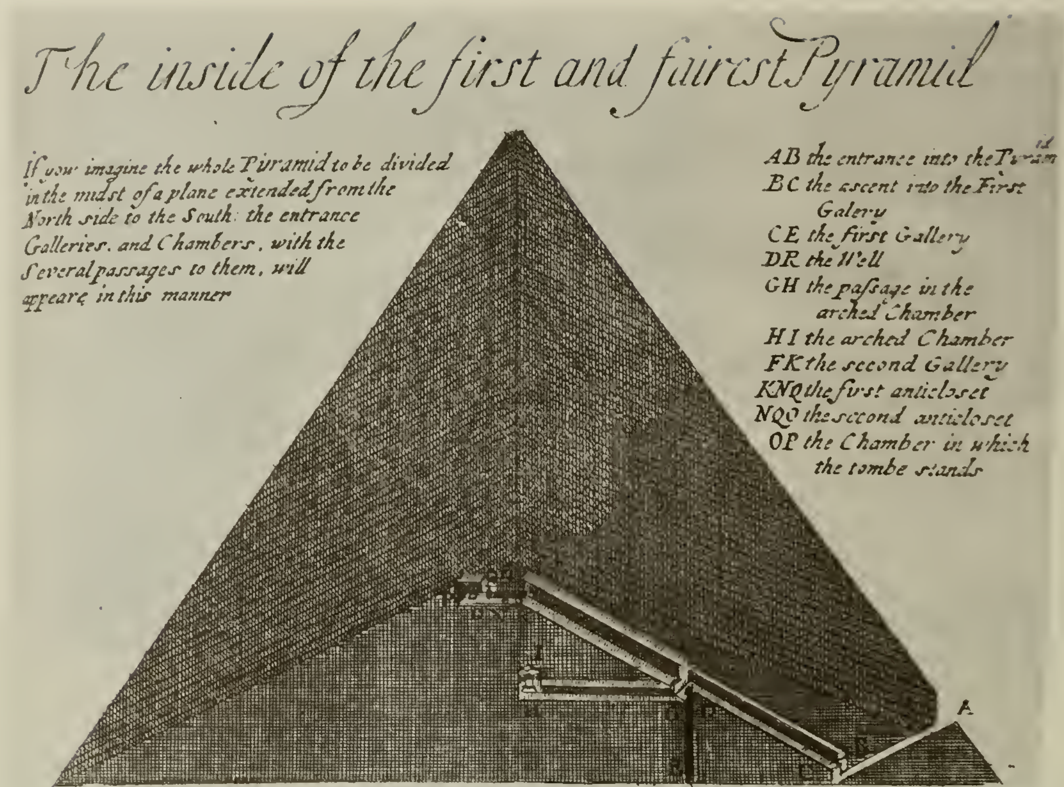
To scare off the bats and clear the air, Greaves resorted to firing his pistols; the explosions reverberated like cannon shots in the restricted passage of the Pyramid.

Working his way downward, Greaves reached the point where Al Mamun's original tunnel joined the Descending Passage, but was unable to proceed in a downward direction because of the debris left behind by Al Mamun's men when they had broken up the series of limestone plugs that had filled the upper passage.

Following in the Arabs' footsteps, Greaves climbed around the massive granite plugs and up into the low Ascending Passage. Having scrambled to the top, Greaves retraced Al Mamun's course along the short Horizontal Passage to the Queen's Chamber, where he found the stench of vermin so offensive he could not linger.

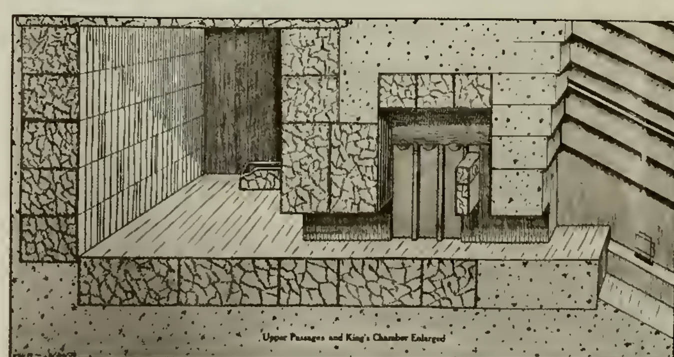
Everything Greaves came across was a puzzle to him. The steepness of the Grand Gallery seemed to preclude its having been designed as a chamber: the difficulty of scaling its polished slope made it impractical as a stairway. Also, it was accessible only through the preceding very low passage.

He admitted nevertheless that the Pyramid was "a very stately piece of work, and not inferior, either in respect of the curiosity of art or richness of materials, to the most sumptuous and magnificent buildings." He noted that it was built of polished limestone "very evenly cut in spacious



squares or tables"; and he found that the "coagmentation or knitting" of the joints was so close it was scarcely discernible with the naked eye.

Making his way to the King's Chamber, Greaves was puzzled that so incredibly imposing a structure as the Pyramid should be built around a single chamber with a single empty coffer. He could see no apparent reason for its portcullis entrance or for the complexity of its antechamber where the walls changed mysteriously from limestone to granite. But being a scientist by nature, Greaves set to collecting and noting data about the building.



How the King's Chamber and its Antechamber with its portcullis are entirely cased by granite blocks within the limestone body of the Pyramid.

Entrance to the "well."

In the west wall of the Grand Gallery, not far from the north wall, a small part of the ramp is missing, allowing entry into a shallow pit. At the bottom of this pit a short passage leads westward to an opening in the floor which becomes a shaft.

This shaft descends through the nucleus masonry of the Pyramid and penetrates a rocky core which was left by the builders as an anchor for the Pyramid *above* the level of the foundation pavement.

A grotto opens off the shaft and the shaft passes through several natural fissures in the bedrock.

For many centuries the shaft's terminus was a mystery, as was its purpose.

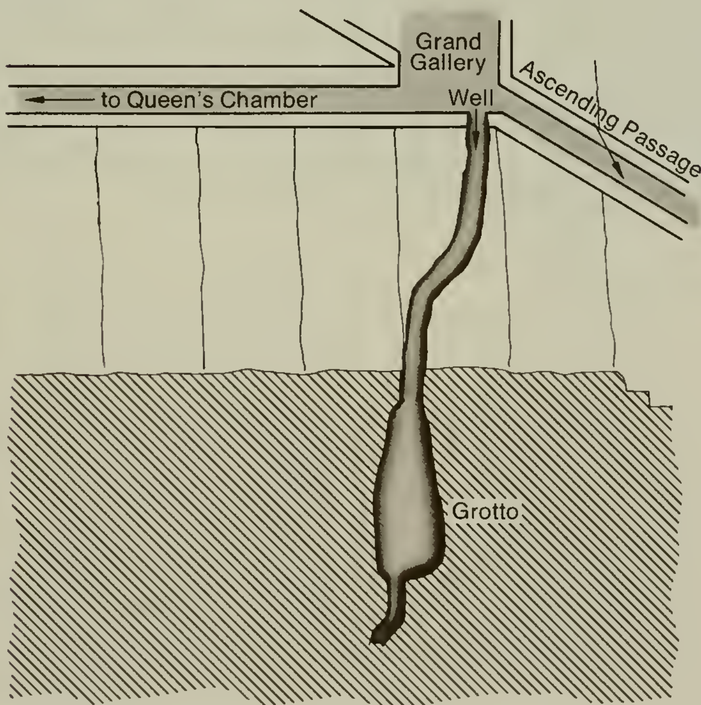
Shaft entrance to the grotto.

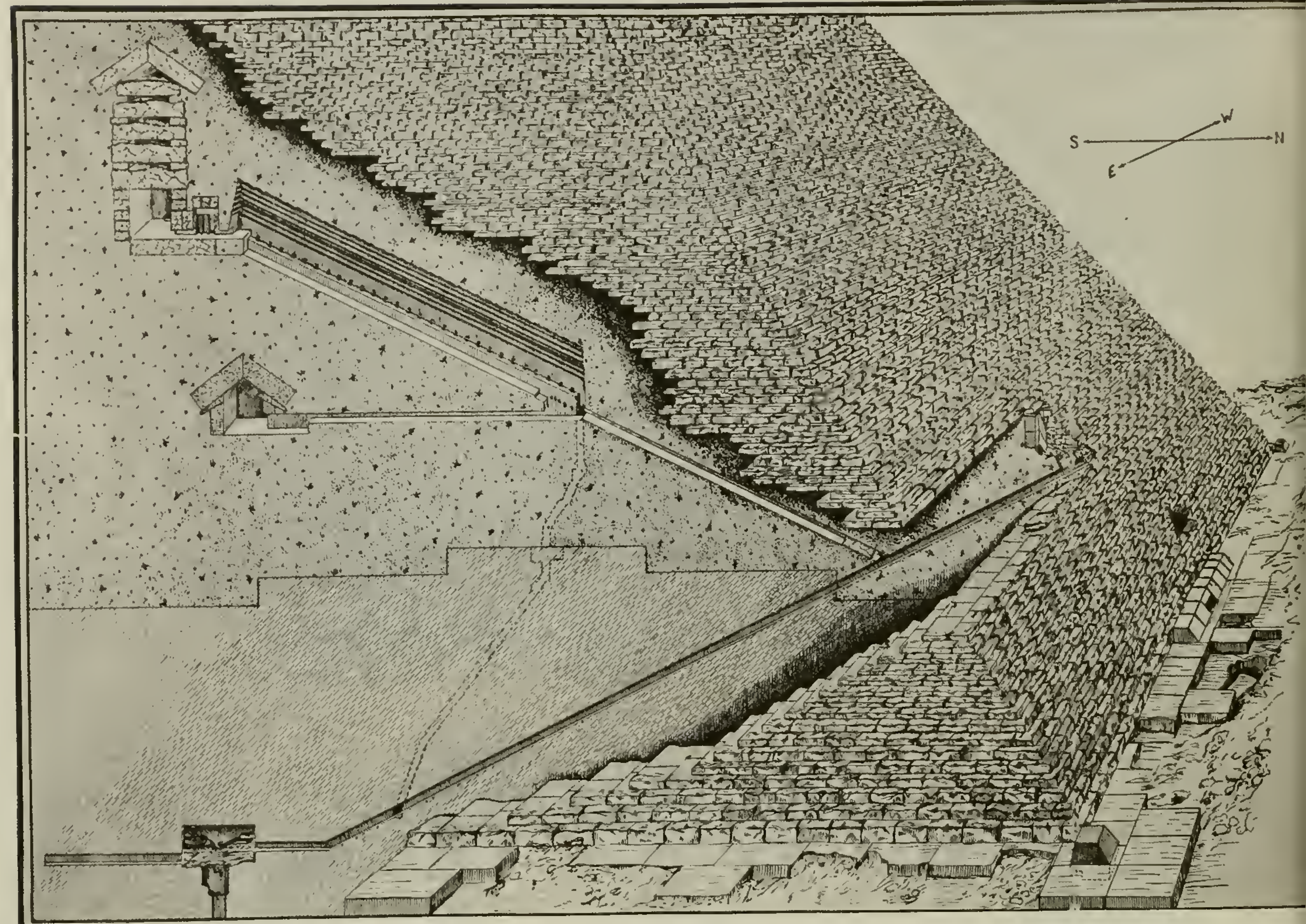
In London Greaves had furnished himself with a special 10-foot measuring rod based on a standard English foot deposited in Guild Hall, finely divided into 10,000 equal parts. With great care he measured the length, breadth and width of the King's Chamber, commenting that "the structure of it hath been the labour of an exquisite hand." He counted its tiers of granite, measured their length and breadth, and did likewise to the empty coffer, "even to the thousandth part of a foot," finding it to be 6.488 English feet.

Picking his way back to the foot of the Grand Gallery, Greaves made a new and startling discovery. From the ramp at one side, a stone block had been forcibly removed and a passage appeared to have been dug straight down into the bowels of the Pyramid.

The aperture was a little over 3 feet wide; but as notches had been carved opposite one another on the sides of this "well," Greaves lowered himself into it and descended about 60 feet, to where the shaft had been enlarged into a small chamber, or "grotto." Below him the shaft continued into the murky darkness, but the air was so foul, and the bats so thick, that Greaves decided to climb back up the way he had entered, puzzled by this strange feature of the Pyramid.

That the well shaft was not bottomless he established by dropping a lighted flare which continued to flicker from its depths.





Chambers and passages in the Great Pyramid.

Outside, Greaves climbed to the top of the Pyramid. From this high point he could admire the minarets of Cairo, the range of Mokattam hills across the Nile, and the silhouettes of the pyramids of Abusir, Saqqara and Dashur to the south.

On his way down Greaves was the first to make a reasonable count of the Pyramid's visible tiers of chiseled blocks, which he figured to be 207, estimating the total height of the structure to be 481 feet, or 499 with the missing capstone. This was within a dozen feet of being correct.

As a length for the base, Greaves estimated 693 feet, which was short of the mark by some 70 feet: but the base was so littered with rubbish that he had no way of telling where the first tier might rise from the hidden base.

Back in England Greaves was rewarded for his efforts at the Pyramid by being appointed Savilian Professor of

Pyramidographia:

O R, A

DESCRIPTION

OF THE

PYRAMIDS

IN

Æ G Y P T.

By JOHN GREAVES, *Profeſſor of Aſtronomy in the Univerſity of* Oxford.

Romanorum Fabricæ & antiqua opera (cum veniâ id dictum ſit) nihil accedunt ad Pyramidum ſplendorem, & ſuperbiam.
Bellon. lib. II. Obſerv. cap. 42.

Astronomy at Oxford. All the facts and figures Greaves had accumulated he meticulously wrote up in a scholarly booklet entitled *Pyramidographia.*

His conclusions led to a very lively discussion—with as much con as pro—in which even the celebrated Dr. William Harvey, discoverer of the circulation of blood, took part. Harvey was surprised that Greaves had not described, or apparently even discovered, any conduits by means of which the central chambers in the Pyramid could be ventilated from the exterior. According to Harvey such conduits were bound to have existed, or the air in the King's Chamber would have become extremely foul—"Seeing we never breathe the same air twice, but still new air is required to a new inspiration (the succus alibilis of it being spent in every expiration)." Harvey's surmise turned out to be true, but was not established for another two generations.

Greaves had indeed noted "two inlets or spaces, in the south and north sides of the chamber, just opposite from one another," but attributed the blackness within them to their being receptacles for burning lamps.

Before returning to England, Greaves had left his instruments, including the special 10-foot rod, to a young Venetian whom he had met in Egypt and who had accompanied him to the Pyramid, Tito Livio Burattini, who who was as anxious as Greaves to find out not only the exact measurements of the Pyramid, but the unit—whether cubit, foot or palm—on which it had originally been designed.

Burattini's trip to Egypt had been subsidized by the Jesuit Father Athanasius Kircher of Cracow, Poland, who had moved to Rome and entered into correspondence with Galileo Galilei on the subject of a universal standard of measure.

At that time Galileo was living in seclusion near Florence, having been tried and imprisoned by the Inquisition for supporting the Copernican belief that the earth and the planets revolved round the sun, and the equally heretical conceit that the earth and the sun spun on their own axes.

As a young man Galileo had timed the oscillations of a lamp swinging in the Duomo of Pisa by means of his pulse beats and found the time for each swing to be the same, no matter what the amplitude of the oscillation, thus discovering what is known as the isochronism of the pendulum.

Developing Galileo's idea, Burattini had tried to obtain a universal standard of measure by using the length of a pendulum that would vibrate exactly 3600 times in one hour, or once every second, but the gold-ball pendulum he devised proved impractical because it was found that its swing varied with temperature, location, and altitude above sea level.

Burattini lingered four years in Egypt taking careful measurements with Greaves's instruments, and he sent reports of the results to Father Kircher by letter, which was lucky for the scientific world: on Burattini's journey through the Balkans back to his adopted Poland he was set upon by bandits and deprived of not only his cash but all his notes on the Pyramid which he intended to have printed as a book in Italy.

There remained the data which he had sent to Father Kircher; but it was from Greaves's data that Sir Isaac Newton deduced that the Great Pyramid had been built on the basis of two different cubits, one of which he called "profane" and the other which he called "sacred." From Greaves's and Burattini's measurements of the King's

Sir Isaac Newton is described by Giorgio de Santillana, of MIT, as "the last of the magicians, the last of the Babylonians and Sumerians, the last great mind which looked on the visible world with the same eyes as those who began to build our intellectual world rather less than 10,000 years ago."

Chamber, Newton computed that a cubit of 20.63 British inches produced a room with an even length of cubits: 20×10. This cubit Newton called the "profane," or Memphis, cubit; whereas a longer, more arcane cubit appeared to measure about 25 British inches.

This longer, or "sacred," cubit Newton derived from the Jewish historian Josephus's description of the circumference of the pillars of the Temple at Jerusalem. Newton estimated this cubit to be between 24.80 and 25.02 English inches, but believed the figure could be refined through further measurement of the Great Pyramid and other ancient buildings.

All of this Newton wrote up in a small and now hard-to-find paper called *A Dissertation upon the Sacred Cubit of the Jews and the Cubits of several Nations: in which, from the Dimensions of the Greatest Pyramid, as taken by Mr. John Greaves, the ancient Cubit of Memphis is determined.*

Newton's preoccupation with establishing the cubit of the ancient Egyptians was no idle curiosity, nor just a desire to find a universal standard of measure; his general theory of gravitation, which he had not yet announced, was dependent on an accurate knowledge of the circumference of the earth. All he had to go on were the old figures of Eratosthenes and his followers, and on their figures his theory did not work out accurately.

By establishing the cubit of the ancient Egyptians, Newton hoped to find the exact length of their stadium, reputed by classical authors to bear a relation to a geographical degree, and this he believed to be somehow enshrined in the proportions of the Great Pyramid.

Unfortunately Greaves's and Burattini's measurements of the *base* of the Pyramid were incorrect because of the accumulated debris, and though Newton's figure for the cubit was very close to perfect, the false measurements of the base failed to give him the answer he was searching.

To resolve Newton's problem, Burattini suggested taking the actual measure of two or three degrees of latitude across the flat countryside of Poland; but the operation proved too costly. Unfortunately, neither Newton nor Burattini knew that in 1635 Richard Norwood, author of *Sea-Man's Practice,* had made an observation of the sun at noon at York using a sextant more than 5 feet in radius, and a similar observation in London near the Tower; the distance between the two points was 9149 chains, and he thus obtained a figure of 69.5 English statute miles for 1° of latitude. This figure would have solved Newton's problem, but because of the political unrest in Cromwellian England he did not hear of it; so he put away his theory of gravitation for several more years, or until the French astronomer Jean Picard repeated Norwood's feat with rather more fanfare.

In 1671 Picard measured a degree of latitude between Amiens and Malvoisine. His method was to measure a base line at Amiens very meticulously with wooden rods, then measure the angles formed by this base line with a point on the horizon and deduce its distance by trigonometry. Selecting a series of points on hilltops easily distinguished with a telescope and measuring only the angles between their sides, he was able to string out a series of thirteen large triangles across the countryside and obtain a very accurate degree of 69.1 English statute miles.

On the basis of this computation Newton was able to announce his general theory of gravitation—that all bodies in the universe attract each other in proportion to the product of their mass and inversely as the square of their distance apart—and so launch a new era of physics.

As the English poet Alfred Noyes summed up the event:

> . . . Newton withheld his hope
> Until that day when light was brought from France,
> New light, new hope, in one small glistening fact . . .
> Picard in France—all glory to her name—
> Had measured earth's diameter once more
> With exquisite precision . . .

But all this Anglo-Gallic dalliance was short-lived because an argument developed between Newton and a French family of astronomers, map makers, and surveyors called Cassini. Newton figured that the centrifugal force of the globe spinning on its north-south axis would cause the earth to bulge at the equator and be slightly flattened at the poles.

In his *Principia* Newton estimated that this would have the effect of making a degree of latitude longer nearer the poles and shorter nearer the equator.

The theory was heatedly opposed by the Cassinis, who had extended Picard's triangulation survey north to Dunkirk and south to Perpignan on the Spanish border, and maintained that the earth was elongated like an egg, as depicted in Ptolemaic Egypt: that the degree of latitude was *shorter* north of Paris.

To settle the argument the French Academy of Sciences sent out two expeditions, one to Lapland to measure an actual degree near the Arctic Circle and another to Peru to measure a degree near the equator.

After 18 months of being frozen in winter and devoured by mosquitoes in summer, the expedition to Lapland returned with a figure that showed a degree of latitude was *longer* near the flattened Pole. The Peruvian expedition suffered

The Great Sphinx lies about twelve hundred feet southeast of the Pyramid of Cheops near the valley building of Kephren. Carved from a single sandstone knoll, the colossus is 240 feet long, 66 feet high, and 13 feet 8 inches at its widest.

The headdress and the cobra on the forehead are said to have been symbols of royalty; the features are thought to resemble those of Kephren.

At one time the Sphinx may have been coated with plaster and painted in various colors.

A rational explanation of the mystery of the Sphinx was produced by the British astronomer Sir Norman Lockyer, who said that its being half lion, half virgin symbolizes the junction of the constellations Leo and Virgo which occurred at a summer solstice in the fourth millennium B.C.

even worse conditions, measuring from mountaintop to mountaintop in the Andean highlands, but after ten years of misery, came back with a similar conclusion that the degree was shorter at the equator, vindicating Newton: the Peruvian degree measured 56,734 French *toises,* the Paris degree was 226 *toises* longer, and the Lapland degree 362 *toises* longer still.*

Cassini, who very sensibly proposed the adoption of a geodetic foot representing 1/6000th part of a terrestrial minute of arc, would have been astounded had he known that just such a foot had been in existence for several millennia and that the Sphinx, which could be used as a geodetic marker to indicate the equinox, also once had an obelisk between its paws whose shadow could be used to compute not only the correct circumference of the earth but the variance in the degree of latitude.

But in all this geodetic enterprise the Pyramid's geodetic values were forgotten; its secrets remained as enigmatic as those of its neighbor the Sphinx, which by this time was almost obliterated in the accumulation of wind-blown sand from the Libyan desert.

* The *toise,* or double arm's length, was the standard of measure used by the French before the development of the meter.

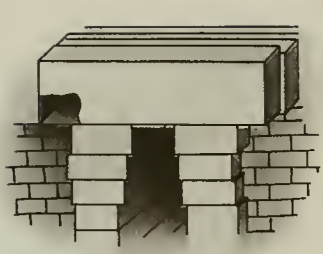
IV. THE AGE OF ENLIGHTENMENT

Travel to the Giza plateau became a dangerous undertaking in the eighteenth century. Though Egypt was still nominally under the suzerainty of the Ottoman Turks, the traveler was likely to be robbed or killed by gangs of bandit Arabs unless protected by a bodyguard of friendly Janissaries such as had accompanied Greaves.

Not until the time of the American Revolution was any further discovery of importance made at the Pyramid. In 1765, Nathaniel Davison, who was later British Consul General in Algeria, was able to spend a vacation in Egypt in the company of Edward Wortley Montagu, former British ambassador to the Sublime Porte, and carefully explore the Pyramid.

More intrepid than Greaves, Davison lowered a lamp into the "well," tied a rope round his waist, and had himself carefully lowered into its ominous darkness, about a hundred feet farther than Greaves, only to find the bottom blocked with sand and rubbish. To Davison it appeared strange that anyone should go to such an enormous amount of effort to dig a shaft almost 200 feet into the heart of the Pyramid and simply come to a dead end. But there was nothing more he could do. It was extremely close and filthy at the bottom of the "well," and his candle soon burnt up what little air was available. Also, an immense number of huge bats made it difficult for Davison to keep his candle alight; so he laboriously made his way back to the surface.

Abandoning this quest, Davison set about finding any other secret features within the interior of the Pyramid. At the top of the Grand Gallery he noted that his voice was answered in a curious way by repeated echoes which appeared to resonate from somewhere above him.



Davison's hole at the top of the Grand Gallery.

Placing a candle at the end of two long canes, Davison was able to spot a small rectangular hole about 2 feet wide at the very top of the Grand Gallery, where its wall joined the ceiling.

To reach this hole was a precarious ordeal: the walls of the gallery were polished and slippery; the perch upon which he had to place his ladder was extremely small and stood high above a yawning drop of 150 feet, all the way down the Grand Gallery. Nevertheless Davison managed to raise seven short ladders till the topmost reached the small rectangular hole.

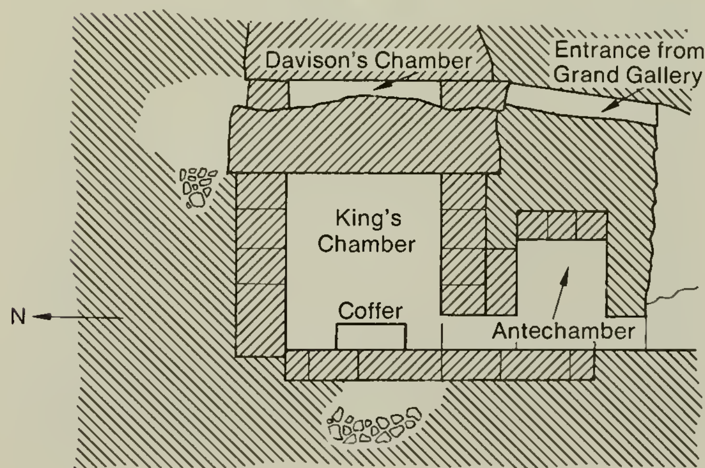
Davison climbed this rickety echeloning with difficulty. At the top he found that he was prevented from entering the 2-foot hole by some 16 inches of bat dung, which had accumulated through the centuries.

Masking his face with a kerchief, Davison managed to wedge himself into the stifling passage and crawl 25 feet to a chamber not high enough to stand in, but every bit as wide and as long as the King's Chamber below it.

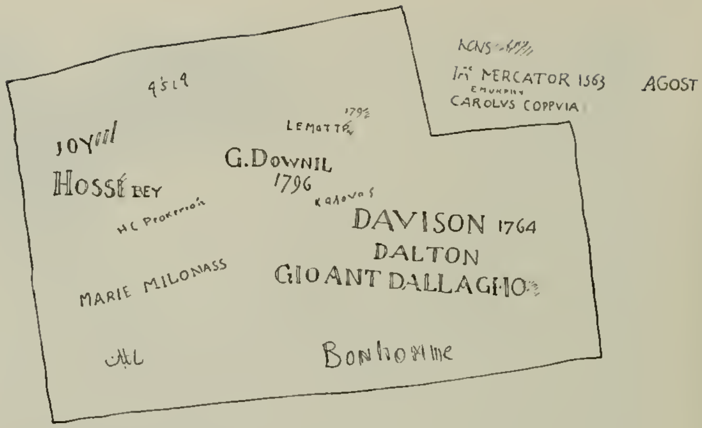
Beneath the bat dung Davison was able to make out a floor consisting of the tops of nine rough-hewn monolithic granite slabs, each weighing up to 70 tons, or as much as a modern railway engine. The under sides of these slabs formed the ceiling of the King's Chamber. To Davison's amazement, the low flat ceiling of the chamber was also constructed of another similar row of granite monoliths.

Otherwise, Davison could find nothing of either historical or architectural interest: no treasure, no inscription, no sign of any further passage. His sole reward was to carve his

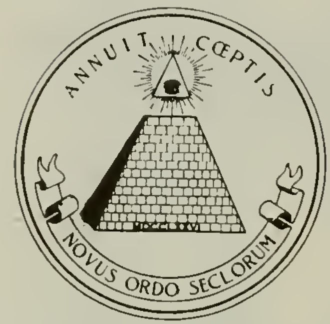
Three distinct types of Egyptian bats as depicted in the eighteenth century. The bats found by Greaves in the Great Pyramid were over a foot long, with an even greater wingspread. Of the more than a thousand known varieties of these curious nocturnal mammals the "flying foxes" of Australia have a wing-spread of up to 5 feet.



Davison's Chamber above the King's Chamber.



Davison's and other graffiti in the Great Pyramid, including that of Mercator, the Flemish cartographer.



Reverse of the seal of the United States of America. According to Manly P. Hall, an expert on Masonic lore, not only were many of the founders of the U.S. government Masons, but they received aid from a secret and august body existing in Europe, which helped them to establish the United States for "a peculiar and particular purpose known only to the initiated few." The Great Seal, says Hall, was the signature of this exalted body, and the unfinished pyramid on its reverse side "is a trestleboard setting forth symbolically the task to the accomplishment of which the U.S. Government was dedicated from the day of its inception." The eagle was apparently intended to represent a phoenix, or symbol of the immortality of the human soul. Great currency has been given to the pyramid and phoenix symbols by placing them upon a one dollar bill.

graffito on the wall and to have the newly discovered chamber named Davison's Chamber in his honor.

When the American Revolution was followed by the French, and Napoleon set out to spread his political doctrines of Free Masonry, interest was rekindled in the Pyramid.

The American revolutionaries had already gone so far as to adopt the ancient Masonic symbol of the Pyramid for the reverse of the Great Seal of the United States.

In their own revolutionary housecleaning, the French outlawed the biblical seven-day week and reverted to the decades of the ancient Egyptians. The *sans-culottes* replaced the old holidays with feast days celebrating Nature and the Supreme Being, the Human Race, the Martyrs of Liberty, Truth, Justice, Paternal Tenderness, Conjugal Faith and even Misfortune. To replace the archaic *toise* made up of six *pied de roi,* the new academicians remeasured the arc from Dunkirk to Perpignan and adopted as a decimal unit the meter, which they computed to be exactly one ten-millionth of the Paris meridian from pole to equator.

On the last day of the month of Floreal in the IXth year of the revolution—our May 19, 1798—General Bonaparte, a sallow little man of 29, set sail from Toulon with a force of 35,000 soldiers crammed into 328 vessels, to conquer Egypt as a steppingstone to India and world domination. Bored by the company of his fellow officers, Napoleon spent most of his time with an extraordinary collection of erudite French civilians classified as "savants." He had brought them along because they were reputed to have acquired a profound knowledge of Egyptian antiquities despite the fact that no one had yet deciphered Egyptian hieroglyphics, so that very little was known of Egypt's remote antiquity.

These savants, a hundred and seventy-five of whom were scattered throughout the fleet, were treated with something less than respect by Napoleon's lower ranks, who were convinced that the "graybeards" had been brought along solely to help locate and dig up hidden treasure. Once the learned gentlemen had landed in Egypt, where their function was to "civilize the natives," they were issued no rations or billets, and whenever the French came under attack from the Mameluke forces of Murad Bey, Napoleon's soldiers would form their famous squares and shout "savants and asses to the center."

Not that the savants ran any real risk. When the French reached the Great Pyramid and were attacked by 10,000 Mameluke horsemen armed with glittering yagatans under the command of Murad himself, in a brilliant green turban astride a snow-white charger, the slaughter consisted entirely of the intrepid Mamelukes. Renowned for having withstood the hordes of Genghis Khan, they were no match for the French sharpshooters and cannoneers.

In two hours two thousand Mamelukes were killed for two score Frenchmen.

Mameluke Beys and their horsemen were mostly converted Christian slaves like the Janissaries and Pages of the Sublime Porte, trained to police, tax, and control Egypt under the nominal suzerainty of the Ottoman Sultan.

In 1811 the Mamelukes were destroyed in one of the foulest but most successful ambushes in history. May 1 they were invited to a feast by Mohammed Ali, the Greek-born adventurer who governed Egypt for the Turks. Dressed in their finery, on richly caparisoned horses, 420 Mameluke Beys arrived at the citadel. Once they were crowded into the narrow street, Mohammed Ali's Albanian mercenaries opened fire from rooftops and windows with rifle and cannon. The Mamelukes screamed, their horses neighed, the street ran with blood. In half an hour all the Mamelukes were dead with the exception of Amir-bey whose horse is reputed to have leapt from the battlements and carried him safely to Syria.

Bonaparte's general staff arriving at the Great Pyramid.

Napoleon Bonaparte before the Battle of the Pyramids.

Murad Bey, whose Mameluke forces were defeated.

July 12, 1798, in the shadow of the pyramids of Giza, some 25,000 Frenchmen, demoralized, hungry, and sleepy from a ten-hour march, were ordered by Napoleon to face what he overestimated to be 78,000 Egyptians, including 12,000 mounted Mamelukes in multicolored turbans and gold-embroidered caftans that floated like gauze. The French formed into squares, ten soldiers deep, their cannons (and savants) in the center. With remarkable discipline the French held their fire till Murad Bey's cavalry were upon them. The Mamelukes outdid themselves in bravery, slashing through the barrels of the Frenchmen's rifles with their scimitars, but in vain. In two hours the squares were surrounded by corpses, the Battle of the Pyramids was over, and Napoleon was master of Egypt. As the flames from the Egyptian fleet illumined Cairo's minarets, Napoleon's men feasted on hoards of captured sweetmeats and looted the gold-laden bodies of the Mamelukes, dumping them into the Nile to float seaward the news of the Egyptian defeat.

Jomard, Coutelle and Le Père exploring the Grand Gallery.

The discoveries of the savants within the Pyramid were not sensational, mostly because of the hindrance of bats, which had greatly increased since the time of Davison.

Edmé-François Jomard, one of the younger but more astute of the savants, described the painful process of moving through the passages bent double, seared by the heat of the torches, stifled by lack of air, and sweating profusely from the effort.

Colonel Jean Marie Joseph Coutelle, a military member of the expedition, made another exploration of the well, but complained of being attacked by clouds of infuriated bats, "who scratched with their claws and stifled with the acrid stench of their bodies."

Discharging their pistols at the top of the Grand Gallery, the French were astonished at the repeated echo which sounded like thunder moving away into the distance.

In Davison's Chamber the accumulation of bat dung had risen to 28 centimeters. The savants retired without further contribution to the problem of the Pyramid's interior.

Outside, the savants were more successful. Jomard dogtrotted round the Pyramid, appalled by the amount of sand and debris which had accumulated on its flanks.

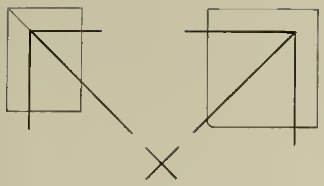
With the help of 150 Ottoman Turks, the French were able to clear the northeast and northwest corners of the building and make an important discovery.

They found the "esplanade" on which the Pyramid had originally been established, as well as two shallow rectangular "encastrements," or sockets, 10 feet by 12, hollowed some 20 inches into the base rock, quite level with each other, where the original cornerstones had once been laid.

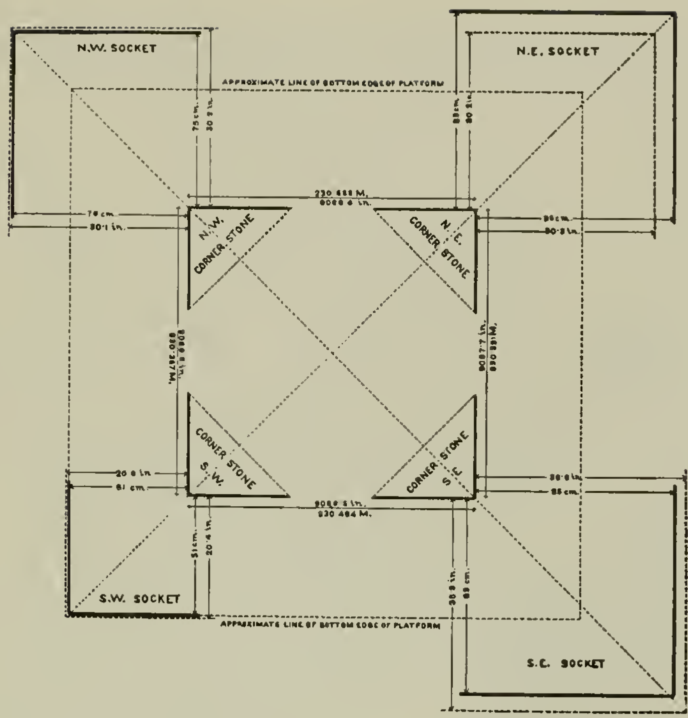
These gave the savants two firm points from which to measure the base of the Pyramid. Though the huge mounds of debris all along the north face of the structure still impeded their efforts, Jomard was able to make a series of measurements up and down and around. These gave a length for the base of 230.902 meters, or 757.5 English feet. The French now needed to know the height.

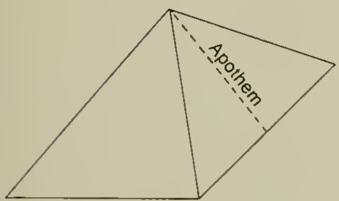
Jomard took almost an hour to climb the Pyramid, stopping on the way for breath. Once he reached the summit, his imagination was exalted by the view of the green Delta to the north, the black strip of fertile earth along the Nile, the wavelike dunes to the west. Arab villages looked like anthills on the horizon; men at the base of the Pyramid were barely distinguishable.

With a slingshot Jomard tried to hurl a stone far enough to clear the base, but in vain. Not even the Arabs had been able to shoot an arrow from the summit that would clear the footing.



The positions of the sockets.





To obtain a height of the Pyramid, Jomard measured down each step, for a total of 144 meters, or 481 feet. By elemental trigonometry this gave him an angle for the slope of 51° 19′ 14″ and an apothem of 184.722 meters.

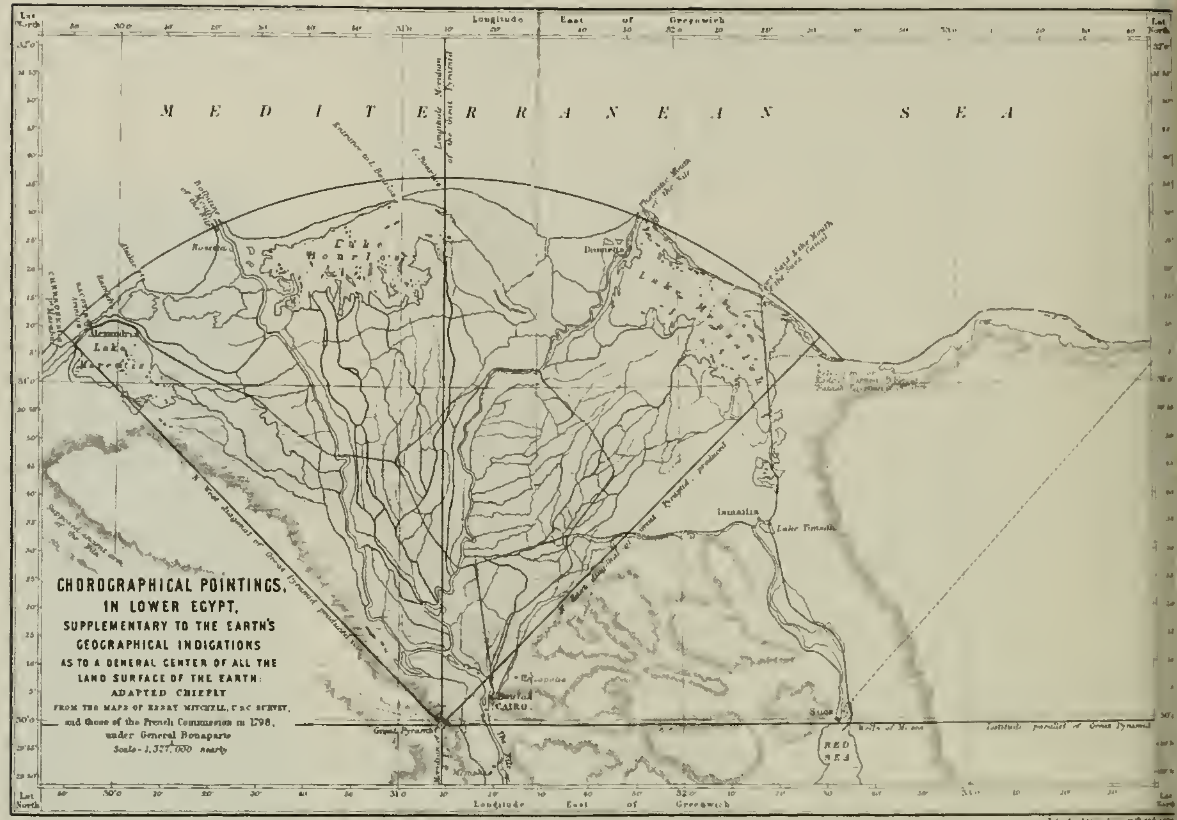
The apothem is the slant height of the Pyramid, or line from apex to center of each base, down which a raindrop would run as the shortest distance to the ground.

Because the outer casing was entirely missing there was no way to know just how thick it had been: so the measure for the apothem had to be an estimate; but the figure of 184.722 meters was to open up a whole new vista for Jomard, who was a very well-read young man.

Jomard remembered that according to Diodorus Siculus and Strabo, the apothem of the Pyramid was supposed to be one stadium long. He also knew that an Olympic stadium of 600 Greek feet—from which our modern stadium is derived —was a basic unit of land measure in the ancient world, one which was said to be related to the size of the earth.

Searching further through the trunks full of classics which the savants had brought to Egypt, Jomard found that the stadium of the Alexandrine Greeks (of Eratosthenes and Hipparchus) had been the equivalent of 185.5 meters—which was within a meter of what he had found for the apothem.

To reinforce the point, Jomard discovered that the



Bonaparte's surveyors found that the Pyramid was accurately oriented to the four cardinal points of the compass and therefore used the meridian running through its apex as the base line for their measurements.

Having mapped Lower Egypt, they were surprised to find that this meridian neatly cut the Delta region into two equal portions, and were even more surprised when they found that the diagonals drawn through the Pyramid, at right angles to each other, completely enclosed the entire Delta.

Evidently a structure which could serve as such a perfect geodetic benchmark could not have been located at random, and without considerable proficiency in astronomy, as well as a developed understanding of the configuration of the planet.

distance between the Egyptian localities as measured by Napoleon's surveyors also coincided with the classical distances between these localities computed in stadia, if the stadium was taken to be 185 meters.

Finally, Jomard learnt from his perusal of the classics that a stadium of 600 feet was considered to be 1/600 of a geographical degree.

Jomard calculated that a geographical degree at the mean latitude of Egypt was 110,827.68 meters. Dividing this figure by 600 resulted in a measure of 184.712 meters. This was within 10 centimeters of his value for the apothem.*

Could the Egyptians, Jomard wondered, have been capable of working out their basic units of measure—such as the stadium, the cubit, and the foot—from the size of the earth and then built this knowledge into the Pyramid?

To reinforce this exciting hypothesis Jomard found that several Greek authors reported that the perimeter of the base

* At Seyne the degree of longitude is 110,791.11. At Alexandria it is 110,892.66. The mean for the whole planet is 111,111.9. Jomard took the mean for Egypt.

of the Pyramid was intended to measure half a minute of longitude. In other words, 480 times the base of the Pyramid was equal to a geographical degree.

Jomard took the 110,827-meter degree and divided it by 480. The result was 230.8 meters, or again within 10 centimeters of his measured length of the base.

To find the length of the cubit that would fit these measures, Jomard again consulted the classics. According to Herodotus 400 cubits made a stadium of 600 ft. Jomard divided the apothem of the Pyramid by 400 and obtained a cubit of .4618 meter. To his surprise this turned out to be the common cubit of the modern Egyptians.

According to other Greek sources the base of the Pyramid was said to be 500 cubits. Multiplying his .4618 meter cubit by 500, Jomard got 230.90 meters—which was just what he had measured for the base.

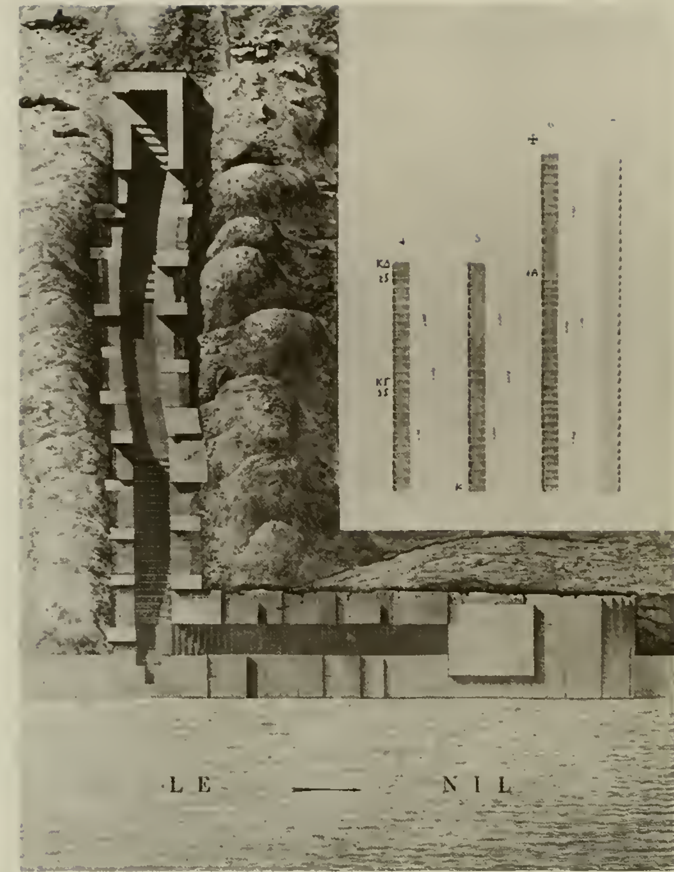
Jomard's theory was impressive to his colleagues; but when Gratien Le Père and Colonel Coutelle *re*-measured the base of the Pyramid, they found it to be 2 meters longer. They also *re*-measured the height with a specially designed instrument, step by step, and the results showed Jomard's angle of incline to have been too low, and his apothem consequently too short.

In vain Jomard argued that he had found an even more surprising coincidence in that the four-hundredth part of his base of the Pyramid gave a figure of .5773 meter, which was exactly the length of a longer modern Egyptian cubit called the *pyk belady*.

Jomard's colleagues insisted there was no evidence in any other ancient Egyptian building of the use of such odd cubits and that the only adequate cubit they had found was the one marked on the nilometer of Elephantine, which was nearly the same as the "royal" cubit of Memphis of .524 meter, or 20.63 inches, which Newton had derived from the dimensions of the King's Chamber.

Unperturbed, Jomard continued his observations. It seemed to him that from the bottom of the Descending Passage, the ancients might have been able to see the transit across the meridian of some circumpolar star, and thus have previously established true north and correctly oriented the building. Because of the length and narrowness of the passage, he said, they might even have been able to see such a star by daylight. His colleagues argued that the trap door would have prevented any such observation.

Jomard suggested that the King's Chamber, with its empty sarcophagus, might not necessarily have been a tomb but a metric monument, designed to embody, and perpetuate, a system of measures.



Nilometer discovered by the French at Elephantine, near Syene, used by the Egyptians for measuring the rise of the Nile at flood time, and marked in cubits very close to the royal cubit of Memphis.

To the end, Jomard remained convinced that the builders of the Pyramid had the necessary astronomical know-how to measure a geographical degree and thus the true circumference of the earth, and had developed an advanced science of geography and geodesy which they had immortalized in the geometry of the Great Pyramid.

Jomard pointed out that Herodotus, Plato, Diodorus and many others had all named Egypt as the birthplace of geometry, that Solon as well as Plato had come to Egypt to study geometry, and that Pythagoras had learnt from the Egyptians his theorems of geometry, his art of calculation, and his doctrine of metempsychosis.

Jomard's classically indoctrinated colleagues could not stomach the idea that their cherished Greeks might not be the founders of geometry; so the pursuit was dropped.

One last boost to Jomard's theory was given by one of Napoleon's favorite generals, Louis Charles Antoine Desaix: on his way up the Nile to conquer Upper Egypt, the 29-year-old general found a gorgeous temple near Thebes half

Edmé-François Jomard.

buried in the sand. On its ceiling was a circular zodiac. Because the zodiac clearly depicted the skies over Egypt and showed the recognizable constellations in quite different positions, the savants deduced that it must have represented the skies many centuries in the past and that the ancient Egyptians must have been acquainted with the zodiacal constellations in remote antiquity.

Unfortunately, an inscription also found in the temple appeared to date it from Ptolemaic times, shortly before our era; so another of Jomard's balloons was pricked.

Meanwhile Napoleon, whose logistical mind enabled him to figure that the Great Pyramid and its Giza neighbors contained enough stone to build a wall 3 meters high and one meter thick all around France, had become attracted by the arcane qualities of the King's Chamber.

On the twenty-fifth of Thermidor (the Revolutionaries' August 12, 1799) the General-in-Chief visited the Pyramid with the Imam Muhammed as his guide; at a certain point Bonaparte asked to be left alone in the King's Chamber,

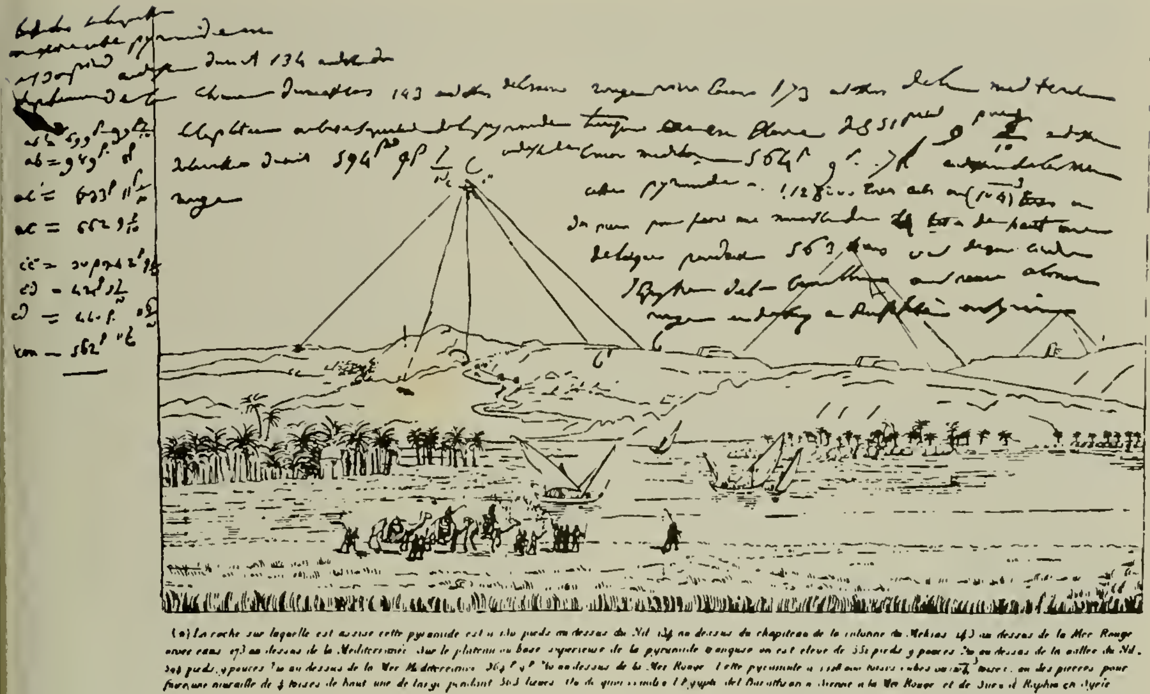
Napoleon in the King's Chamber.

as Alexander the Great was reported to have done before him.

Coming out, the general is said to have been very pale and impressed. When an aide asked him in a jocular tone if he had witnessed anything mysterious, Bonaparte replied abruptly that he had no comment, adding in a gentler voice that he never wanted the incident mentioned again.

Many years later, when he was emperor, Napoleon continued to refuse to speak of this strange occurrence in the Pyramid, merely hinting that he had received some presage of his destiny. At St. Helena, just before the end, he seems to have been on the point of confiding to Las Cases, but instead shook his head, saying, "No. What's the use. You'd never believe me."

When military and political priorities obliged Napoleon to pull out of Egypt, he abandoned his savants to be captured by the British. Chivalrously treated as civilians, they were allowed to return to France with their notes and drawings. By the time they got home Napoleon had gained sufficient power as First Consul to order them to produce a truly monumental work on all they had discovered about the sites, buildings, inscriptions, life, language and manners of the ancient and modern Egyptians. With the help of an army of painters, typographers and four hundred engravers, the study was completed and published over a period of 25 years



Napoleon's notes on his sketch of the Pyramid.

with the title, *Description de l'Egypte ou Recueil des observations et des recherches qui ont été faites en Egypte pendant l'expédition de l'armée française.*

The work ran to nine folio volumes of text and twelve of plates, and was described as "the most immortal conception and glorious performance of a book ever realized by man." Jomard contributed to it brilliantly, but his perspicacious thesis received little credit.

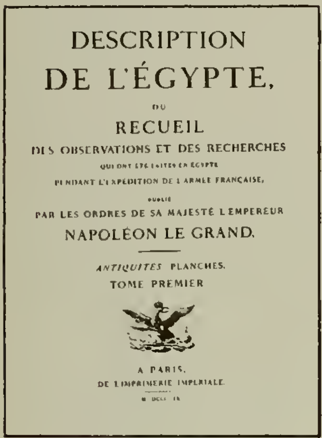
The savants were scooped by the wily Baron Vivant Denon, who brought out two volumes of the etchings he had made during the campaign in Egypt. His *Voyage dans la basse et la haute Egypte* became an instant best seller, stunning Europe with incredible sights of an unknown world of Egypt both ancient and modern, and launching a great vogue for the style known as *Empire.*

Denon's publication and the *Description de l'Egypte* which followed it piecemeal were to turn what had been a French military disaster into a cultural triumph. They also shattered once and for all the figment that before the Homeric Greeks there had been nothing but primitive barbarism.

Scientifically the most sensational discovery made by the French in Egypt proved to be a 3-foot diorite slab engraved with hieroglyphics found by a Captain Bouchard in a branch of the Delta near Rosetta. Hijacked by the British, the


GAZA
NAZARETH
SYENE
THEBES
ABOUKIR

Frontispiece for the twenty-one volume *Description de l'Egypte,* bearing Napoleon's imperial crown, and showing a composite picture of the principal monuments described by the French.



DESCRIPTION
DE L'ÉGYPTE,
OU
RECUEIL
DES OBSERVATIONS ET DES RECHERCHES
QUI ONT ÉTÉ FAITES EN ÉGYPTE
PENDANT L'EXPÉDITION DE L'ARMÉE FRANÇAISE,
PUBLIÉ
PAR LES ORDRES DE SA MAJESTÉ L'EMPEREUR
NAPOLÉON LE GRAND.

ANTIQUITÉS PLANCHES.
TOME PREMIER

A PARIS,
DE L'IMPRIMERIE IMPÉRIALE
M DCCC IX

Dominique Vivant Denon accompanied Napoleon on his expedition to Egypt and produced a series of drawings and etchings of the land of the Pharaohs which revealed a whole new world to an amazed Europe.

Born an aristocrat and renowned mostly for a series of pornographic etchings, Denon managed to ingratiate himself with the revolutionaries and escape execution. Hypnotically attractive to women, Denon was befriended by such notables as Madame de Pompadour and Catherine II of Russia. He was introduced to Napoleon by his wife Josephine.

In Egypt Denon would ride ahead of the French columns, sometimes under fire, to catch the vivid scenes of action. Sketching directly from the saddle, in which he had been for as many as sixteen hours, his eyelids ripped by the windblown sand, and seeing through a veil of blood, Denon managed to reproduce the most evocative scenes of Egypt, ancient and modern, full of verve and an exquisite sense of composition.

Brought up to think that Greek architecture of the best period was *the* standard of beauty, he was seized by the extraordinary beauty of the Egyptian works "with no extraneous ornaments or superfluity of lines." His two-volume illustrated description of Bonaparte's campaign in Egypt was an instant bestseller in Europe.

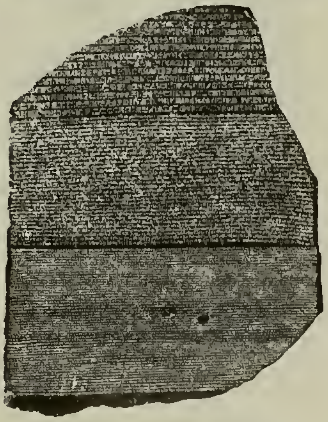
Denon was made a baron by his emperor and became superintendent of the Louvre and director of the Beaux Arts.

Nubians drawn by Denon in 1799.

Denon making a sketch in Upper Egypt.

Napoleon reviewing the French troops at Rosetta.

J. F. Champollion.



The Rosetta Stone, found in 1799, was ordered by Napoleon to be placed in the French Institute in Cairo. By an article of the treaty of capitulation it was surrendered to the British in 1801. Major General Turner sailed with it to Portsmouth in 1802 and deposited it with the Society of Antiquarians in London who turned it over to the British Museum.

A plaster of paris cast of its inscription in hieroglyphs, demotic Egyptian, and Greek, enabled Champollion to decipher the hieroglyphic language of the ancient Egyptians and formulate a system for their grammar; this made it possible for archeologists and Egyptologists to read the millennial inscriptions found throughout Egypt.

trophy ended up in the Egyptian Gallery of the British Museum. It lay there undeciphered for twenty years, until another young Frenchman, Jean-François Champollion, was to crack the mystery of its ancient hieroglyphs and throw the first real light on several millennia of Egypt's mysterious past.

As Napoleon had somewhat pompously remarked when elected a member of the National Institute, "the only true conquests are those gained by knowledge over ignorance."

V. EXPLORING WITH CHISEL AND GUNPOWDER

After Wellington's victory at Waterloo, the efforts of the French savants at the Pyramid were forgotten and the sockets they had cleaned were covered once more with the sands of the desert.

It remained for an obscure Italian to make the next impressive discovery within the Pyramid. While Napoleon was languishing on St. Helena, an exophthalmic Genoese merchant, Captain G. B. Caviglia, arrived in Egypt as the master of a Maltese vessel flying the British flag. Seized by the mystery of the Great Pyramid, he gave up the sea and settled down to exploring the Pyramid and its neighbors on the Giza plateau, financing himself by helping rich Europeans scavenge the surrounding tombs to assuage their taste for original Egyptian antiquities—a taste which ran to anything from scarab rings to thousand-ton obelisks.

Described by a contemporary as an "enthusiastic devotee at the shrine of antiquarian learning, who sacrificed country, home, friends and fortune for the indulgence of the refined though eccentric taste of exploring the hidden mysteries of the Pyramids and Tombs of Egypt," Caviglia cleared out the bat excrement from Davison's Chamber and set up housekeeping within it, turning "the gloomy recess into a residential apartment"—though how this was accomplished under a 3-foot ceiling is not explained.

Alexander William Crawford (later Lord Lindsay), who encountered Caviglia in Cairo, found the Italian to be a deeply religious man, well versed in the Bible, which he constantly quoted, but also a man with some pretty strange ideas about what he would find in the Pyramid. To England Crawford wrote: "Caviglia told me that he had pushed his studies in magic, animal magnetism, etc., to an extent which nearly killed him . . . to the very verge, he said, of what is forbidden man to know, and it was only the purity of his intentions which saved him."

Caviglia was convinced that if he dug into the Pyramid he would eventually encounter a secret room. To find it he hired a gang of Arab workmen to dig a tunnel leading off from Davison's Chamber. But no matter how far they dug, they found nothing but solid masonry.

Caviglia cleared the sand from the base of the Sphinx and revealed the footing for a missing obelisk between its paws.

At last Caviglia was obliged to give up the job; to console himself he set about analyzing the mystery of the "well." Lowering himself down the shaft, Caviglia got as far as 125 feet below the grotto only to find, as Davison had before him, that the bottom was completely stopped, and that the air was so scarce his candle spluttered, making it difficult for him to breathe.

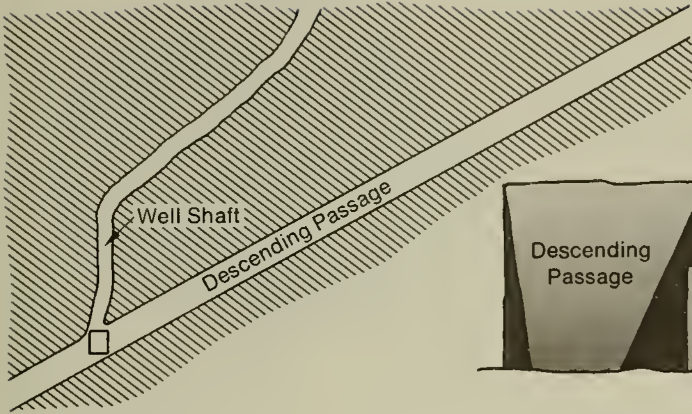
However, as the bottom appeared to be mostly sand and loose rocks, Caviglia was determined to unplug it and see where it led. For a while he managed to impress a gang of Arabs into raising basketfuls of the sand all the way up to the top of the well; but the shaft was so tight, the air so fetid with bat dung, and the dust so suffocating, that the Arabs began to faint and refused to work further. Caviglia attempted to clear the air at the bottom of the well by burning chunks of sulfur, but it was still impossible to breathe that far down for any length of time, and the Arabs would not resume their digging.

Lower end of the well shaft.

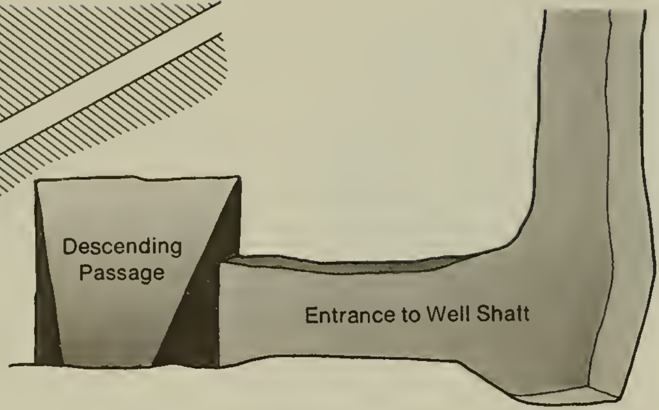
Caviglia decided to attack the problem from a different angle. He would attempt to clear the main Descending Passage to the subterranean pit which had been filled since Al Mamun's time with the refuse of the plugs they had broken out of the Ascending Passage. Caviglia had the refuse carried up and out of the Pyramid, and was able to push his way on hands and knees down the passage for 150 feet; then the air became so impure and the heat so great that he started to spit up blood. Still, he would not give up. At the end of another 50 feet he made a discovery which seemed to indicate he might be on the right track. On the west side of the passage he found a low doorway leading into a hole. As the Arabs began to dig upward into this hole, Caviglia noted a strong smell of sulfur. It occurred to him that he might have hit upon the solution to his previous problem: the smell of sulfur might be coming from the bottom of the well, which must therefore be very close.

Digging harder, the Arab workmen dislodged some loose earth. A pile of dust and rubbish fell onto them, including a basket and ropes which had been left at the bottom of the well. There was also a sudden gush of air up the tunnel, and those in the passage were able to breathe with ease. Caviglia had discovered the end of the well. But a greater mystery remained. Why had it been dug there, when, and by whom?

As Caviglia set about resolving this mystery, another



Where the well joins the Descending Passage.



strange figure joined in the Pyramid research, one quite the opposite of the romantic, uncommunicative Caviglia. Richard Howard-Vyse, a British Guards officer, at first collaborated heartily with Caviglia, but they soon grew angry at each other and came to a heated parting.

Colonel (afterward General) Howard-Vyse in 1830.

Colonel Howard-Vyse, son of General Richard Vyse and grandson of the Earl of Stafford, was a martinet with little humor who had been equerry to the Duke of Cumberland (later first king of Hanover) and had stood unsuccessfully for Parliament in the borough of Windsor. He has been described as thoroughgoing and as artless as Wellington, under whom he served.

A trial to his family, who were pleased to have him away from the county seat in Buckinghamshire, even if it cost them some of the family patrimony, Howard-Vyse was to spend over 10,000 pounds sterling on exploration of the Pyramid site.

Howard-Vyse first saw the pyramids on a moonlit ride from across the Nile at Turah in November of 1836, during a trip to Egypt as "a fashionable amusement seeker." In his own words he was attracted by "the remote antiquity and uncertainty of their origin, and . . . the peculiarity of their mysterious construction." He was curious about "the purpose for which the passages and chambers already discovered were originally intended, but in much greater degree respecting any other passage or apartments which might reasonably be supposed to exist in the enormous structures."

Impressed by Caviglia's theories about the mysterious and hermetic purposes for which the Great Pyramid had originally been constructed, Howard-Vyse hired the services of a professional civil engineer, John Shae Perring, who had been an assistant to Mohammed Ali, the khedive of Egypt. Perring was to take measurements of all the pyramids and tombs which had thus far been discovered on the Giza plateau, as well as many of those farther south.

In his *La Pyramide de Cheops ât-elle livré son secret* Fernand Ihek says that the shape of the Great Pyramid was such that it enabled bodies (either animal or vegetable) to become naturally mummified when placed within the King's Chamber. He says the end result was a desiccation or dehydration of the body with no sign of putrefaction. Experiments revealed that an uncleaned trout became mummified in thirteen days, a radish in fifteen days, and the heart of a sheep in forty days.

Ancient Egyptians removed the brain and entrails of a body to be mummified without scarring it by pulling the brain out through the nose and the viscera through the anal aperture.

The body was then soaked in brine for a month; aromatic plugs, often perfumed with onion, were placed in the nostrils and other orifices.

According to Manly P. Hall, there is every reason to suppose that originally only those who had received some grade of hermetic initiation were mummified; for "it is certain that, in the eyes of the Egyptians, mummification effectually prevented reincarnation."

Reincarnation was considered necessary to imperfect souls, or those who had failed to pass the tests of initiation. "The body of the Initiate," says Hall, "was preserved after death as a species of Talisman or material basis for the manifestation of the soul upon earth." When the body of a "god-like" Pharaoh was mummified it could serve as a medium through which survivors could communicate and plead their cause with "the beyond." At first only Pharaohs appear to have been mummified; later it was done to persons of royal rank, and to anyone who could afford it; eventually even animals were mummified.

Howard-Vyse set up his headquarters in an empty tomb near the Great Pyramid and was soon employing a larger number of workmen than anyone since the time of Al Mamun, often as many as seven hundred, using Captain Caviglia as superintendent of works.

All went well till the colonel chose to take an extended tour up the Nile to inspect a further series of pyramids. When he returned he was outraged to find that Captain Caviglia had almost entirely neglected the Great Pyramid and was using the men hired by Howard-Vyse to search for mummies and little green idols in the neighboring burial pits.*

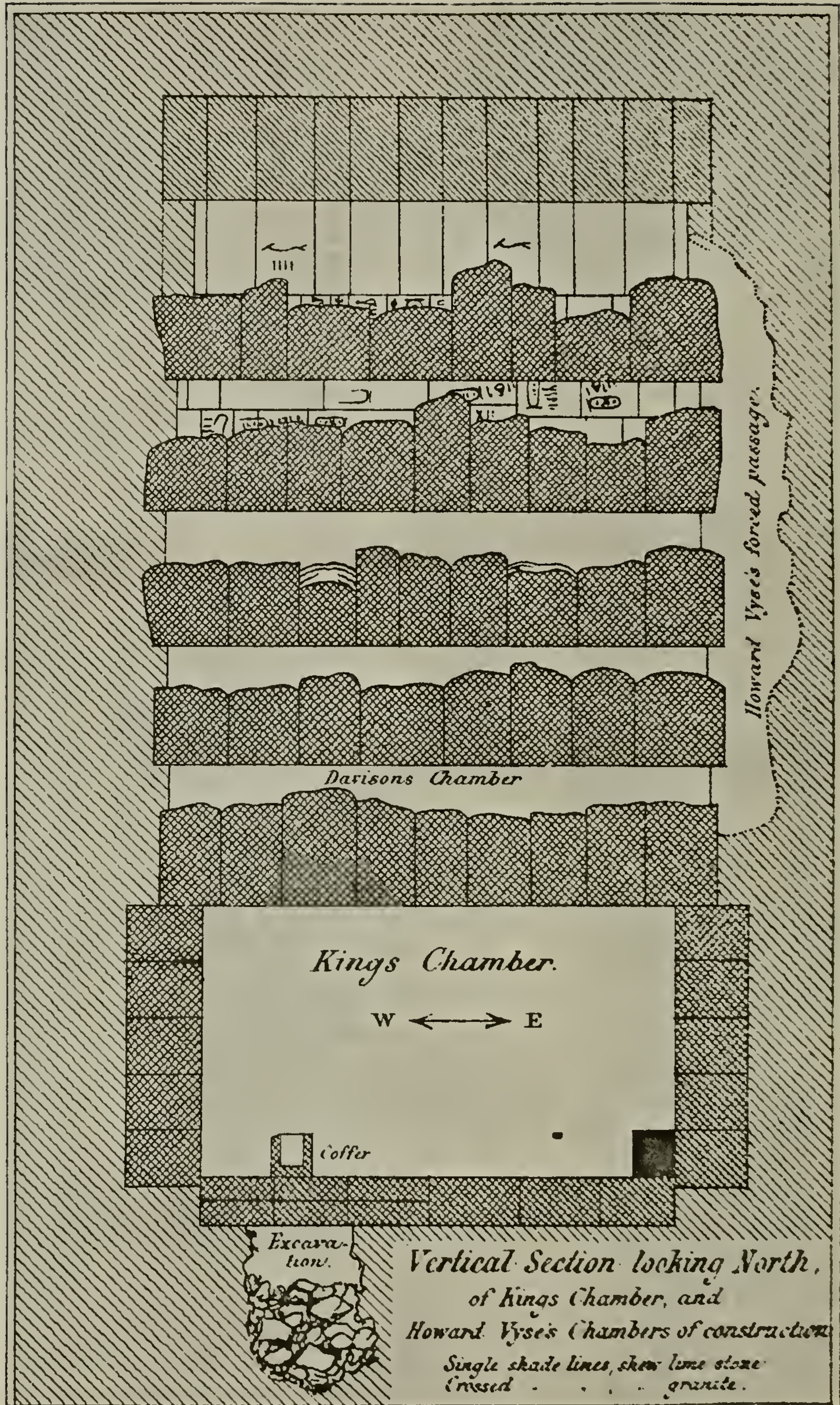
Caviglia became equally outraged at the colonel's reprimands, and gesticulated abusively declaring that "he alone had the head to conduct excavations and to understand the value of 'curios' and '*anticos*,' the colonel having nothing but money."

When the colonel asked for the return of his money, Caviglia disdainfully appeared at breakfast in the colonel's tent and threw on the table the money wrapped in an old stocking.

It was the end of Caviglia's exploring in Egypt. He retired to Paris, where he was sporadically supported by another great scavenger of antiquities, the former British ambassador to the Sublime Porte, Lord Elgin.

Howard-Vyse took over Caviglia's duties. In the words of a Victorian lady admirer, the colonel "sat down before the Great Pyramid as a fortress to be besieged, and through winter and spring and the burning summer of Egypt, long after all travelers had left the country, became the sole director of operations, clerk of the works and paymaster of his hundreds of workmen, day after day, month after month, until they had wrought out his own ideas of pyramidical exploration to the full. For not only was he one of those men who was never known to turn back after having put his hand to the plow, but he was a religiously [*sic*] minded man, a devout Christian, who felt that he was in this case called to a certain work for the Master, and though in the first instance he had distrusted himself in a new field of labor

* Mummy flesh was in great demand in Europe during the sixteenth and seventeenth centuries as a medicinal; it was a common drug to be found in all apothecaries. Mistaken for Persian *moma*, or pitch, which was used to heal cuts and bruises, mummy flesh was believed to make fractures unite in a few minutes and to be good for all kinds of internal ailments. When mummies became scarce traders used the bodies of executed Christians, or the bodies removed from hospitals, many of which had died of loathsome diseases. The bodies were stuffed with bitumen, wrapped in bandages and baked.



Vertical Section looking North, of Kings Chamber, and Howard Vyse's Chambers of construction.

Single shade lines, shew lime stone. Crossed . . . granite.

so that he had thought it better to use the purchased help of the Italian professional, yet when that failed he became a most admirable example to all kinds of men, rich and poor alike, of giving himself to the work, putting his own shoulder to the wheel, and never quitting it until the end was gained, during all the time, too, preserving the utmost urbanity, but dealing out the strictest justice in a manner that made a most honorable and lasting impression on the tawny Arabs around him."

In the Queen's Chamber Colonel Howard-Vyse had relays of men work day and night digging up the floor in front of the niche, but all they found was an old basket: so they refilled the hole.

In Davison's Chamber they found a crack in the ceiling through which they could run a reed about 3 feet long. Believing this to be an indication of a similar chamber above, Howard-Vyse had the workmen chisel their way into the granite over their heads. But the stone was too hard, and again the Arabs could not stand the heat in the restricted space of Davison's low-ceilinged chamber.

Special quarrymen were imported from the Mokattam hills across the valley. When even they could not manage the job, the colonel resorted to gunpowder to blast his way upward. To handle the charges he found a workman called Daued who lived mostly on hashish and alcohol. Daued successfully set off the blasts—a job that was particularly dangerous as the splintered granite flew about like shrapnel.

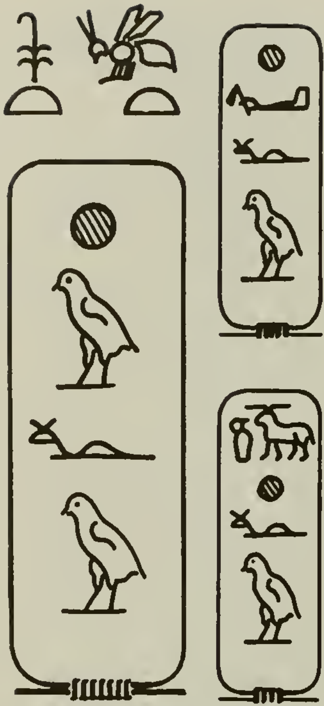
When the dust subsided Howard-Vyse found that they had indeed broken through to another chamber, which he chauvinistically named after Wellington. Its floor was the top of the nine monolithic blocks of granite which formed the rough-hewn ceiling of Davison's Chamber, each block weighing over 50 tons. About a yard above them lay another flat ceiling made of eight blocks of granite.

The new chamber had a strange effect on those who entered; it turned them black. Instead of bat dung, the floor was covered with a thin black powder which when analyzed turned out to be exuviae, or the cast-off shells and skins of insects. Of living insects there were none to be found.

Convinced that the monoliths of the ceiling were in turn the floor of a third chamber, Howard-Vyse ordered the blasting resumed. The colonel's excavations above the King's Chamber became more and more difficult as they rose vertically to a height of 40 feet and took three and a half months to accomplish.

One by one, three more chambers were found above the two already discovered, the uppermost being gabled with huge blocks of sloping limestone. These chambers

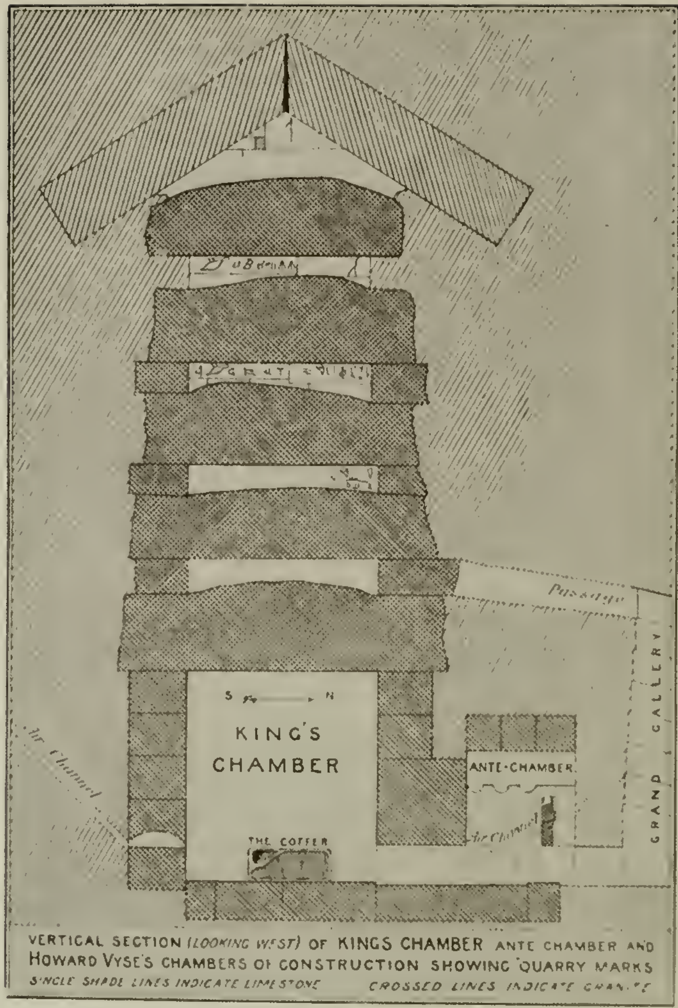
Construction chambers above the King's Chamber.



As some of the quarry marks found in the chambers are hieroglyphs signifying "year 17," Egyptologists deduced that the building had reached that stage in the seventeenth year of the king's reign. Most of the marks were roughly daubed in red paint and appeared upside down, indicating they were quarry marks and not decorations.

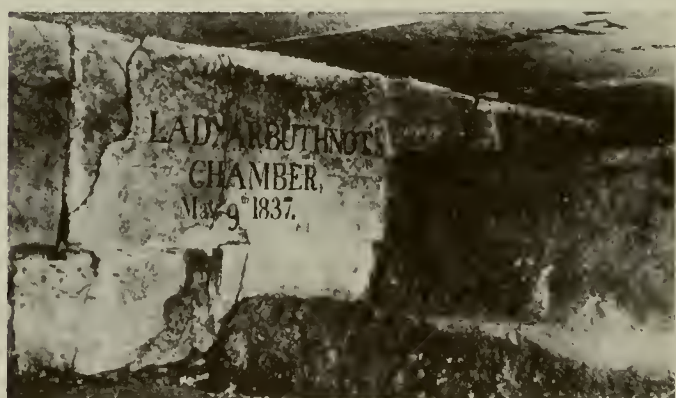
Similar marks, mostly red, but occasionally black, were also found on the first five or six courses of the Pyramid, behind the casing blocks.

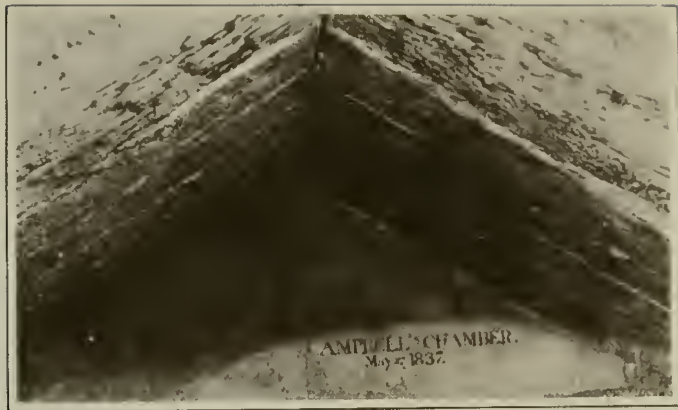
Howard-Vyse sent copies of the crayon marks to Samuel Birch of the British Museum who identified one of the ovals as belonging to King Suphis, or Shofo, or Khufu.



Sectional drawing of the King's Chamber, looking west, showing all four chambers discovered by Howard-Vyse.

Lady Arbuthnot's Chamber, discovered by Howard-Vyse.





Ceiling construction above Campbell's Chamber.

Howard-Vyse named in turn for Admiral Nelson, for Lady Ann Arbuthnot, wife of Lt. General Sir Robert Arbuthnot, who happened to visit the Pyramid shortly after the room was discovered, and for Colonel Campbell, Her Brittanic Majesty's Consul in Cairo.

The most interesting discovery was not so much the chambers themselves but some red-paint cartouches daubed on the inner walls of the upper chambers. Thanks to the Rosetta Stone and Champollion's successors, one of these cartouches was recognized by Egyptologists as belonging to Khufu, believed to be the second Pharaoh of the Fourth Dynasty, called Cheops by the Greeks, whose reign was thought to have occurred in the third millennium before our era.

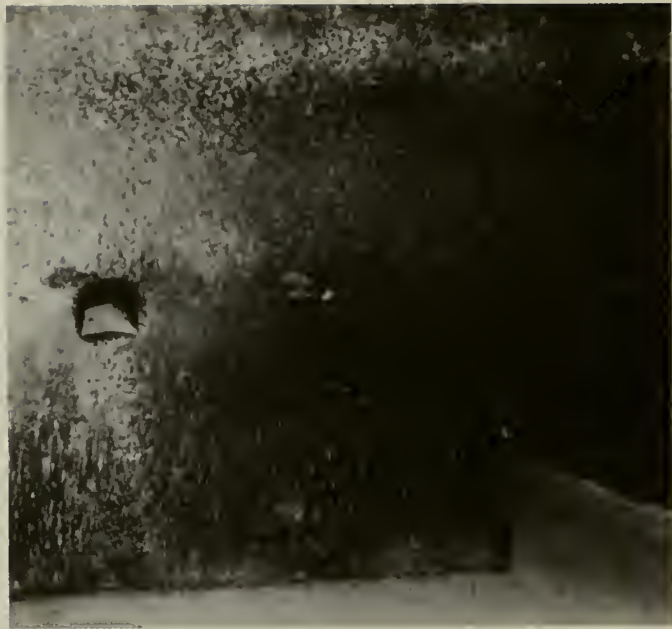
There was, of course, no way to prove that this Khufu was indeed the Cheops who had reigned in Egypt. But the fact that similar cartouches had been found in the quarries of the Wadi Magharah hills, from which much of the stone for the Pyramid was derived, added weight to the assumption.

One thing seemed clear. Whoever had daubed the cartouches on the inner walls of the upper chambers must have done so *before* the chamber was sealed and the Pyramid completed; there appeared to be no entrance or exit other than the one blasted by the colonel.

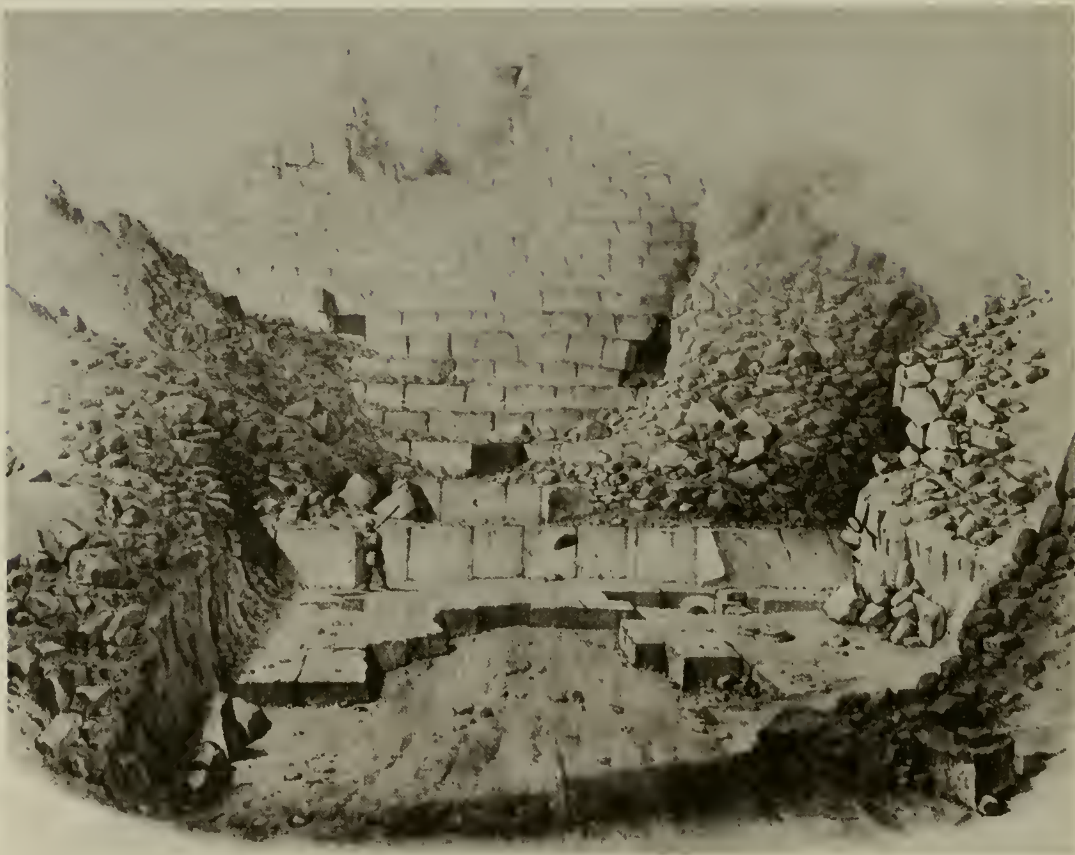
Doubt still lingered that there might have been a far earlier king with a similar cartouche, quite unknown to Egyptologists; but until further evidence could be adduced, it seemed hard to go against the theory of the Pyramid having been built in the reign of the historic Cheops, as reported by Herodotus and other classic authors.

As for the reason for the five superimposed chambers, it was the conclusion of Howard-Vyse, and many who came after him, that they had been designed to relieve the flat

Air vent in the north wall of the King's Chamber.



Casing stones and pavement as exposed by Howard-Vyse. Both entrances can be seen, Al Mamun's on the sixth course, and the original entrance ten courses higher.



ceiling of the King's Chamber from the pressure of the 200 more feet of solid masonry piled above it.

Another remarkable discovery made by the colonel in the walls of the King's Chamber was to vindicate the hypothesis of Dr. Harvey. Greaves had found the two 9-inch-wide openings in the side walls of the King's Chamber, but it was not till Mr. Hill, one of Howard-Vyse's assistants, who ran a hotel in Cairo, climbed high up on the outer surface of the Pyramid and found two similar outlets that it was established they were connected for over 200 feet right through the solid masonry to the holes in the King's Chamber. The colonel's engineer, Perring, was nearly decapitated when a stone dislodged by Hill came crashing all the way down one of these conduits.

When the conduit was cleared, an immediate rush of cool air entered the King's Chamber. Thus ventilated, the temperature of this chamber in the center of the Pyramid was to remain at an even and pleasant 68 degrees, irrespective of the weather or season outside, a prehistoric system of air conditioning. This added substance to Jomard's theory that the chamber might have been the repository for weights and measures which require an even temperature and constant barometric pressure, such as the Paris observatory for measurements of standards 85 feet below ground.

Even more sensational for those who were bent on unraveling the secrets of the Pyramid was the next discovery of Howard-Vyse. Ever since the Middle Ages, when the Arabs had despoiled the outer casing, the whole perimeter of the base of the Pyramid had been heaped high with fragments of limestone, and sand and debris, often in piles as high as 50 feet. The two northern corners uncovered several years earlier by the French had already been buried again. This time Howard-Vyse decided to clear away a patch of debris in the center of the north façade to see if he could get down to the very base and bedrock of the Pyramid. In doing so, he was to make a great discovery: two of the original polished-limestone casing stones on the lowest level of the Pyramid were still in the spot where they had been originally placed.

This ended the argument about the casing; it silenced forever those who had continued to consider it a fiction that the whole of the Pyramid had once been covered with a fine mantle of limestone. The original limestone was there, and so finely carved that it was now possible to correctly measure the angle of the slope on which the Pyramid had originally been constructed. The blocks, 5 feet high, 12 feet long, and 8 wide, showed an angle of about 51° 51′, a little sharper than the one estimated by the French.

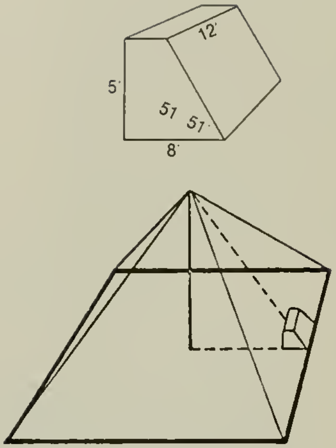
Hewn to the correct angle and polished to a uniform surface, they were quite perfect, in the words of Howard-Vyse, "in a sloping plane as correct and true almost as modern work by optical instrument makers. The joints were scarcely perceptible, not wider than the thickness of silver paper."

The colonel also managed to uncover part of the original pavement on which the building rested, and which appeared to stretch away to the north. "It was well laid and beautifully finished," noted Howard-Vyse, "but beneath the edifice it was worked with even greater exactness, and to the most perfect level."

Though the reason for this astounding accuracy on the northern side was not to become apparent for some years, Howard-Vyse summed up his discoveries thus: "I consider the workmanship displayed in the King's Chamber, in the pavement and the casing stones, is perfectly unrivaled."

The colonel had the casing stones quickly covered up pending permission to take them to the British Museum, but he was not able to prevent the infuriated local Moslems from uncovering them again and smashing the fine edges with hammers, jealous that Christians might obtain and dispose of something of value in their country.

With the angle of 51° 51′ of the casing stones and the base length of 763.62 feet measured by the Frenchmen Coutelle and Le Père, it was now possible to obtain by trigonometry a new dimension of the Pyramid. Its perpendicular height to where the missing capstone was presumed to have come to a point was figured to be 485.5 feet, or 147.9 meters, above the center of the base.



Relation of the casing stones to the slope of the Pyramid.

The base circuit of the Pyramid rests on a platform of finely finished limestone blocks which project beyond the end of the casing stones for an average of 2 feet on the south, east and west sides, and are still in place some 33 feet from the north edge.

This platform is so finely leveled that the official survey of the Egyptian government found it does not exceed 7/8 inch from dead level, and this variation may be due to subsidence.

At present it is not possible to say how far the platform extends under the building; but where the platform stones have been removed, the bed-rock is found to have been cut and leveled to receive each individual stone, sometimes as deep as 2 inches.

On the north side the platform stones have been deliberately laid at irregular angles, each corner being carefully cut out to receive the next irregularly angled stone.

Stone sarcophagus found by Howard-Vyse in the pyramid of Mykerinos, which was lost at sea en route to the British Museum.

In 1840 Colonel Howard-Vyse sailed for England with his accumulated notes. Back home, at his own expense, or his family's, he produced two elegant volumes crammed with detailed but patronizingly Victorian descriptions of his exploits in Egypt, called *Operations Carried on at the Pyramids of Gizeh in 1837*. The book had the merit of including quotations from the works of 71 Europeans and 32 Asiatic authors who had written about the Pyramid from the fifth century B.C. to the nineteenth century.

The colonel's assistant John Perring also produced a handsome volume with some lovely copperplate etchings, *The Pyramids of Gizeh from Actual Survey and Measurement on the Spot*.

Unfortunately, Howard-Vyse was to lose his best trophy, the sarcophagus of Mykerinos, which he had found in the subterranean chamber of the Third Pyramid; the ship carrying it foundered in a storm off the coast of Spain and was sunk in deep water.

But the general measurements taken by Howard-Vyse and Perring were to open a whole new phase in the study of the Great Pyramid, now to be ennobled by the appellative "pyramidology."

VI. FIRST SCIENTIFIC THEORIES

A poet and essayist who had never set eyes on the Pyramid was to take the measurements of Howard-Vyse and those of the French savants and draw from them a set of conclusions, the most far-reaching thus far about the origin and purpose of the Pyramid.

John Taylor, the son of a London bookseller, whose regular job was editing the *London Observer,* already in his fifties when Howard-Vyse returned from Egypt, was to spend the next thirty years collecting and comparing accounts of travelers who had visited the Pyramid.

A gifted mathematician and amateur astronomer, Taylor made models to scale of the Pyramid and began to analyze the results from a mathematician's point of view. To account for the discrepancies in the length of the base reported by successive travelers—which increased progressively from the 693 feet of Greaves to the 763.62 feet of the French—it occurred to Taylor that as each measurer had arrived on the scene, more sand and rubble had been cleared from the base. Each had measured accurately, but at a constantly deeper layer of masonry.

Taylor set about drawing and redrawing every feature of the Pyramid on the basis of the measurements reported by Howard-Vyse, so as to see what geometrical or mathematical formulas might be derived from the structure.

Taylor was puzzled as to why the builders of the Pyramid should have chosen the particular angle of 51° 51′ for the Pyramid's faces instead of the regular equilateral triangle of 60°.

Analyzing Herodotus' report of what the Egyptian priests had told him about the surface of each face of the Pyramid, Taylor concluded they had been designed to be equal in area to the square of the Pyramid's height. If so, this meant the building was of a particular if not unique geometric construction; no other pyramid has these proportions.

Taylor then discovered that if he divided the perimeter of the Pyramid by twice its height, it gave him a quotient of 3.144, remarkably close to the value of π, which is computed as 3.14159+. In other words, the height of the Pyramid appeared to be in relation to the perimeter of its base as the radius of a circle is to its circumference.

John Taylor.

This seemed to Taylor far too extraordinary to attribute to chance, and he deduced that the Pyramid might have been specifically intended by its builders to incorporate the incommensurable value of π. If so, this was a demonstration of the advanced knowledge of the builders.* Still today the oldest known document which indicates that the Egyp-

* Not till the sixth century was π correctly worked out to the fourth decimal point by the Hindu sage Arya-Bhata. It took another thousand years before the Dutchman Pierre Metius calculated π to six decimals by means of the fraction 335/113. In 1593 François Viete carried the computation to eleven figures, and a generation later Rudolph Van Ceulin, just before he died, took π to 127 figures by postulating a circle with 36,893,488,147,419,103,232 sides. In 1813 the English mathematician William Shanks developed π to 707 decimals. Modern computers have carried the operation to 10,000 points of decimal, but with no solution to this apparently incommensurable number.

tians had a knowledge of the value of π is the Rhind Papyrus, dated about 1700 B.C., and therefore much later than the Pyramid. Found in the wrappings of a mummy in 1855 by a young Scottish archeologist, Henry Alexander Rhind, the rare papyrus is now in the British Museum. It gives a very rough value for π of 3.16.

Searching for a reason for such a π proportion in the Pyramid, Taylor concluded that the perimeter might have been intended to represent the circumference of the earth at the equator while the height represented the distance from the earth's center to the pole.

Perhaps Jomard had been right: perhaps the ancient designers *had* measured the length of a geographical degree, multiplied it by 360° for the circumference of the globe, and by the π relation had deduced the polar radius of the earth, immortalizing their knowledge by making the circumference to scale with the perimeter and the radius to scale with the height of the Pyramid.

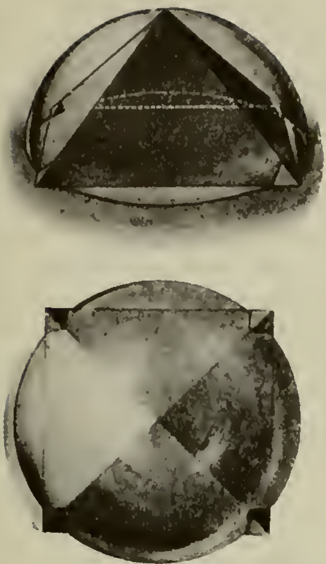
Taylor underlined his thesis: "It was *to make a record of the measure of the Earth* that it was built." He then elaborated: "They knew the Earth was a sphere; and by observing the motion of the heavenly bodies over the earth's surface, had ascertained its circumference, and were desirous of leaving behind them a record of the circumference as correct and imperishable as it was possible for them to construct."

But it was evident to Taylor that the builders of the Pyramid could not have used for their calculations such a unit as the British foot, which fitted neither the height nor the base exactly; he therefore looked for a unit that would retain the π proportion and fit the Pyramid in whole numbers.

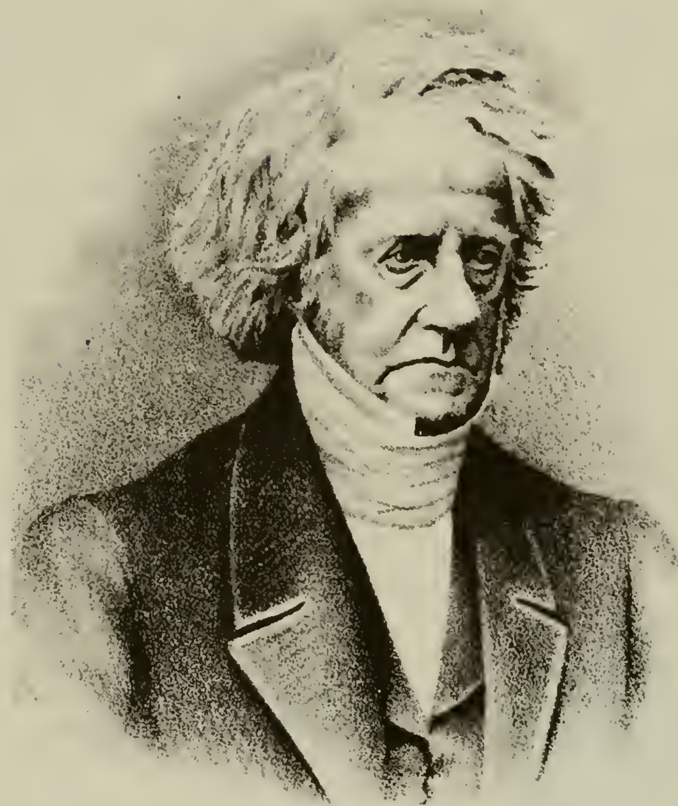
When he came to 366:116.5 he was struck by the similarity of 366 to the number of days in the year and wondered if the Egyptians might have intentionally divided the perimeter of the Pyramid into units of the solar year.

He then noticed that if he converted the perimeter into inches, it came to very nearly 100 times 366. Also he was surprised to see that if he divided the base by 25 inches, he obtained the same 366 result. Could the ancient Egyptians have used a unit so close to the British inch? And a cubit of 25 such inches?

By coincidence, Sir John Herschel, one of Britain's most eminent astronomers at the beginning of the nineteenth century, had just postulated a unit half a human hair's breadth longer than a British inch as the only sensible earth-commensurable unit, or unit based on the actual size of the earth.



Relation of a hemisphere to the Pyramid.



Sir John F. W. Herschel.

Herschel criticized the French meter derived from a curved meridian of the earth as being erratic and variable from country to country because the earth is not a true sphere, and each meridian of longitude would therefore be different. (What's more the French had erred, and produced a meter that was .0002 too short.)

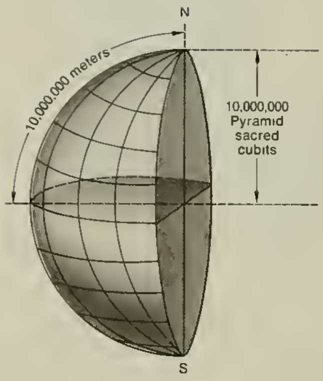
According to Herschel the only really reliable basis for a standard of measure was the polar axis of the earth— the straight line from pole to pole—which a recent British Ordnance Survey had fixed at 7898.78 miles (by taking the mean of all the available meridians measured). This translated into 500,500,000 British inches, or an even five hundred million inches if the British inch were half a human hair's breadth longer.

Herschel suggested that the regular British inch— which was officially computed as the length of three grains of barley taken from the middle ear and placed end to end— be arbitrarily lengthened by a mere one-thousandth part in order to obtain a truly scientific, earth-commensurable unit exactly one fifty-millionth part of the polar axis of the earth.

Fifty such inches, said Herschel, would make a yard that was exactly one ten-millionth of the polar axis, and half that measure, or 25 inches, would make a very useful cubit.

By coincidence these were the cubit and the inch which Taylor had found to fit the Great Pyramid in multiples of 366.*

Another unexpected piece of evidence astounded Taylor. He discovered that recent maps produced by the British Ordnance, the largest and most expensive yet undertaken, had been done on a scale of 1:2500. This scale turned out to bear no relation to the standard British mile of 5280 feet, which had varied through the ages, but almost miraculously fitted the "sacred" cubit as postulated by Newton, as well as the British acre, one side of which was equal to 100 cubits of 25 inches. It appeared that the British inch must have been an ancient unit of measure which had lost a thousandth part as it was handed down from generation to generation.†



To Taylor the inference was clear: the ancient Egyptians must have had a system of measurements based on the true spherical dimensions of the planet, which used a unit which was within a thousandth part of being equal to a British inch.

Fired by what he considered a stunning discovery, Taylor launched into a monumental study of the cubits, feet, spans, inches and stadia, not only of the ancient Egyptians, but of the Babylonians, Hebrews, Greeks and Romans. He found that all kinds of cubits had been used in the past, some of which appeared to have mathematical relations to each other. He also analyzed the ancient measures of cubic capacity along with the modern gallons, firkins, kilderkins,

* That this figuring was not arbitrary was confirmed by the International Geophysical Year 1957–58 geodetic research with orbiting vehicles, which obtained a figure of 3949.89 miles for the polar radius of the earth. Divided by 10,000,000 British inches, this gives 25.02614284, or the length of Taylor's and Newton's "sacred cubit" correct to the third point of decimal.

† Corroborative evidence for Taylor's conclusion was recently produced by Algernon E. Berriman in his *Historical Metrology,* published by E. P. Dutton in New York in 1953. "The English acre," writes Berriman, who is an engineer and an architect, "is the most intriguing of ancient measures because it is virtually equal to a hypothetical geodetic acre defined as one myriad-millionth of the square on the terrestrial radius." Berriman noted that the geodetic acre could also be defined as measuring one myriad square cubits of a hypothetical cubit equal to one ten-millionth of the terrestrial radius. Berriman gave a value to this cubit of 25.064 inches, saying "its former existence is as plausible (or as incredible) as a cubit derived from the sexagesimal division of the Earth's circumference." Berriman also noted that the slightly larger Scottish and Irish acres are related to each other and to the basic English acre as a square to an inscribed circle.

hogsheads, butts, barrels, gills, pecks, faggots, and chaldrons—all in the hope of finding an ancient unit of measure that could be used as a standard, and from which others could have been derived or corrupted.

Pursuing Jomard's theory that the King's Chamber and its sarcophagus might have been designed not so much as a tomb as to monumentalize a system of weights and measure, Taylor was amazed to find that the cubic capacity of the granite coffer was almost precisely four times what the British farmer still used as a standard measure for grain: the *quarter*, or eight bushels.

From all his studies, Taylor concluded that the proportions of the Pyramid had definitely been intended to incorporate geometric and astronomical laws simply and easily expressed, and that its purpose had been to preserve and pass on this knowledge to future generations.

However, as there was nothing in Taylor's philosophy to indicate the existence in such remote antiquity of any civilization which could have had a knowledge of the true shape of the planet, its actual size, and its motion in the solar system; and as the conceit was not then current that this planet might have been visited by superior beings from some other part of the universe, Taylor was hard put to explain the sources of science he found incorporated in the Pyramid. More than a scholar and a mathematician, Taylor was also a profoundly religious man, thoroughly steeped in the Old Testament which he believed to be literally true. To Taylor the creation of Adam had occurred in 4000 B.C. and the Flood in 2400 B.C. It seemed to him hard to believe that in a mere 300 years man could have redeveloped to the point of building so complex a structure as the Great Pyramid. Taylor could come to but one conclusion: whoever had built the Pyramid must have done so under the direct influence of Divine Revelation as Noah had built the Ark. In his own words: "It is probable that to some human beings in the earliest ages of society, a degree of intellectual power was given by the Creator, which raised them far above the level of those succeeding inhabitants of the earth."

Taylor even ventured the hypothesis that the builders of the Pyramid were of "the *chosen race* in the line of, though preceding Abraham; so early indeed as to be closer to Noah than to Abraham."

Because of the close similarity of the British inch to the "Pyramid inch," his idea was to give impetus to the theory that the British were related to the Lost Tribes of Israel, "which during their captivity and wanderings preserved a knowledge of the wisdom of the Egyptians."

As might have been expected, Taylor, who had been known as a benign and dignified old gentleman, had a hard time convincing his quiet Victorian contemporaries of such wild and revolutionary theories, especially as they were just then being rocked by Darwin's theory of the descent of man.

A paper on the Pyramid which he presented to the prestigious Royal Society was rejected with the suggestion that such a paper might be more appropriate for the Society of Antiquarians.

Growing older and more infirm, Taylor was afraid he would die without developing any audience for his theories which by 1859 he had formulated into a volume entitled *The Great Pyramid: Why Was It Built & Who Built It?*

Nearing his death, he had the luck to find the support of an eminent academician with the reputation of having an excellent and sober mathematical mind: Professor Charles Piazzi Smyth, the Astronomer Royal of Scotland.

VII. FIRST CONFIRMATION OF SCIENTIFIC THEORIES

Piazzi Smyth, who was born in Naples to Admiral William Henry Smyth (and named for his godfather, the renowned Sicilian astronomer, Father Giuseppe Piazzi, discoverer of the first known asteroid), was enough of a mathematician not to mock at Taylor's reasoning. Carefully studying Taylor's figures, Piazzi Smyth decided to support them with a paper which he presented to the Royal Society of Edinburgh, of which he had become a member because of his important contribution to the new science of spectroscopy.

It was Smyth's conclusion that the sacred cubit used by the builders of the Great Pyramid was the same length (25.025 British inches) as the one used by Moses to construct the tabernacle and by Noah when he built his Ark, and because the twenty-fifth part of this cubit was within a thousandth part of being the same as a British inch, Smyth also concluded that the British had inherited this "sacred" inch down through the ages.*

Smyth's fellow academicians treated him no better than they had treated Taylor.

During the last few weeks of Taylor's life, there was an animated correspondence between Smyth and Taylor. When Taylor died in 1864 Piazzi Smyth decided that the only way definitely to confirm or refute Taylor's theories about the π relation, and the Pyramid cubit, would be to go to Egypt and carefully measure the Pyramid.

In "utmost straits for funds," Smyth asked his fellows of the Royal Society in London for help; though the Society

* Attributing to Newton the original discovery of the presence of the sacred cubit in the Pyramid, Smyth wrote: "How thankful should we be that it pleased God to raise up the spirit of Newton amongst us; and enable him to make one of the most important discoveries of his riper years—though the opposition of the Church of England has caused it to remain unread almost to the present day—that while there undoubtedly was in ancient times a cubit of 20.7 inches nearly . . . and which Newton calls "the profane cubit" there was another which he equally unhesitatingly speaks of as the *sacred* cubit, decidedly longer."

C. Piazzi Smyth, Astronomer Royal for Scotland.

was "in receipt of a large annual grant from the government for the assistance of precisely such special efforts in science, it not only gave nothing to my semi-pauperized expedition, but actually sent back part of that year's grant to the government on the plea that there was nothing going on that needed it."

That same December, Piazzi Smyth and his wife—then in their early forties—set sail for Egypt with a vast number of boxes containing scientific instruments more accurate than any yet taken to the Pyramid, and with stores and equipment enough for several months.

Despite a series of mishaps, and the almost ruinous expense of everything in Egypt—which was in the midst of a cotton boom engendered by the American Civil War—the Smyths eventually arrived in Cairo, where they were obliged to hang around waiting for permits and local supplies. In his diary Smyth morosely entered exotic descriptions of "the abominations of the worst city in the world," where the food reeked of garlic, lard and African macaroni, the air was fetid from mounds of desiccated human excrement, where he was infested with flies by day and mosquitoes by night, and woken up by a predawn cacophany of howling cats and dogs which roused the pigs which roused the geese and turkeys "just before the disk of the sun comes up like a ball of liquid fire."

Poignantly he described little girls "diving between the hind feet of colossal camels to pick up its hideous droppings, pat them into nicely shaped cakes . . . to make high-scented ammonia-filled fuel for the cooks . . . of the resplendent city."

Smyth was so well received by Ismail Pasha (who a few years later was to commission Verdi's opera *Aïda* which opened in Cairo in 1871) that he tried to buttonhole the viceroy into providing men and funds to remove the great mounds of debris around the base of the Pyramid, to have a 3-inch hole carved through the center of the granite plugs in the Ascending Passage (so as to ascertain its true meridian), to have the ventilating ducts to the King's Chamber cleared, and to sink a shaft through the hole in the pit down to the level of the Nile.

The pasha shook his head, promising to provide twenty men for two weeks to clean and wash the main chambers of the Pyramid so that Piazzi Smyth might take some measurements. The pasha also kindly agreed to provide the Smyths with donkeys and a camel train to bear them and their luggage to the Great Pyramid.

Leaving "the purse-proud modern Muslim city with its tulip-clothed individuals struggling for wealth," the Piazzi

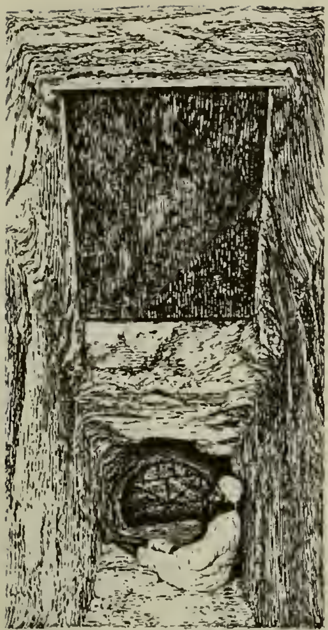
Traveling from Cairo to the Great Pyramid in the mid-nineteenth century.

Sandstorm in the desert.

Smyths set off for the Pyramid. On the way they stopped to eat buns "from Mrs. Smyth's commissary" and refresh themselves with Nile water "muddy and opaque as milk with suspended clay" but celebrated, says Smyth, for its health-giving qualities, the best cure for "the windy melancholy arising from the shorter ribs."

The pyramids, tinted by the golden rays of the setting sun "embalmed in the intense azure of the western heaven," appeared to grow no larger as the caravan approached. Only in the immediate vicinity did they suddenly tower so completely as "to take possession of the mind."

Looking up at the vast stepped sides toward the "dizzy apex 480 feet above in perpendicular height, the mind slowly and almost painfully began to realize the enormous size of the mountainous buildings."



Descending Passage blocked by Arab guides below the level of the granite plug.

As a place to live within reach of the Pyramid, the Smyths selected an abandoned tomb in the eastern cliff of the Giza hill which had previously been used as a storeroom by Howard-Vyse. It proved to be an agreeable residence: the solid rock was the best possible protection against the midday heat, and the orientation of the cave protected it from the sandstorms and the clouds of multicolored locusts that otherwise made life in the desert a misery.

To assist Smyth in his measurements, and to help with the general chores, he found a whiskered Arab called Ali Gabri who had carried baskets for Colonel Howard-Vyse a generation earlier.

At twilight Professor and Mrs. Smyth sat on campstools and watched with amazement as flock after flock of bats flew out of the Pyramid, "for almost twenty minutes without any cessation," to be pounced on by hawks or owls.

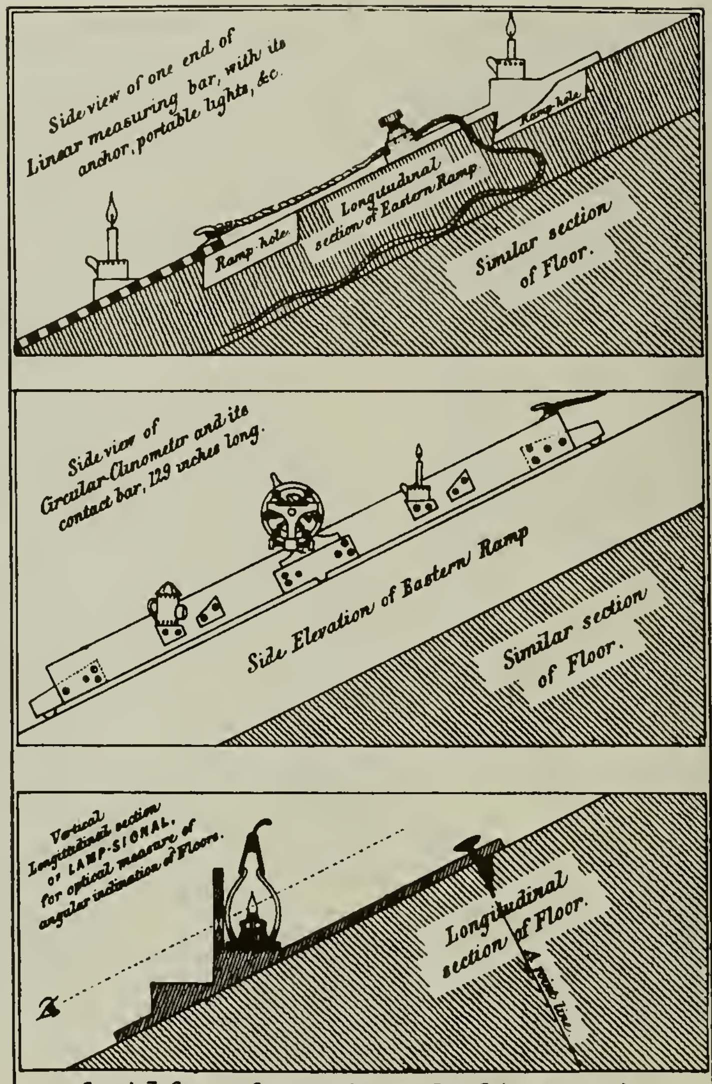
Several days were wasted while Ali Gabri impressed a gang of Arabs to clean the chambers of the Great Pyramid, but at last, in late January, the day came for Smyth to enter what he called "the largest building in the world by the smallest of all doorways."

As Smyth picked his way down the Descending Passage, partly on his seat and partly on hands and knees, he was relieved to find that shallow notches had been dug by Howard-Vyse every 2 or 3 feet so as to keep from slipping on the steep incline. However, each step raised a cloud of fine white dust that made it almost impossible to breathe. To his distress, Smyth also found that the passage leading down to the "pit," which had been cleared by Caviglia, was once more blocked with sand and stones, and barred by a grill just below Al Mamun's hole to the Ascending Passage.

It was explained to Smyth that it cost the Arab guides too much time and candle grease to accompany tourists all the way down to the "pit" before making the long climb back up to the King's Chamber, so they had blocked the passage and informed gullible tourists there was nothing but sand beyond the barrier.

Bent on finding proof that the Great Pyramid had been built on units of his "sacred cubit," Smyth had brought from England a 105-inch metal bar with built-in thermometers at either end to indicate the slightest variation in temperature with which to measure the available passages. A mere change of .01 degree Fahrenheit was enough to produce a sensible change in the length of the standard bars.

To obtain the exact angle of the Descending Passage, Smyth had a specially designed clinometer equipped with a gunmetal circle 8 inches in diameter, divided into units of



Special forms of apparatus, employed in measuring in the Grand Gallery.

The Grand Gallery as Piazzi Smyth saw it in 1865.

Brass-tipped mahogany measuring rod.

Piazzi Smyth's special apparatus for measuring the Grand Gallery.

10 seconds, and fitted with three pairs of verniers. The slope he calculated was the most precise to date: 26° 27′.

For measuring the individual stones of the floors, walls and ceilings, Smyth had mahogany and teak rods tipped with brass, carefully painted or waxed to prevent variation from humidity or temperature. One special ruler, remarkable for its straight, fine grain, had been obtained from an antique musical organ dating from the reign of Queen Anne. To fashion these measuring instruments, Smyth had obtained the services of an expert optician.

Each rod was checked daily for atmospheric shrinkage

"Miniature" camera, 8 inches long, used by Piazzi Smyth to photograph the interior and exterior of the Great Pyramid. On the right is a tiny container for the vulcanite nitrate bath which held the exposed wet-collodion plates which measured an inch square. Some two hundred microscope negatives, packed in a storage box, are still missing, but 48 lantern slides, 24 transparencies and 23 stereotypes are in the possession of the Royal Society of Edinburgh, examples of which are reproduced with their permission.

The camera is in the possession of the present Astronomer Royal for Scotland, Prof. H. A. Brück, and is here reproduced by kind permission.

or enlargement against a basic fine-grained clinkstone which could be measured with a magnifying glass to 1/100 inch.*

Thus began the first really systematic analysis of the Pyramid with modern measuring equipment. For weeks on end Smyth measured and remeasured whatever he could reach in the interior of the Pyramid, counting the stones in passages and chambers, computing angles and declinations.

Measuring the coffer in the King's Chamber, Smyth concluded that Taylor had been correct in recognizing it as a standard of linear and cubic measure. Unlike the European standards, such as the yardstick kept at Whitehall, which vary with temperature and barometric pressure, shrink, decompose, tarnish or oxidize with time, the coffer appeared to be designed to remain at a constant temperature and barometric pressure, its polished sides unaffected by decomposition over a period of thousands of years, subject only to the vandalism of man.†

* A clinkstone is a compact grayish-blue felspathic rock little subject to atmospheric changes which makes a clink sound when struck.

† Smyth echoed Herschel's complaint about the standard yard at Whitehall. Herschel had called it "a purely individual object, multiplied and perpetuated by careful copying, from which all reference to a natural origin is studiously excluded, as much as if it had dropped from the clouds."

Today our yard is related to the meter, which is determined by a finite number of wavelengths per second in vacuum of an atom of Krypton 86—measured by means of light waves. A second is no longer defined as the 3600th part of an hour but as the duration of cycles of radiation in a cesium atom.

Photograph of Mrs. Piazzi Smyth taken by her husband outside their tomb apartment in the Giza Hill, which Piazzi Smyth characterized as "a quiet nook, looking out over the green Egyptian plain."

For outside measurements Smyth used a 500-inch cord, and for elevations he had theodolites, sextants and telescopes, which were laboriously carted from spot to spot, up and around the Pyramid, to measure all that could be measured, despite the mounds of debris.

With his long and varied experience in observational astronomy, Smyth had brought the requisite apparatus for obtaining astronomical observations with a high degree of precision.

To obtain the correct latitude of the Great Pyramid without having his plumb line diverted from the perpendicular

Photograph of Ali Gabri (sometimes spelt Alee Dobree) seated outside the tomb in the east bank of Pyramid Hill where Piazzi Smyth, who is handling the camera, had his quarters.

by the attraction of the huge bulk of the Pyramid, Smyth made his observations from the very summit; there the Pyramid's pull of gravity would be directly downward.

Smyth and his wife spent several nights on the circumscribed platform, close to the stars, along with Ali Gabri, who complained he could not sleep because of indigestion. Smyth described the first night as eerie but wonderful, with the ghostlike summit of Kephren's pyramid lurking in the misty darkness. At daybreak he saw "a broad pinioned eagle floating serenely along looking downwards on other things, as we were looking down on him."

From the vantage of the summit Smyth figured the latitude of the Pyramid to be 29° 58′ 51″. From this he concluded that the designers might have purposely not placed the Pyramid directly on the thirtieth parallel because of the atmospheric refraction, which would have caused an error in their observations of about that much. Later he attributed the displacement to a gradual shifting of latitude, registered at Greenwich as 1.38″ per century.*

As for the extraordinarily precise orientation of the Pyramid—which Smyth found to be far superior to that of the world-renowned observatory of the sixteenth-century Danish astronomer Tycho Brahe—the Scottish astronomer concluded that for such refinement a meridian must have been obtained by observing a polar star along the Descending Passage.

When Caviglia had cleared this passage of the rubble left by Al Mamun, he noticed one night that the North Star was observable in the small patch of sky—about 1° square—of the opening. Intrigued by this phenomenon, Howard-Vyse had asked Sir John Herschel whether the direction of the passage could have been determined by the polestar. Herschel replied that 4000 years earlier Ursa Minor could *not* have been seen from the passage at any time throughout the twenty-four hours. He added, however, that alpha Draconis, the leading star in the constellation of Drago, would have been near the pole, and that though a comparatively insignificant star of less than the third magnitude, it could nevertheless have been clearly seen by an observer at the bottom of the passage at the moment of its inferior culmination, when its circumpolar orbit was at its lowest.

Smyth proceeded to subtract the 26° 17′ angle he had found for the Descending Passage from the Pyramid's latitude of 30° (or height of a true North Star above the horizon as seen from 30° of latitude) and obtained an angle of 3° 43′. Calculating that alpha Draconis would have been 3°43′ from the pole at its lower culmination in 2123 B.C. and again in 3440 B.C., Smyth concluded that either date might be taken as the one when the Great Pyramid had been laid out.

* Other pyramid experts have attributed the slight displacement to the fact that the Pyramid needed the solid basis of the Giza plateau for a foundation, and could not have been built any farther north, in the soft sand of the Nile valley. The astronomer Richard A. Proctor suggests that the emplacement was the result of the mean latitude obtained from observing sun shadows and star elevations, which are affected in opposite directions by the atmospheric refraction. An interesting explanation was produced by Dr. Everett W. Fish of Chicago who suggested at the turn of the century that the deviation of the Pyramid's latitude from 30° is neither an error in instrumentation, nor in polar axis, or latitude, but compensates for the spheroidal shape of the earth as postulated by Newton.

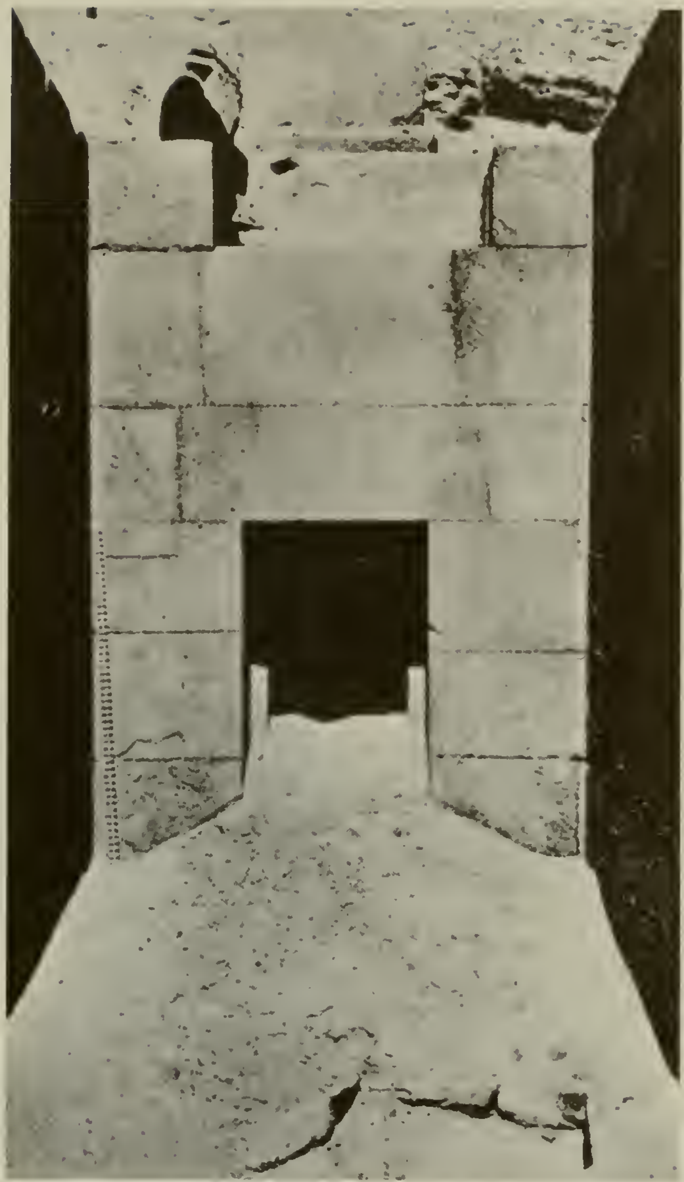
This photograph was taken by Piazzi Smyth and sold at auction after his death. It shows Mrs. Smyth sitting on the edge of what Smyth calls Shafre's burial chamber north of the Great Sphinx. It was taken at high noon to show that the tomb was correctly oriented along the meridian so that with the sun at its zenith, no light would fall on either the east or the west wall.

To ascertain the correct moment for noon Piazzi Smyth spent the previous night observing the stars with his telescope.

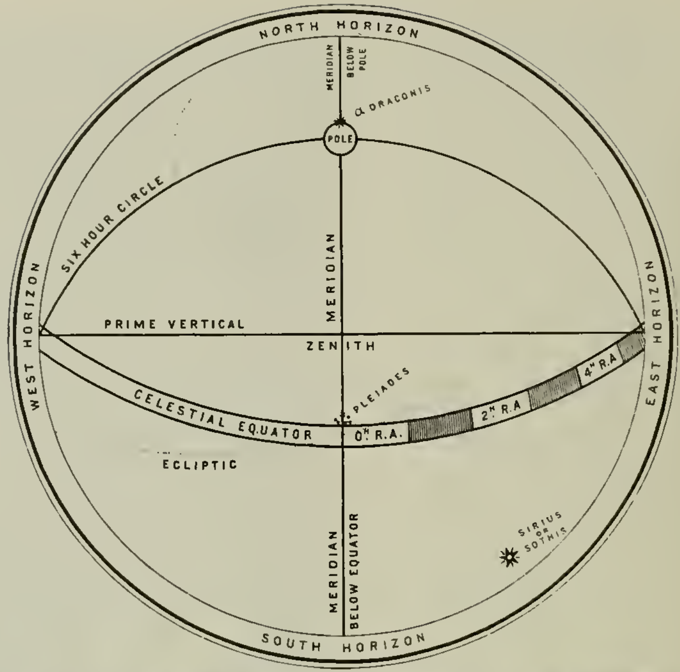
Piazzi Smyth photographed the Great Pyramid with the same scientific thoroughness with which he measured it, despite the difficulties of developing in the desert. He brought all his own chemicals, and used a special 1-inch plate "as small as an ordinary microscopic slide," which gave results that could be blown up with almost the detail of the larger photographic plate. To light the interiors of the Pyramid he used magnesium flares, experimenting with varying amounts so as to obtain the best exposure and the clearest detail. He had to wait hours between exposures in the King's Chamber, which filled up with smoke from each magnesium flare.

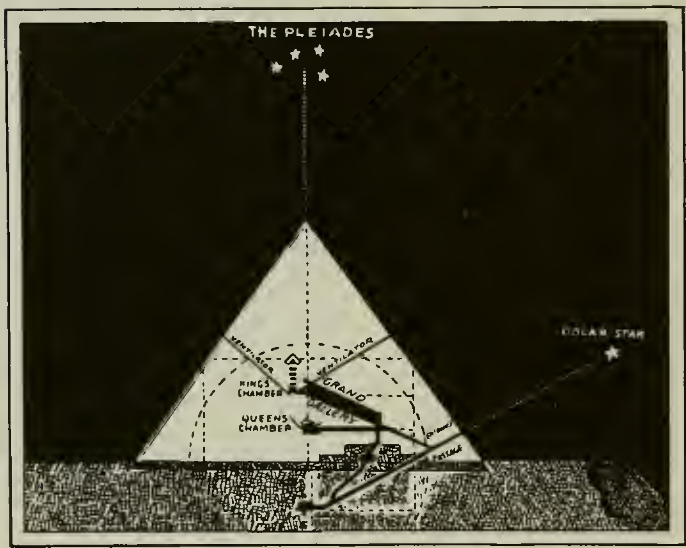
Smyth also achieved some remarkable stereoscopic effects by shooting with two cameras, and is responsible for the innovation of placing his cameras much farther apart than the standard 2 inches.

For lack of funds Smyth was unable to publish some fourscore photographs thus obtained at the Great Pyramid. The positive prints which he made were lent to scientific exhibitions or donated to friends interested in pyramidology, and gradually became lost, with the exception of this rather poor reproduction.



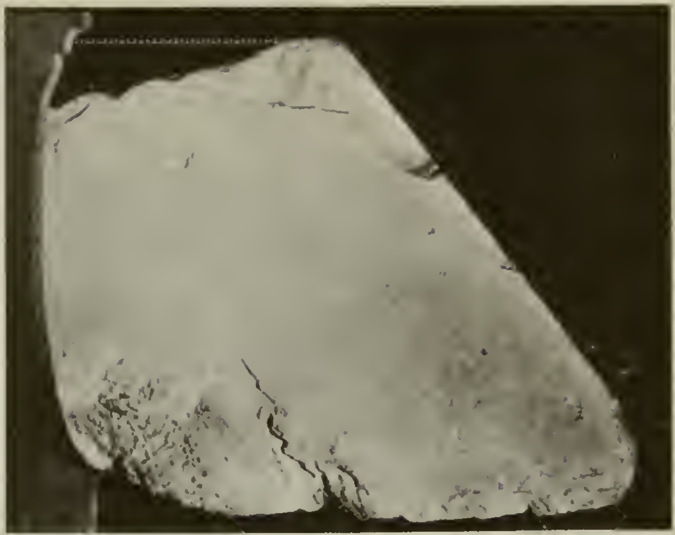
In support of the later date Smyth worked out that if the foundation of the Pyramid had occurred at midnight of the equinox in 2170 B.C., when alpha Draconis was at meridian below the pole, another very important star would have been crossing the meridian above the pole: *n*-Tauri, or Alcyone, of the Pleiades. In other words, when alpha Draconis was visible down the Descending Passage, the chief star of the Pleiades, *n*-Tauri, would have been crossing the meridian in the vertical plane of the Grand Gallery, at the moment of the autumn equinox.





Piazzi Smyth's ground plan of the circles of the heavens above the Great Pyramid, at the epoch when he believed it was founded: midnight of the autumnal equinox 2170 B.C. Smyth noted that *alpha* Draconis was on the meridian below the pole while the Pleiades were on the meridian above the pole, coincidentally with the vernal equinox.

Piazzi Smyth figured that the Great Pyramid might have been built so its Descending Passage was aligned with the polestar and at a time when the Pleiades were at the zenith at midnight.



Casing stones donated by Smyth to the Edinburgh Museum, showing the angle of the slope of the Great Pyramid.

Smyth considered this a very important date in history, as many ancient peoples dated the beginning of their year at Halloween, when the Pleiades and the equinoctial point were on the meridian together at midnight.

But Smyth's prime preoccupation was still with establishing whether Taylor's π proportion was really incorporated in the structure.

Along the face of the Pyramid, Smyth checked the angle of the casing stones discovered by Howard-Vyse. Unfortunately the sharp lines had already been almost obliterated by the Arabs and by the chipping away of souvenir hunters. But searching through the debris piled high round the base, Smyth was able to find fragments of casing stones with the angles still intact.

Invariably the angle checked out at about 52°, or its complement of 128°, confirming Taylor's theory that the height of the Pyramid was designed to be in relation to the perimeter of its base as the radius of a circle is to its circumference.

To see if he could refine this angle, Smyth observed the silhouette of all the backing stones against the sky by means of a very accurate altitude azimuth circle which had been donated to his friend and mentor Professor Lyon Playfair by his students in 1806 and in turn lent to Smyth.

By this method Smyth obtained an angle of 51° 49′. Meanwhile Sir John Herschel had obtained a figure of 51° 52′ 15.5″ from the dimensions of the casing stones as reported by Howard-Vyse. Smyth chose to take the mean of these available measures as 51° 51′ 14.3″—a difference of less than a minute from either figure. He also chose to take the mean of the 763.62-foot base line measured by the

Magnesium-light photography had been developed only a few months before Piazzi Smyth took this double exposure of the coffer in the King's Chamber. The apparent reflections are those of Ali Gabri and another Arab. Mrs. Smyth's head appears beyond the coffer. Smyth's method of burning magnesium powder in a spirit-lamp flame was an innovation in photography.

French and the 764 feet measured by Howard-Vyse, and got 763.81—a difference of barely 2 inches on a length of 763 feet.

This was an arbitrary act, but the result produced an astounding value for π in the Great Pyramid proportions of 3.14159+.

Searching for a reason for the incorporation in the Pyramid of this relation of the radius of a circle to its circumference, Smyth pursued Taylor's theory of the base being divided into 366 units to coincide with the number of days in the year.

To have been absolutely precise, the perimeter should have measured 365,24.2 Pyramid inches. This would require that each side be 9140.18 British inches. The measure obtained by Howard-Vyse and the French savants, though within 6 inches of each other, were both about 2 feet too long.

The only solution appeared to be to dig up the sockets and remeasure the base line more accurately; but time and money were running short. Fortunately two engineers from Glasgow, Messrs. Inglis and Aiton, happened to pass through Egypt on their way from a tour of the Holy Land. Cajoled by their fellow Scot, they agreed to help him uncover the sockets originally found by the French (which had once more become covered with debris in the intervening half century) and make a truly accurate survey.

Following Smyth's complex computations, the engineers were able to uncover not only the sockets but a perfectly leveled stretch of pavement at the perimeter of the base.

Stereographic photo taken by Piazzi Smyth of Mr. Inglis and Arab workers in the northeast socket cleared in April of 1865. The Royal Engineer surveyor went all over the floor of the socket with a spirit level and found it absolutely level.

To measure the distance between the sockets, up and around the debris, required a great deal of digging and moving of rocks. But Smyth could not tarry. His own instruments were already packed and his passage had been booked by the British consul. When the engineers promised to take great care in their measurements and forward the results to Scotland, Smyth disconsolately agreed to depart as scheduled.

All that remained to be done was to dispense the customary baksheesh to the neighboring Arabs who had helped during four months' stay. The Smyths gave each man a gold sovereign plus a present depending on the willingness with which he had served his Scottish employers: the best got globe lamps mounted in copper; the middling got frying pans; and the worst got mousetraps.

When the ancient Arab who guarded their cave by night appeared for his just reward, Piazzi Smyth puritanically noted that the old man "seized on the money with such an agony of clutch, and his eyes brightened with so strange a fire, that alas for perverted human nature! we feared we had done more harm to his soul than good to his body."

As the camel train was prepared for departure, the faithful Ali Gabri stood silent for a time, "then suddenly putting his fingers to his eyes" rushed into the desert to conceal his crying.

Back in Scotland, Piazzi Smyth received the results of the engineers' survey; these gave a much shorter length of 9110 inches for a side of the Pyramid. Smyth concluded that the true length must be the mean between this figure and the

longer one of 9168 inches obtained by Howard-Vyse, or 9140 inches, which was just 1 inch less than was required for Smyth's theory, resulting in a year of 365.2 days instead of the precise 365.24 required by theory.

A great deal now hung on the exactness of these figures. If Smyth's theory could be proved correct, it could mean that the ancient Egyptians had produced a structure whose basic unit, the Pyramid inch, incorporated not only a system for linear measurement—with the cubit and the inch—but also for temporal measurement, with a year of 365.24 days, both based on the most sensible foundation: the polar axis of the planet around which it rotates once in a day.

In Smyth's opinion "the linear measure of the base of this colossal monument, viewed in the light of the philosophical connexion between time and space, has yielded a standard measure of length which is more admirably and learnedly earth-commensurable than anything which has ever yet entered into the mind of man to conceive. . . ."

Smyth summed up his work: the Pyramid "revealed a most surprisingly accurate knowledge of high astronomical and geographical physics . . . nearly 1500 years earlier than the extremely infantine beginning of such things among the ancient Greeks."

From the Royal Society of Edinburgh, Smyth received a gold medal for the careful measurements he had taken in Egypt; these he published in monographs, and in a three-volume opus running to 1600 pages entitled *Life and Work at the Great Pyramid of Jeezeh during the Months of January, February, March and April, A.D. 1865.*

The work was not well received. As much of a religious zealot as had been his predecessor Taylor, Smyth was unable to account for the mathematics displayed by the ancient Egyptians. Like Taylor he was obliged to attribute this science to Divine Wisdom, somehow imparted to an earthly architect who had constructed the Pyramid under the direct influence of revelation. "The Bible," said Smyth, "tells us that in very early historic days, wisdom, and metrical instructions for buildings, were occasionally imparted perfect and complete, for some special and unknown purpose, to chosen men, by the Author of all wisdom."

The idea was received by some with derision, by others with acrimonious opposition. One reviewer remarked that Smyth's book contained "more extraordinary hallucinations than had appeared in any other three volumes published during the past or present century." A friendly reviewer summed up reaction to the book saying "it evoked numerous illustrations of envy, hatred, malice, and much uncharitableness from vain, flippant, and unqualified writers, the author being scoffed at, traduced, worried and all but *argued* with, by opponents who only succeeded in proving their egotistic inefficiency to apprehend the truth."

To make things worse another Scot, a religious enthusiast called Robert Menzies, advanced the theory that the passage system in the Great Pyramid was nothing less than a chronological representation of prophecy, corroborating the Bible, built on a scale of one pyramid inch to the solar year.*

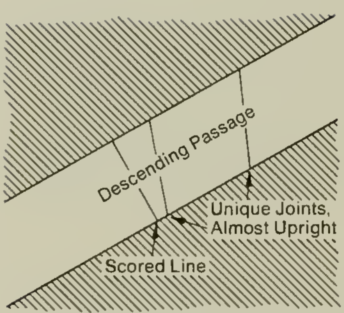
As Menzies' theory was formulated before anything was known of ancient Egyptian messianic prophecy, such as *The Book of the Dead,* the texts of which had not yet been deciphered, this new contribution merely added to Smyth's problems. Smyth was further derided and lampooned by his

* Menzies, knowing that Smyth had made an approximate calculation of the date at which alpha Draconis shone exactly down the Descending Passage, put forward the theory that the date of this important astronomical phenomenon should be clearly marked some way in the Descending Passage itself, at the place representing the said date on the chronological scale. To Menzies' delight, Smyth replied that he had discovered two scored lines on each side of the passage at the very spot indicated. Although the joints in the walls of the Descending Passage were perpendicular to the floor, said Smyth, there were two joints on each wall, immediately to the north of the scored lines, that were not so: these were peculiarly vertical joints, as if intended to draw attention to something of importance: in Smyth's and Menzies' opinion, evidently the scored lines.

fellow academicians. Sir James Y. Simpson, an eminent member of the Royal Society of Edinburgh, publicly ridiculed Smyth before his fellow members, saying, "the whole of Professor Smyth's theory about the Great Pyramid is a series of strange hallucinations, which only a few weak women believe, and perhaps a few womenly men, but no more." Simpson added that he had "talked about it to a great many engineers, mathematicians, and others, and found them scoffing at and despising it."

Smyth's mixing of religious and prophetic conclusions with sound scientific discoveries caused his entire theory to be discarded by skeptics. To this day, the lampooning persists. One modern writer on pyramidology still refers to Smyth as the world's "pyramidiot," and laments that "such a first-class mathematical brain should have wasted its energies in so unprofitable a field."

But Piazzi Smyth was far from being quashed. He continued to produce even more fantastic theories from the results of his measurements of the Pyramid. Recomputing the height of the Pyramid, Smyth found it to be about 6 inches longer than Taylor's figure of 5813 inches from base rock to apex. The new measurement revealed that the Pyramid rose from its base in a proportion of 10:9, that is, for every 10 units of height, the Pyramid extended 9 units in width. To Smyth this was an indication that the proportions were intended to symbolize in yet another way the earth's circuit round the sun. Multiplying the height by 10^9, he obtained an astonishing result. Reduced to British miles, the answer was 91,840.000—or a very good figure for the mean radius of the earth's orbit round the sun. The present figure varies between 91 and 92 million miles. Was this mere coincidence? The argument between the supporters of Smyth's theories and the entrenched academicians who opposed them became intensely heated.



Scored lines in Descending Passage.

Basic to the whole argument was the fact that no one had a series of absolutely reliable measurements for the *exterior* of the building, especially beneath its debris where the base line must actually be measured. Even a new survey by the Ordnance surveyors made in 1869, which gave a length of 9130 inches, was made on the basis of cumulative measurements up and down and around the piles of debris that still clogged part of the base of the Pyramid between the exposed sockets. Results which varied by even 3 or 4 inches could not be considered accurate enough to prove or disprove the theories of Taylor and Smyth. So long as the *actual* dimensions of the Pyramid, both interior and exterior, were not obtained, correct to a fraction of an inch, there would be no real way of *knowing* if Smyth had a point or not.

VIII. FIRST REFUTATION OF SCIENTIFIC THEORIES

To resolve the problem of the dimensions of the Pyramid once and for all, a mechanical engineer by the name of William Petrie, who had become fascinated by the theories of both Taylor and Smyth, set about designing and constructing even more specialized sextants, theodolites, and verniers with which to tackle the technical problems encountered by Smyth. It was no easy job. Smyth had gone a long way in perfecting his own equipment, and it was to take William Petrie all of twenty years to accomplish the task to his own satisfaction. Petrie stressed the importance of further exploration of the Pyramid because of its "paleologic, chronologic, metrologic, geodetic, geologic and astronomic interest to mankind," and above all "for its symbolic interest relating to the higher ideas intentionally embodied therein by its originator." Yet Petrie kept tinkering with the new instruments and postponing his departure for Egypt.

His young son, William Flinders Petrie, perhaps because of a spirit of adventure inherited from his maternal grandfather, the great explorer Matthew Flinders, became so impatient he finally decided to prime the pump by leaving ahead of his father, convinced that his father would quickly follow.

Fascinated by the varied standards of measure used in different parts of the world, young Petrie had read all he could on the subject; instead of going to school, he tramped around England, becoming proficient as a surveyor by measuring churches, buildings and ancient megalithic ruins such as Stonehenge, about which he was to write the first of his several score books.

At the age of thirteen, young Petrie had read Piazzi Smyth's *Our Inheritance in the Great Pyramid*. It had not only revived in him the ideas of Greaves and Burattini, but convinced him that a real history of measures might be deduced from a careful measurement of surviving monuments and objects. He was also determined to prove, one way or another, whether or not Taylor and Smyth had been correct in their theories regarding the Pyramid. To do so he would have to resurvey and measure the entire building.

William Flinders Petrie.

On a stormy day in November of 1880, Flinders Petrie, now a bearded professional surveyor of twenty-six, set off from Liverpool with a vast quantity of boxes containing the rare instruments designed by his father to eliminate the defects revealed by Smyth's experience. He also had with him the necessary supplies with which to survive for a long period in the inhospitable, bandit-infested desert. The gale blew so hard Petrie slept on the engine grating, too seasick to go below deck. Within a week of landing at Alexandria, Petrie had transported his equipment to Cairo, where he managed to get hold of Ali Gabri to help transport his food and instruments to the Giza plateau.

Ali Gabri was now a veteran of 40 years' service with Caviglia, Howard-Vyse and Piazzi Smyth. Reaching the Pyramid in December, Petrie followed the established practice of setting up house in an abandoned tomb.

Ali helped Petrie furnish his quarters with shelves and a hammock, helped him stock the larder with ship's biscuits,

Petrie standing before his living quarters in a tomb on the Giza plateau.

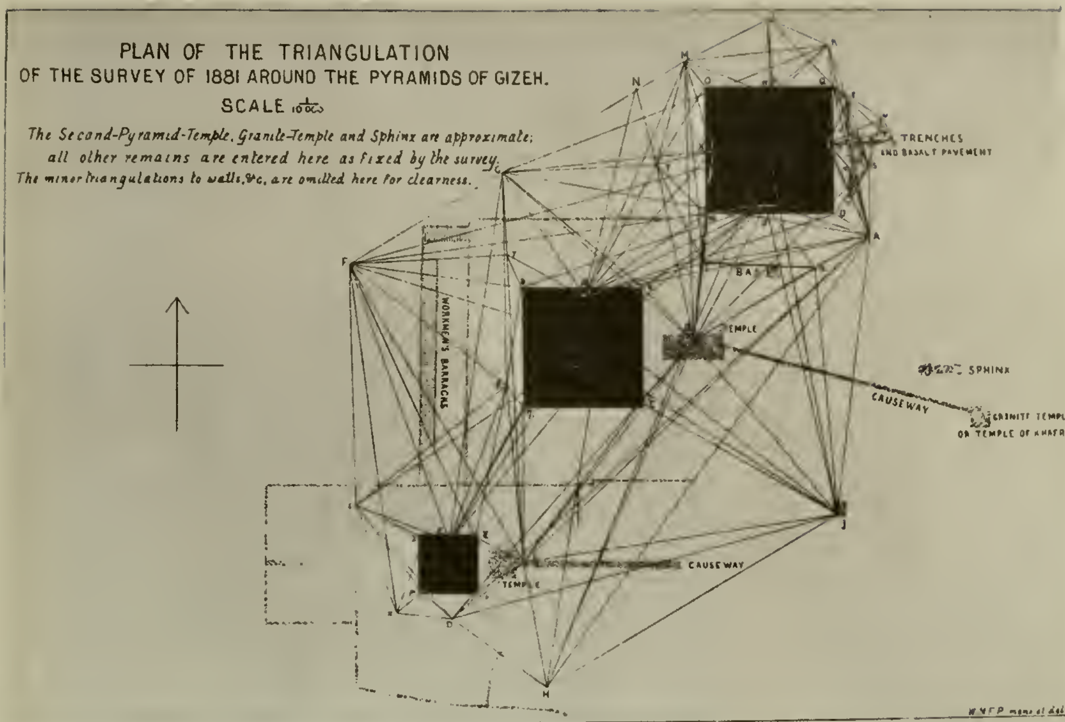
canned soups, tapioca and chocolate. To cook his evening meal Petrie had brought along a kerosene stove. Like his predecessors, Petrie found the solid rock of the tomb an extremely hospitable home, remarking that it seemed "as good as a fire in cold weather, and deliciously cool in the heat."

Petrie's day started with the lighting of his kerosene stove and the ritual boiling of tea water while he enjoyed a makeshift bath.

Breakfast was the time he accorded to reception. Men and women would look in at the door of his tomb, and if a special Arab friend paid a visit, Petrie would brew some coffee in his honor on the little stove by the door.

Petrie got along well with the Arabs, noting that "the smallest entering into their ways pleases them enormously; only sit squat, return the proper replies to salutations, catch their tricks of manner, and imitate their voice, and they will laugh heartily and treat you as a friend."

Petrie's first preoccupation was to accomplish what had been beyond the means of Smyth: a very precise triangulation all over the hill of Giza, including points around all three large pyramids, as well as the surrounding temples and walls which belonged to the complex. Though he couldn't remove the rubble, Petrie hoped to establish the dimensions of the pyramids by triangulation to within a fraction of an inch.



Petrie accomplished his triangulation of the Great Pyramid over a period of months, by means of a ten-inch French theodolite, "a splendid theodolite by Gambay" with a ×35 telescope. Some of the angles were read as many as 14 times from as many as 50 fixed stations. Petrie estimated the probable error in his base measurement of the Pyramid to be ±.03 inch, or 1/260.000 of the whole. But because of the debris and the fact that the cornerstones were missing, Petrie could not establish where the original corners had actually been placed.

Using a highly accurate theodolite by means of which single seconds of angle could be read, Petrie repeated his observations so many times that it would take him from dawn till sunset to accomplish the work at a single station. A second of arc is so fine that it is commonly referred to as the angle subtended by a dime at the distance of a mile.

All the while Ali Gabri held a huge parasol over the theodolite to keep the sun from shining on the metal circle and expanding it unevenly. Once the sun had gone down Petrie would have a solitary meal, washing his own dishes—because he distrusted the Arab's idea of cleanliness—and then sit down to meticulously write up his figures, laying the groundwork for that scientific archeology of which he was to become the prime promoter. His sole entertainment was the "indescribable" tunes played on a reed flute by Ali Gabri's nephew, whose job was to guard him from a neighboring tomb through the night.

Choosing good days, with cool air but no wind, and working for ten hours at a stretch without food, Petrie was able to get a figure to within a quarter of an inch, and usually to within a tenth of an inch, for the actual layout of the three large pyramids at Giza. He was amazed to find the layout of the Great Pyramid "a triumph of skill. Its errors, both in length and in angles, could be covered by placing one's thumb on them."

Victorian tourist and her escort being helped up the Pyramid courses by Arab guides.

The Great Pyramid was so precisely aligned with the cardinal points of the compass that it surpassed in accuracy any human construction to date.

As the weeks wore on, Petrie realized he would not complete the exteriors before springtime and the arrival of the tourist season; so he had the way prepared for his indoor measurements by having a gang of Arab workmen clear the Descending Passage down to the lower "pit" which Smyth had been unable to reach because of the rubble. Armed with baskets, a chain of workers were able to carry the debris up and out of the main entrance.

When the tourists did begin to trickle toward the Pyramid, Petrie devised a system to avoid being bothered by going about outside the Pyramid in nothing but his pink underwear. At the sight of him, the good Victorian ladies kept a safe distance.

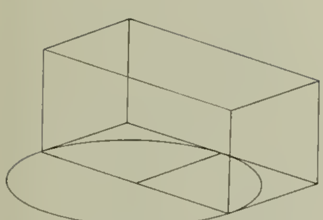
That the tourists were a formidable menace to the pursuit of science had been made clear by Piazzi Smyth, who described "many and multitudinous scenes of lurid-lighted revelry, indulged in by many smoking, tobacco-stinking gentlemen and a few ladies, from some vulgar steamer" who performed "whirling dances over King Cheops' tombstone with ignorant cursing of his ancient name . . . and the painful thunder of the coffer being banged, to close upon breaking, with a big stone swung by their Arab helps."

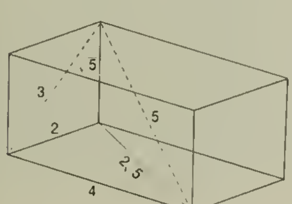
For lack of salacious statues or pictorial attractions at the Pyramid, the more boisterous tourists would amuse themselves by removing loose blocks from the summit which they would send crashing down to the already vast heaps of rubble accumulated round the base.

At the end of the day, once the tourists had left, Petrie would work in the intense accumulated heat of the Pyramid, often till midnight and sometimes right through till morning, like "the Japanese carpenter who had nothing on but a pair of spectacles, except that I do not need the spectacles." The ventilating shafts in the King's Chamber, which had been opened by Howard-Vyse, had once more been clogged by vandals, making the air unwholesome. After the first few hours the dust which was raised at every move caused Petrie feverish headaches; but he persevered in his task.

With steel tapes and special chains 1200 inches long, as well as self-compensating accessory appliances, Petrie set about measuring with a far finer accuracy than Smyth could obtain all that was worth noting. Most of Petrie's instruments allowed him to measure to within 1/100 inch, and some, for really careful work, enabled him to do so to within 1/1000 inch.

To measure upright surfaces he used plumb lines; for horizontal surfaces a leveling instrument. Thus he could find the dimensions of a room at any level, and establish where any faults might lie.





To measure the straightness of the sides of the Descending Passage Petrie used fine observations of Polaris at elongation—when it was farthest east and west from the pole. He was amazed to find that the average error in the part built of masonry was an infinitesimal 1/50 inch in 150 feet; and over the entire length of 350 feet the sides were within 1/4 inch of being absolutely straight.

In the King's Chamber, Petrie established to his satisfaction that the walls had been constructed on the basis of the same π proportion which ruled the exterior of the building. Its length was to the circuit of its side wall as 1 is to π.

This value was not immediately evident, because the floor of the chamber had been inserted between the walls so as to cut off a fraction at the bottom. But the cut was cunning in

President Ulysses S. Grant visited the Pyramid as part of a world tour.

In the archives of the Library of Congress lies a faded daguerreotype, with the unmistakable features of the general.

Piazzi Smyth describes the arrival of a party of enthusiastic Yankee tourists atop the Great Pyramid while Smyth was making early-morning observations. "In the short time they were there," writes Smyth, the Americans "arranged themselves into a meeting on constitutional principles of Anglo-Saxon derivation, with a chairman, secretary and audience; wherein a resolution was proposed, recorded and carried unanimously, to the effect—'that whereas this here pile whips everything in the way of building we've seen in all our grand tour through the used-up, worn-out world, yet we calculate King Cheops, its builder, must have been such a horrid old tyrant and cruel oppressor of the people, that it is hereby resolved by us free and independent citizens of the *Unyted* States that we *won't* give him a cheer.' "

After offering thanks to their "excellent chairman for his well-balanced conduct and impartial attitude on his very elevated seat," says Piazzi Smyth, "the gentlemen liquored up, the ladies, as they bashfully expressed it, consented to take a swallow, and the whole party disappeared down the steep slope of the pyramid . . . every man of them with little Confederate flags picked out on the soles of their boots, so that they might have pleasure in trampling on the hated ensign of the South wherever they went."

As an indication of how *tutto il mondo è paese*, Cheops is said (by Sir Gardiner Wilkinson) to have engraved the figures of the Gods of Egypt on the public roads "in order that they might be trodden under foot by man and beast."

that it thus incorporated in the chamber both the 2– $\sqrt{5}$ –3 and the 3–4–5 Pythagorean triangles.

Checking to see if the π proportion could also apply to the coffer, Petrie found that its dimensions appeared to be all multiples of a square fifth of a cubit. The difference between the requirements of the theory and the actual squares being a mere 1/1500.*

All of this tended to corroborate Smyth's theory that the builders of the Pyramid had been possessed of an advanced science of mathematics. But Petrie also found in the Pyramid an extraordinary mixture of brilliant workmanship and astonishing clumsiness. He was amazed to find that the granite in the antechamber had never been dressed: many of the stones had been left unfinished and some were even defective. From such indications Petrie concluded that "the original architect, a true master of accuracy and fine methods, must have ceased to superintend the work when it was but half done."

From a careful scrutiny of the coffer in the King's Chamber, Petrie established that the ancients had used saws with 9-foot blades, their teeth made of hard jewels, to cut the sides of the coffer out of a single solid block. To hollow it out they had used drills with fixed cutting points also made of hard jewels, probably diamond or corundum.

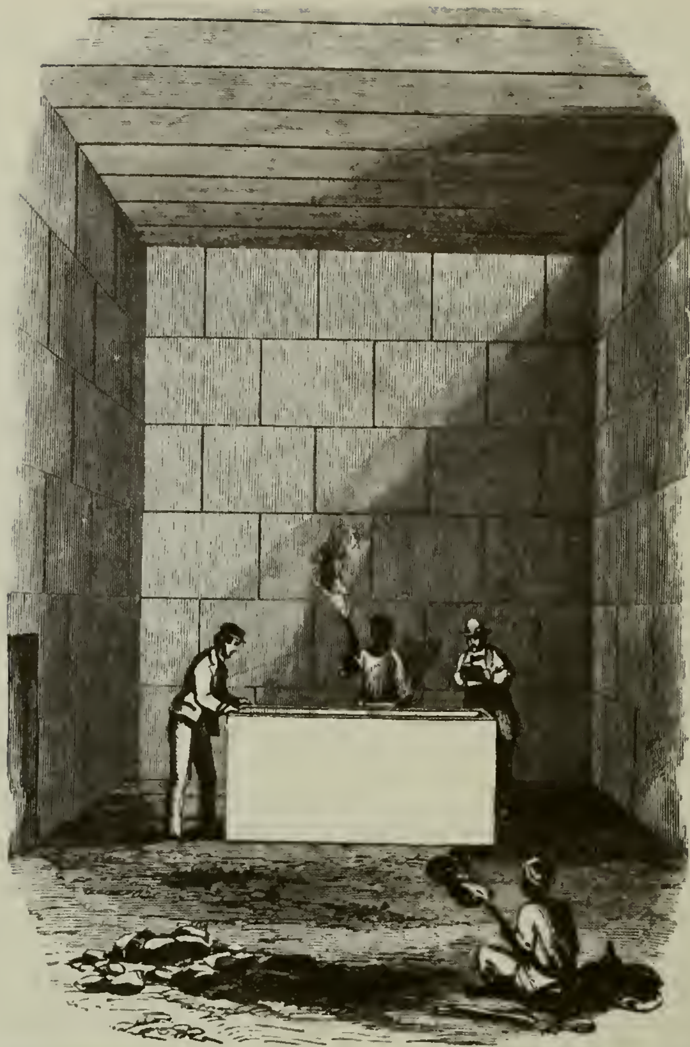
Petrie estimated that in order to cut through the hard granite a pressure of 2 tons would have had to be placed on the drill. How this could be done was a mystery to Petrie, who concluded: "Truth to tell, modern drill cores cannot hold a candle to the Egyptians . . . their fine work shows the marks of such tools as we have only now reinvented."

With such tools the ancient Egyptians were somehow able to cut sharp hieroglyphs into incredibly hard diorite, and also to turn stone bowls to paper-thin surfaces.

To measure the bottom of the coffer and to see if there were any secret opening beneath it, Petrie had its 3 tons raised about 8 inches, but found no sign of any opening. When raised and struck, the coffer produced a deep bell-like sound of extraordinary, eerie beauty.

Outside the building Petrie searched for more casing stones still in their original position such as had been

* Petrie also noted that the squares of the dimensions of the King's Chamber, Queen's Chamber, antechamber and subterranean chamber were all even numbers of cubits, nearly all multiples of ten. From this it followed that the squares of the diagonals were likewise multiples of 10 square cubits. And the King's and Queen's Chambers were so arranged that the cubic diagonals were in even hundreds of square cubits, or multiples of 10 square cubits.



Measuring the granite coffer before it was vandalized.

The coffer showing corner chipped away by tourists.

uncovered by Howard-Vyse at the base of the Pyramid. It was a painstaking and dangerous job to dig down through the accumulated debris. The rubble kept sliding back into the holes dug by the Arabs, and at one point Petrie nearly was killed.

Eventually he did manage to uncover more casing stones, as well as the base of the Pyramid. Petrie found the workmanship on the original casing stones, some of which weighed over 15 tons, quite as remarkable as Howard-Vyse had described it. The faces were so straight and so truly square that when the stones had been placed together the film of mortar left between them was on the average no thicker than a man's nail, or 1/50 inch over an area of 35 square feet.

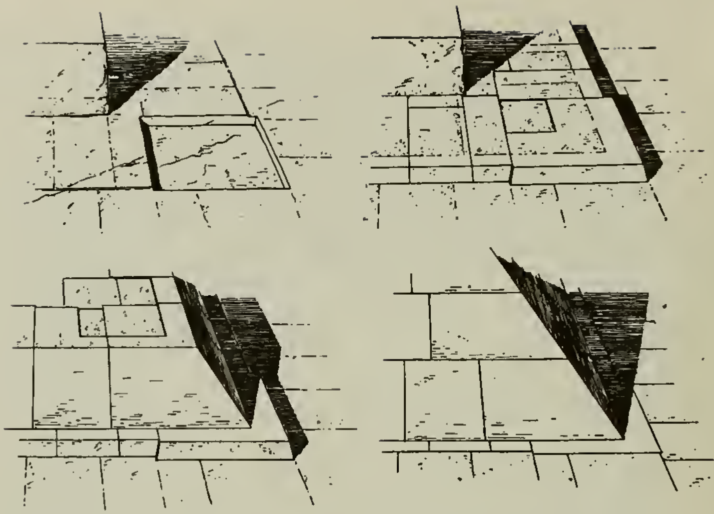
Petrie found that the mean variation of the casings from a straight line and a true square was but 1/100 inch on a length of 75 inches. This staggering accuracy was equivalent to the most modern optician's straight edges.

As Petrie remarked, "Merely to place such stones in exact contact would be careful work, but to do so with cement in the joint seems almost impossible: it is to be compared to the finest opticians' work on a scale of acres."

So fine was the texture of the cement that after millennia of exposure to the elements, the stones shattered before the cement would yield.

The casing stones of the Great Pyramid (looking east), showing the platform on which they rest, the pavement in front, and the leveled natural rock.

Shallow sockets dug into the rock at the corners of the Pyramid were designed to hold the four cornerstones for the base, and were apparently cut through the pavement at these points. This has engendered an argument among pyramidologists as to whether the base circuit should be measured from the edge of the pavement or the edge or bottom of the sockets.
It was at first assumed that the bottom of the Pyramid cornerstones had been fitted into these sockets so as to counterbalance any eventual thrust produced by sliding away from the center of the structure, but modern archeologists discount the assumption because at the northeast corner, the depth of the socket is virtually zero; and the outer edge of the southwest socket is merely an incised line in the rock, more for measurement than for structural support.



But the principal result of Petrie's survey was to prove a little abstruse. He considered the true base length of the Pyramid to be defined *not* by the limit of the sockets as measured by Smyth, but by the edge of the pavement 20 inches higher.

According to Petrie's measurements, the base of the Pyramid at the *pavement* was shorter than the distance between the outer corners of the sockets, as estimated by Smyth. Instead of measuring the 9140 British inches claimed by the Scottish astronomer, Petrie obtained a length of only 9069 inches for the base line.

Discarding Piazzi Smyth's theory that the Pyramid had been designed on an extra-long pyramidal cubit of 25.025 inches, Petrie showed by his own careful measurements that the builders of the Pyramid had used the royal cubit of 20.63 inches in order to produce a base line of 440 cubits and a height of 280 cubits. This confirmed Taylor's theory to the extent that the Pyramid was intended to symbolize the globe by giving a very effective π value of 22/7, or 3.14285, but apparently nullified Smyth's theories about the perimeter of the Pyramid giving the exact number of days in the year. The new product gave only 362.76 days.

Summing up the results of his measurements in a book entitled *The Pyramids and Temples of Gizeh* (which he was able to publish with a fortuitous grant of £100 from the Royal Society in London), Petrie remarked that he had never suspected, 15 years earlier, when he had first read Smyth's fascinating theory, that it would be he who "would reach the ugly little fact which killed the beautiful theory."

With success and recognition, Petrie turned from the romantic exploits of discovery to the prosaic minutiae of scientific archeology.

In the wake of Petrie's demolition of Smyth's basic contention about the length of the year being incorporated in the Pyramid's perimeter, soured academicians were happy to bury Smyth along with his theories. Foremost among such undertakers was Professor F. A. P. Barnard, president of Columbia College in New York, whose spadework in the 1890s consisted in arguing that the value of π was a modern discovery and therefore could *not* have been known to the ancients. In long-winded pieces for small periodicals, Barnard attacked Smyth for his "folly," and the builders of the Pyramid for the "stupidly idiotic task of heaping up a pile of massive rock a million-and-a-half cubic yards in volume."

In Barnard's opinion the Pyramids "originated before anything like intellectual culture existed; have been constructed without thought of scientific method, and have owed their earliest forms to accident and caprice."

Other academicians mocked the theory that the ancient Egyptians could have had an advanced knowledge of geometry, geodesy or astronomy. As recently as 1963 an eminent engineer in Baltimore, author of an expensive privately printed booklet, *Designing and Building the Great Pyramid,* was to write: "Because the sides of the Great Pyramid faced the four cardinal points almost precisely it is usually assumed that the designers intended they should, but it is unlikely that they had more than a vague idea, if any, of the four cardinal points. Like all peoples, the ancient Egyptians knew east and west from seeing the heavenly bodies rise in one and set in the other, but north and south were probably only known to them as general directions. There is no evidence in the Great Pyramid that they had any conception of true north or knew that a north-south line was perpendicular to an east-west line."

For years Smyth's painstaking measurements, carefully collected and illustrated in several large volumes (which went through several editions in his lifetime), were labeled by the academicians so much "trash and fancy."

In the conflict of opinions between biblical scholars and men of science, the true purpose of the Great Pyramid was buried in a rubble of verbiage.

Petrie had become Sir Flinders, and was on his way to becoming the dean of academic archeologists. Had it not been for the careful work of some conscientious scholars, Smyth and Taylor would have suffered the fate of Paracelsus and Mesmer, being relegated in the history books to the role of mountebanks.

IX. SCIENTIFIC THEORY DEVELOPED

Ironically, the next great investigator to throw light on the question of the Pyramid was a man whose object was to destroy and dispose of the theories of Robert Menzies, whose ideas about the prophetic revelations in the passage system had added to the difficulties of Piazzi Smyth.

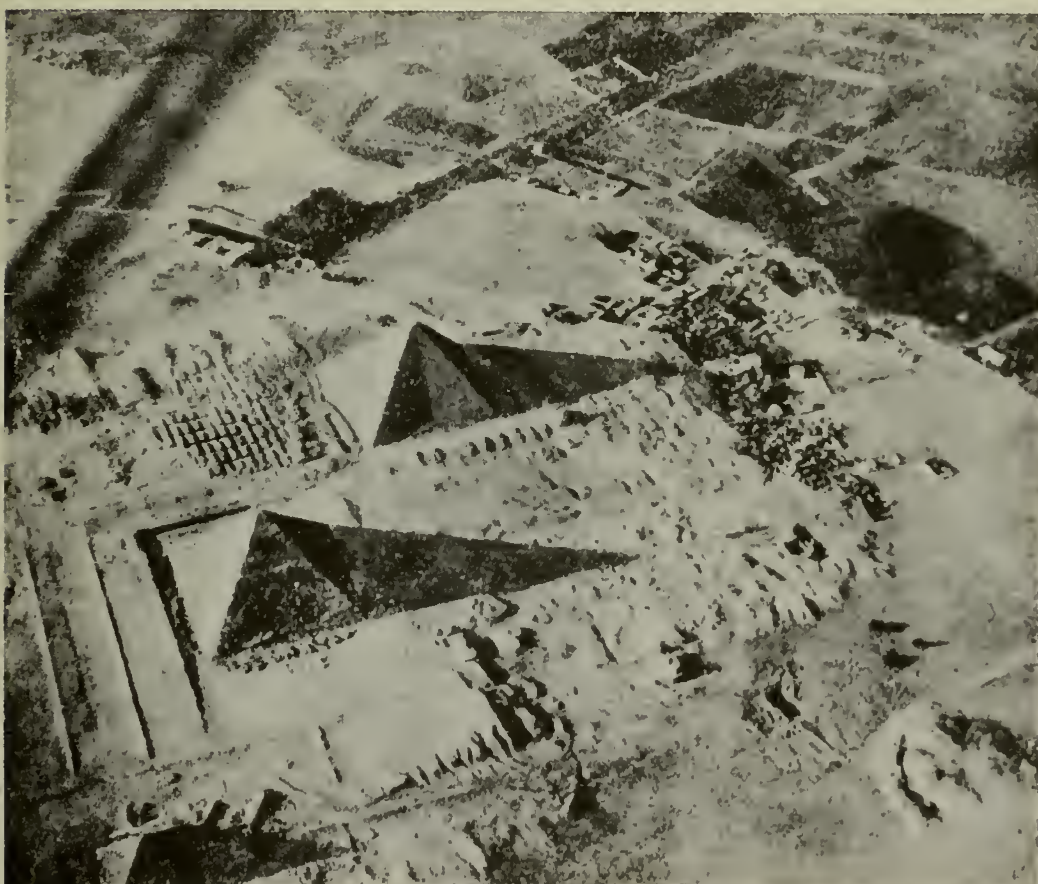
An agnostic and a sober structural engineer from Leeds, in the north of England, David Davidson was determined to destroy Menzies' prophetic theory. But the more he attacked the data, the more he was obliged to assimilate it. In the end he was to produce an encyclopedic literature in support of Menzies' own idea, and to become convinced that the Pyramid was "an expression of the Truth in structural form" and that it "establishes the Bible as the inspired work of God."

From further analysis of the Pyramid, Davidson believed he could confirm Taylor's premise that the science of weights and measures of the ancients was founded upon two functions of the earth and its orbit, the standard time unit being the solar year, and the standard linear unit a decimal fraction of the polar axis about which the earth rotates.

On the question of the length of the Pyramid's base, Davidson was to vindicate Smyth, yet avoid harming Petrie. According to Davidson, not only was Petrie's survey correct, so was Smyth's theory that the Pyramid's base incorporated the length of the solar year.

Petrie, with his meticulously careful measurements, had managed to observe a definite hollowing of the core masonry on each side of the Pyramid. The accuracy of this observation, normally invisible to the human eye, was revealed in Petrie's lifetime in a dramatic aerial photograph taken accidentally at a specific time and angle by Brigadier P. R. C. Groves, the British prophet of air power. A similar line along the apothem, visible in an etching made by Napoleon's savants, had been ignored for a century.

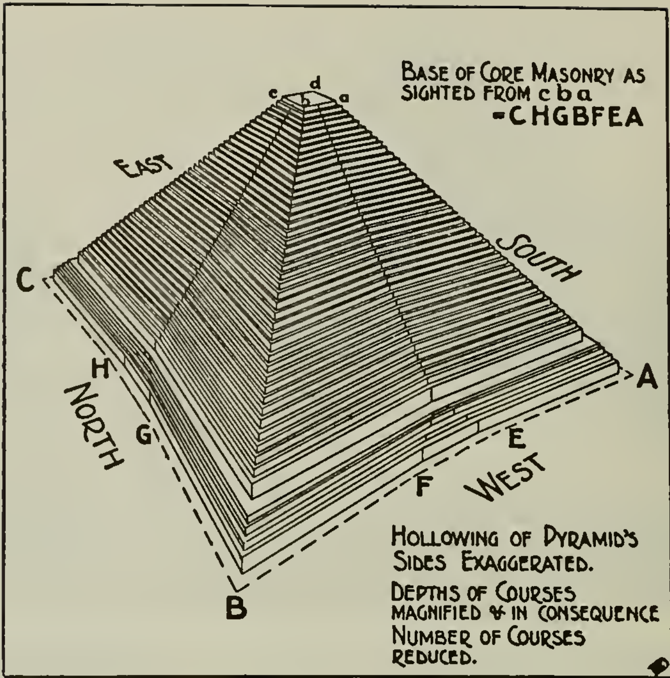
Davidson noted that Petrie had failed to extend this hollowing feature of the core material to his measurement of the outside casing. If this were done, a base length was obtained which fitted Smyth's theoretical length to account for the solar year, to four points of decimal.



Sir Flinders Petrie noted a distinct hollowing of the core masonry in the central portion of each face of the Pyramid. Though the hollowing amounts to as much as 37 inches on the north face, it is not directly observable unless special lines of sight are taken.

Petrie found no evidence of hollowing along the lower-level casing stones, running along the base of the Pyramid, which have now been completely uncovered.

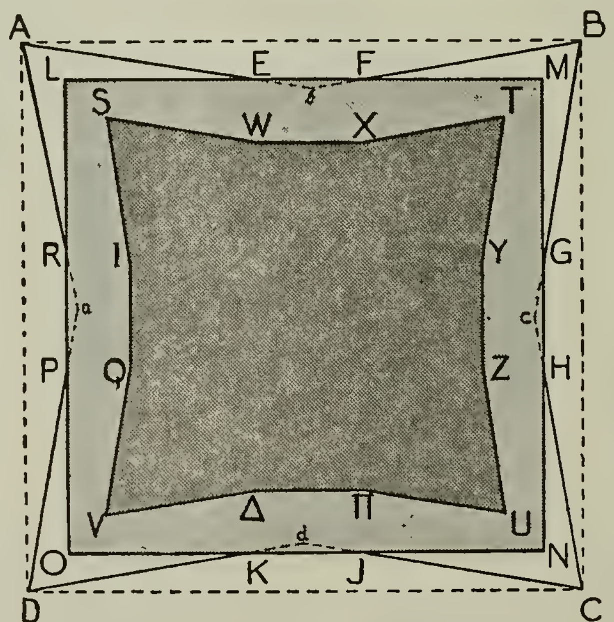
A recent survey by two Italian scholars, Maragioglio and Rinaldi, indicates the casing stones *above* the base line may have been slightly sloped toward a central line.



Davidson's plan of the base of the Pyramid, showing three different ways of measuring the year's length.

CONSTRUCTION OF THE GREAT PYRAMID'S BASE.

(Hollowing-in of core masonry GREATLY EXAGGERATED to show effect.)



LMNO—Base as actually built.
SWXTYZUΠΔVQI—Base of core masonry.

As Davidson put it: "By reason of this unfortunate omission, scientists have been led to believe that the theory of the late Astronomer Royal of Scotland—Professor Piazzi Smyth—requiring a Great Pyramid base circuit of 36,524 inches, was nothing more than a delusion."

The ideal length postulated by Smyth for each side of the base in order to obtain the required length of 9131.5 Pyramid inches was 9141.1 British inches. Petrie's figure, revised by Davidson, came out to 9141.4, or about a third of an inch too long.

According to Davidson, the hollowing effect would give three basic lengths of the year as recorded in the base of the Pyramid: an outer or shortest length, from corner to corner, bypassing the hollowing, a second, slightly longer, which included part of the indentation of the four hollowed faces at the base; and a third, which included the entire angle within each hollowed face. These three measurements, which could have been performed by the ancients at their leisure, could have given the equivalents, according to Davidson, of the three lengths of the year as computed by modern science: the solar, the sidereal, and the anomalistic years, each of which is dependent on the system used for observation.*

The academicians rebutted that all this was purely attributable to chance. An American naval officer who dabbled in digging at Giza remarked that "if a suitable unit of measurement is found—say versts, hands or cables—an exact equivalent to the distance of Timbuctu is certain to be found in the roof girder work of the Crystal Palace, or in the number of street lamps in Bond Street, or the Specific Gravity of mud, or the mean weight of an adult goldfish."

But Davidson's conclusions were to reopen the entire subject of Pyramid measurements and breed a whole new school of pyramidologists.

* The solar year is obtained by observing the exact time between two successive vernal or autumnal equinoxes, when the day is exactly as long as the night. It is now 365 days, 5 hours, 8 minutes and 49.7 seconds, or in decimals: 365.2242. The sidereal year (from the Latin *sidus,* for star) is the time it takes a star to reappear in the same spot in the sky, as seen by an earth observer. It is about 20 minutes longer than the solar year, or 365.25636 days. This 20-minute lag causes what is known as the precession of the equinoxes, which come 20 minutes earlier each year in relation to the stars behind the equinoctial point. The anomalistic, or orbital, year is the time it takes the earth to return to the point in its elliptical orbit nearest the sun, or perihelion. This is about 4 3/4 minutes longer than the sidereal year. According to Davidson, not only does the Pyramid give this value, but it gives the number of solar years it takes for the perihelion to complete a full circle of 360°.

The president of the French College of Astrologers, D. Neroman, a mining engineer by profession, showed in his *La Clé Secrète de la Pyramide,* published shortly after World War I, that Smyth's sacred cubit and Petrie's royal cubit were mathematically related. Neroman revived Newton's conclusion that the Pyramid had been built with both basic cubits, Petrie's shorter cubit for the common workmen, and Smyth's longer cubit for the hermetic science of the designers. Neroman showed that the Pyramid was the precise height and width to contain a round number of each unit. As 33 sacred cubits are equal to 40 profane, or royal, ones, the base measured 440 royal cubits or 363 sacred cubits; the height 280 or 221.*

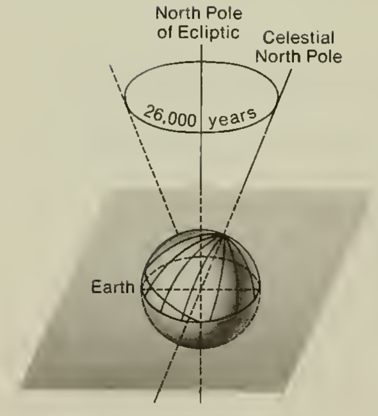
It was suggested that the priests measured the year's length with a sacred cubit so that they alone could make use of the Pyramid's hermetic science. But why this yielded a base of 363 days was not satisfactorily explained.

Another necromantic solution was provided by John B. Schmaltz in a small book entitled *Nuggets from King Solomon's Mines*. Schmaltz demonstrated that the modern deck of cards could be taken as a symbol of the Egyptian year incorporated in the Great Pyramid. According to Schmaltz the 52 cards represent the weeks, the 12 face cards the months, the 13 cards in a suit the lunations, the suits the seasons, the total face value of the cards (counting jack as 11, queen as 12 and king as 13) 364 days, plus the joker as the magic 1.234, for a total of 365.234 days in the year.

A more solid boost to the memory of Piazzi Smyth—quickly made much of by the pyramidologists—was the refined figure for the polar axis of the earth obtained in 1910 by the American geodesist John Fillmore Hayford, who computed it at 6,356,910 meters, the ten-millionth part of which gives a cubit of 635.69 millimeters, or Piazzi Smyth's sacred cubit, correct to .03 millimeter.

Another extraordinary figure found by the pyramidologists in the base of the Pyramid was the sum of its diagonals, which they computed as 25,826.68 pyramid inches. This gave a very close approximation of the number of solar years in what is known as the great year, which is determined by the precession of the equinoxes. The great year is the time it takes the earth to make a complete gyration in the wobble of its axis in relation to the plane of its orbit; this with the solar year, are the two prime standards for astronomical time.

Actually, the rate of precession is far from uniform, and



The precession of the equinoxes.

* 33 × 25.025 = 825.72 and 40 × 20.643 = 825.72. It will be noticed from Neroman's figuring that to obtain this result he arbitrarily lengthened the royal cubit by about 1/100 of an inch.

is at present slowly increasing. According to Davidson, the Great Pyramid recognized this fact and provided a method of sums of diagonals at different levels of the monument to indicate the all-time mean, or average length of the precessional cycle.

To add to the coincidences, Morton Edgar, an ardent supporter of Davidson, who traveled to Egypt just prior to World War I and made extensive measurements and calculations, found that the perimeter of the thirty-fifth course, which is much thicker than any of the other courses, *also* gives a figure for the precession of the equinoxes.

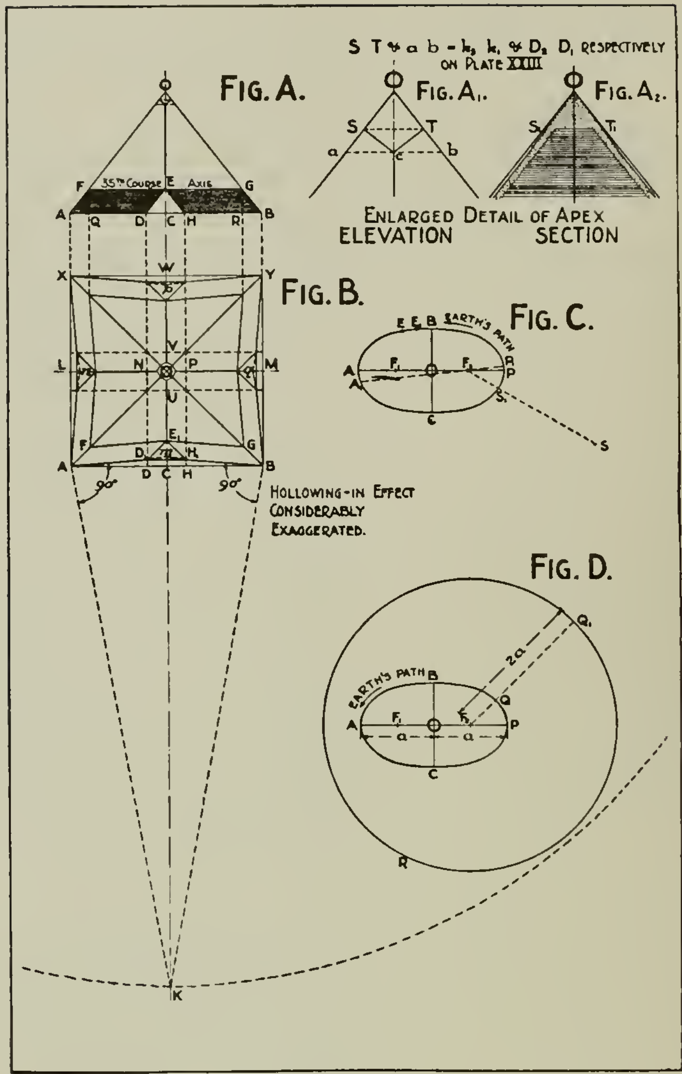
Egyptologists and astronomers argued that if the Pyramid had been designed to incorporate the π proportion, and its base had been designed to be 365.2422 cubits long, the chances of its diagonals being intentionally designed to mark the length of the precession would be simply astronomical.

Davidson replied that to build the Pyramid its designer must have been deeply acquainted with the workings of natural law: that before such a design could be put into effect, the astronomical properties of the solar year would have to be reduced to a simple pyramidical expression.

Davidson claimed that—without getting into higher mathematics—it was evident that if you know the earth's distance from the sun and the length of the sidereal year in seconds, you can compute the rate at which the earth is falling toward the sun. This in turn would lead to finding the specific gravity of the earth, of the sun, of the earth and moon combined, the solar parallax, and even the speed of light.

To Davidson the mathematics of the Pyramid indicate that the former civilization was more highly skilled in the science of gravitational astronomy—and therefore in the mathematical basis of the mechanical arts and sciences—than modern civilization. It was his conclusion "that it has taken man thousands of years to discover by experiment what he knew originally by a surer and simpler method." In Davidson's words: "It means that the whole empirical basis of modern civilization is a makeshift collection of hypotheses compared with the Natural Law basis of the civilization of the past."

As to why the Pyramid was built and its passages carefully secreted, Davidson surmised that the builder intended to monumentalize the science of his time for another civilization far in the future, much as we go about burying time capsules. According to Davidson, the builder knew that the faculties by which he was able to handle the formulas of natural law could atrophy in man, and that by conveying his science to beings of a later civilization he might spur them to recover those powers.

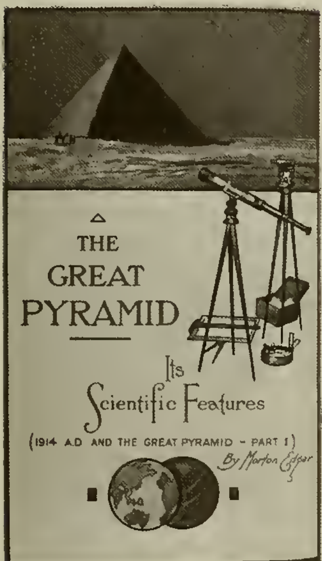


Davidson's computations to show that the Pyramid's base defines the earth and its orbit "in dimensions and motion."

Like Menzies and Smyth before him, all that Davidson managed to accomplish was to antagonize the scientific world with his insistence upon the record-preserving nature of the Pyramid while swamping the average pyramid enthusiast with the overwhelming bulk of his detailed mathematical analyses and computations.

Even worse were the efforts of a succession of pyramidologists who attempted to prove the Great Pyramid contained a six-thousand-year prophetic history of the world commencing in 4000 B.C. and going to A.D. 2045 which coincided with the prophecies of the Bible. They saw in the Pyramid an allegory in stone in which the Descending Passage represented humanity on its way down toward

Morton Edgar, supporter of the prophetic theories about the Pyramid, stooping to enter the King's Chamber. The picture shows how the floor was inserted between the walls so as to obtain both the π value and the 3–4–5 triangle.



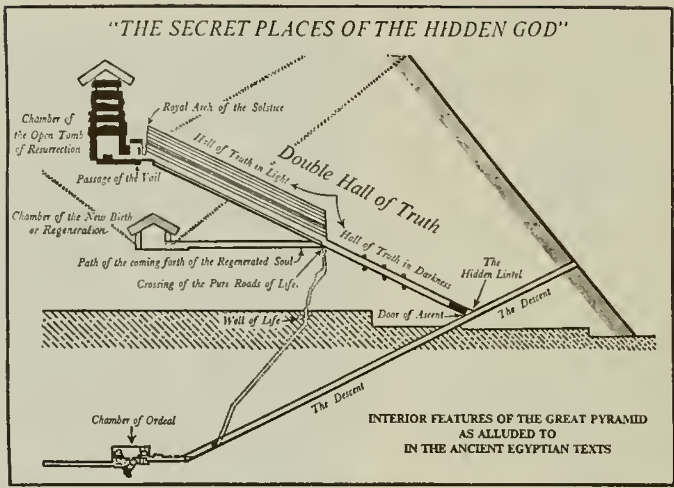
ignorance and evil. At the juncture of the Ascending Passage, evil spirits were to continue toward the pit, whereas the rest of humanity, benefiting by the Christian Dispensation, moved upward along the Ascending Passage toward the Light of the Grand Gallery. Having passed the Great Step, humanity must continue bent in submission through the Antechamber of Chaos—representing the modern age—before it could come out into the King's Chamber and the glory of the Second Coming.

The prophetic chronology was supposed to be marked out along the passages and chambers, with one year corresponding to one pyramid inch, commencing with "Adam," or the "first created man," and ending with the "Day of Judgement."

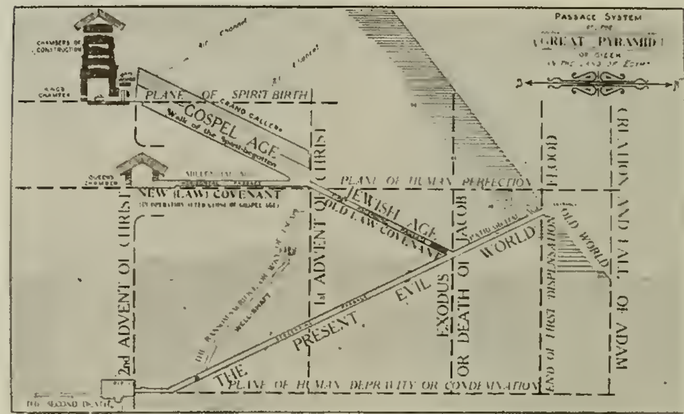
According to Morton Edgar: "By the year 2914, the end of the 1000-year 'Day of Judgement,' mankind will have experienced the full benefit of the sacrificial work of Christ, and will regain that perfect human nature which father Adam lost in the beginning of his disobedience 7040 years previously."

By general agreement the commencement of the Low Passage into the Antechamber was said to mark the beginning of the Great War in 1914. The end of the King's Chamber was supposed to be indicated by the year 1953.

Considering the wide popular acceptance of such medieval prophets as Nostradamus, and such modern prophets as Edgar Cayce and Jeane Dixon, it should not have been harder to believe that some ancient prophet couio



Interior features in the Great Pyramid alluded to in the ancient Egyptian texts such as *The Book of the Dead*, according to the prophetic "pyramidologists."



Chronology of the past 6000 years as indicated in the Great Pyramid passages according to Menzies and Piazzi Smyth.

have had prescience of the following 6000 years, and built his vision into the Pyramid passages; but as each prophetic date went by with no appearance of a Second Coming, the idea of the Pyramid as a prophetic calendar became largely discredited.

By 1920, when the waters of the Mediterranean failed to become thick and viscid, and the rivers and fountains of the world failed to turn into blood, as prophesied by Colonel J. Garnier on the basis of the Pyramid chronology, the whole subject became so unpleasant in the halls of academe that few professors dared mention the Pyramid as anything but the supposed resting place of the Pharaoh Cheops.

Nevertheless, a few intrepid investigators kept minds open enough to continue their research into the structure and purpose of the Pyramid, and to put forth some theories that in the end paved the way for a general vindication of much that Jomard, Taylor, Smyth, and even Davidson had propounded.

X. A THEODOLITE FOR SURVEYORS

One basic function of the pyramids on the Giza plateau was discovered by a chief engineer of the Australian railways, Robert T. Ballard, as he watched them from the window of a passing train in the 1880s.

From the constantly changing relative position of their clear-cut lines against the sky, Ballard realized that the pyramids could serve as excellent theodolites for a land surveyor, enabling him to triangulate the land anywhere within sight of the pyramids.

The land of ancient Egypt was parceled out in small lots to individual priests and soldiers, the boundaries of which would regularly vanish with the flooding of the Nile.*

By means of the pyramids, not only could the surrounding country be quickly resurveyed, but boundaries destroyed by the Nile could be readily restored.

From the silhouettes of the pyramids, the engineer realized that lines could be obtained as perfect as can be laid out nowadays with all of our modern instruments. With a string and a stone held in the hand and the clear-cut point of a pyramid 20 miles away against the ball of the sun 90 million miles away, the error in such a line would be trifling.

What's more, the same building could also be used with either moon or stars.

Knowing the latitude of the pyramids, survey lines could be shown all the way to the coast of the Delta—with nothing more than a string and a weight.

As the engineer's train steamed southward along the bank of the Nile, more pyramids appeared on the horizon, and the engineer realized that with a procession of such theodolites it would have been possible to adjust the boundaries of Egypt from one end of the country to the other.

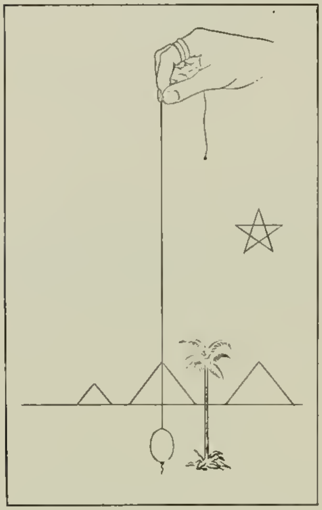
Ballard figured that the simplest portable survey instrument would be a small scale model of the Pyramid of Cheops in the center of a circular graduated board marked like a compass. When the north end of the card was pointed toward the north, and the faces of the model turned to indicate the same light and shade displayed by the Great Pyramid, the

* Statisticians estimate that eight million people were crowded into a space of only 11,500 square miles, giving a density of 695 per square mile—which is more than modern Belgium, the most densely populated part of Europe.

Fig. 38.
From the North West
Bearing 315°
Sun in the West.

Fig. 39.
From the South East
Bearing 135°
Sun in the West

The pattern of shadows cast by the three large pyramids of the Giza plateau can serve to orient the viewer as accurately as a compass or theodolite. Ballard suggests that the smaller pyramid of Mykerinos was intentionally sheathed in red granite, in bold contrast to the other two pyramids, so as to facilitate the work of the surveyor.



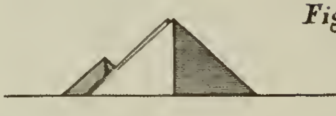


Fig. 40.
From the North East
Bearing 45°
Sun in the East.

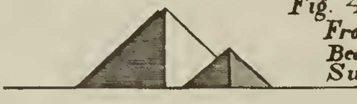


Fig. 41.
From the South West
Bearing 225°
Sun in the East

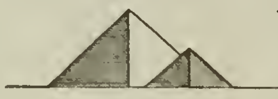


Fig. 42.
South 21 West 20.
Bearing 223°. 36'. 10·15".

Fig. 43
South 4. West 3.
Bearing 216°. 52'. 11·65".

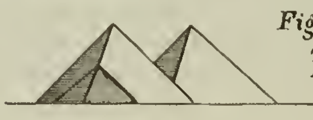


Fig. 44.
South 2. West 1.
Bearing 206°. 33'. 54·18".

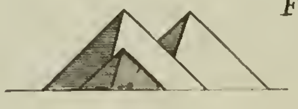


Fig. 45.
South 96. West 55.
Bearing 209°. 48'. 32·81".

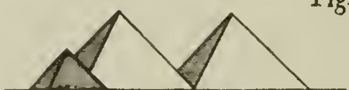


Fig. 46.
South 3, West 1.
Bearing 198°. 26'. 5"82

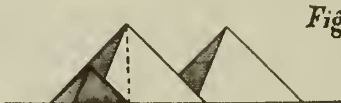
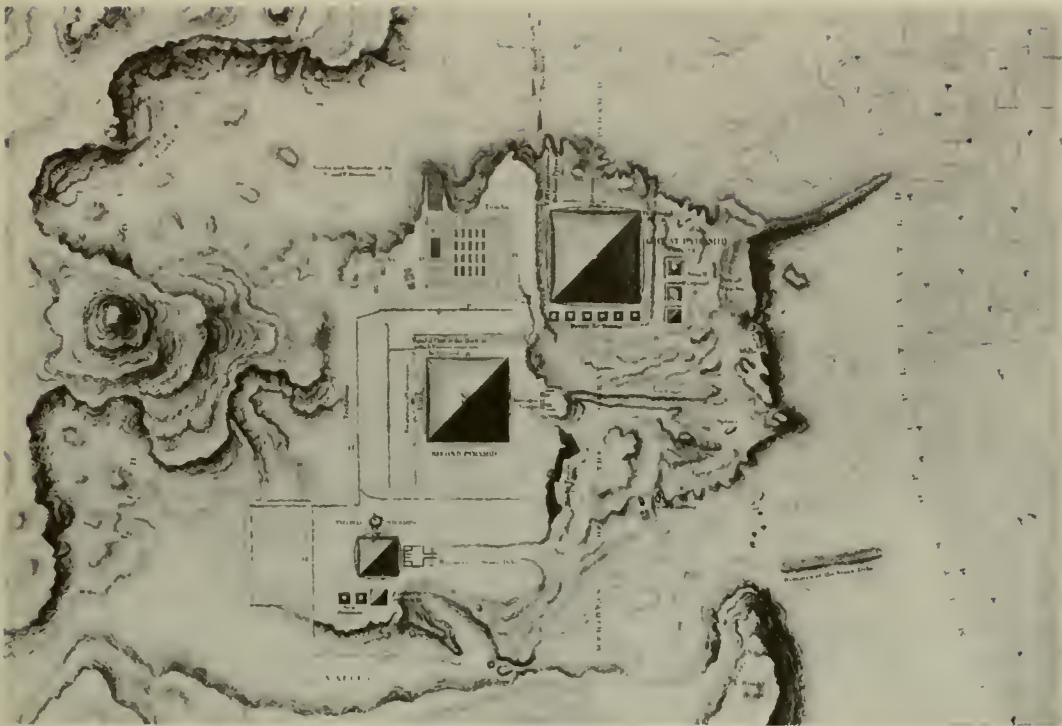
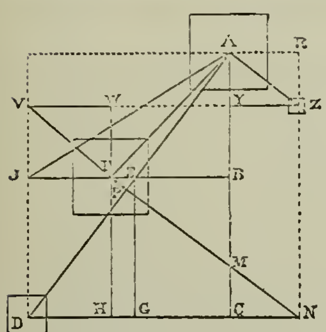


Fig. 47.
South 5, West 2.
Bearing 201°. 48'. 5".

Fig. 48.
South 7. West 3.
Bearing 203°. 11'. 55".





The Giza complex of pyramids, as depicted from the air, showing the north-south meridian through the center of the Great Pyramid.

According to Soviet space engineer Alexander Abramov the three large pyramids on the Giza plateau are arranged in a special geometric configuration known in ancient Egypt as an *abaka*. Ballard found that several Pythagorean triangles could be formed by the perimeters and centers of the pyramids.

surveyor could simply read off the angle of bearing. With a model of all three pyramids, the reading would be that much more exact. Furthermore, observation of the next pyramids farther to the south could be tied in with these readings.

The Australian engineer also worked out that the pyramids could be used for surveying by right-angled triangles with sides having whole numbers, such as the 3–4–5 triangle and the 2– $\sqrt{5}$ –3 triangle Petrie had found in the King's Chamber, both of which were fundamental to land surveying. Similarly incorporated in the ziggurat of the Babylonians, the triangles were conceived by the ancients to explain the secret order of the cosmos, a conceit which percolated to Plato. In the *Timaeus* he explains the cosmos as being constructed by the triangle 3–4–5 and the number $\sqrt{5}$–1 or 1.236068 (which in common practice was taken as 1.2345).

For right-angled trigonometry, the Australian engineer realized, true straight lines could be extended from the pyramids in given directions by direct observation, without aid of other instruments, and that with the simplest of instruments, angles could be exactly observed from any point.

In a short time *anyone* might construct a table for himself answering to every degree or so in the circumference of a circle for which only forty or fifty triangles are required.

Such primary triangulation would be useful to men of almost every trade and profession in which tools or instruments were used.

Having come to these conclusions, Ballard incorporated them in a small illustrated volume with the rather grand title of *The Solution of the Pyramid Problem,* published in 1882.

XI. ALMANAC OF THE AGES

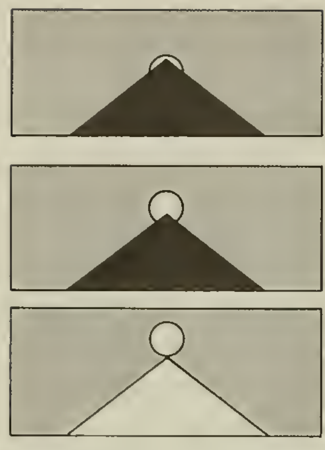
Ballard's little booklet and one of Smyth's discoveries at the Pyramid brought another strange investigator to the scene. Smyth had been astonished that with the advent of spring, when the sun rose high enough to shine down the northern slope of the Pyramid, the structure appeared to swallow its own shadow at noon. Smyth deduced that the Pyramid had been designed as a huge sundial whose shadows could indicate the seasons and the length of the year.

By Smyth's reckoning the Pyramid had been intentionally located, oriented, and sloped for the phenomenon to occur in that latitude at the spring equinox, when at noon the sun is directly over the equator, although for some reason the phenomenon no longer occurred precisely at that particular date.

Unbeknownst to Smyth, the French astronomer Jean Baptiste Biot had been to Egypt in 1853 and noted that "with or without intention by the Egyptians who built the Great Pyramid, it has, since it existed, functioned as an immense sundial which has marked annually the periods of the equinoxes with an error less than one day, and those of the solstices with an error less than a day and three quarters."

The phenomenon had a great impact on an obscure Yorkshireman, Moses B. Cotsworth, a legislative enthusiast whose life's ambition was to reform our present barbarous almanac.*

* The present calendar derives from the early Romans, who had a 10-month year of 334 days: hence our September, October, November, December. In the seventh century B.C. Numa Pompilius is credited with adding January and February for a lunar year of 354 days. The shortage of 11 1/4 days caused the seasons and the calendar to diverge to the point where Julius Caesar was obliged to add 91 days to 46 B.C. and succumb to the suggestion of Cleopatra that he adopt the Egyptian civil calendar of 365 1/4 days. Even so, the difference between the civil calendar and the actual solar year of 365.2422 days added up to an extra day every 128 years, which obliged Pope Gregory XIII to drop 10 days from 1582. When Protestant England refused to go along, Christendom celebrated different Christmases in England and France, till the British finally relented in 1752, though there were street riots in London with shouts of "give us back our ten days." By skipping leap days in centuries which are multiples of 400 and 4000, our calendar is now good for the next 20,000 years, but anyone who troubles to read Cotsworth's impassioned plea for a more rational system than our calendar of floating holidays will find it hard to dispute his logic.



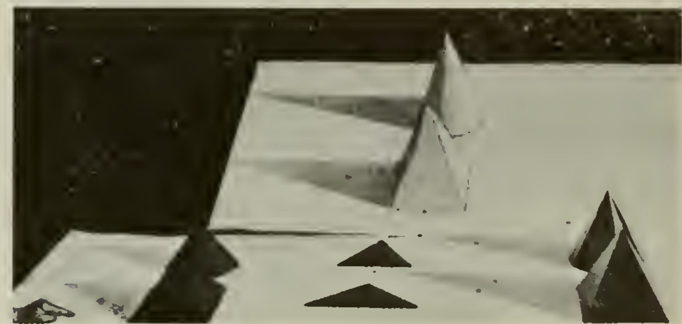
In early spring, when the sun rises just high enough above the apex of the Great Pyramid, the whole shadow on the north face vanishes at the stroke of noon.

Cotsworth was convinced that the designers of the Pyramid had intended their finished structure to serve as a perfect almanac for registering the seasons and the year. To prove his point Cotsworth went in search of further evidence.

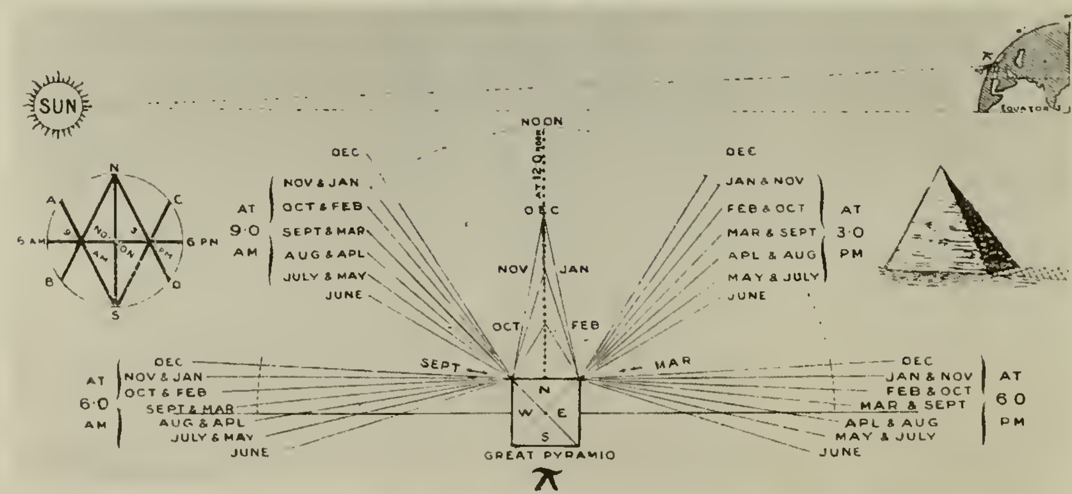
Just before Piazzi Smyth died in 1900, Cotsworth managed to have several conversations with him, and after his death was able to get hold of Smyth's books and papers when they were put up for auction. Though Cotsworth refused to accept Smyth's prophetic theories, he was determined to vindicate the astronomical theories of the ancient Egyptians, so he set about reconstructing with models the sundial system on which he believed the Pyramid had originally been designed.

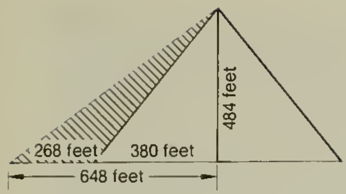
Cotsworth noted that at the latitude of the Pyramid, an ordinary obelisk would serve admirably for telling the time of day, or the general course of the seasons, but could not be built high enough to throw a shadow long enough to detect the length of a whole year of 365 days, let alone throw a shadow fine enough to distinguish the extra quarter of a day to four points of decimal. To obtain the difference in length of 1 foot per day would require an obelisk 450 feet tall, perfectly vertical and precisely oriented.

Cones and pyramids designed by Moses B. Cotsworth to demonstrate how shadow patterns could be used to measure the length of the year.

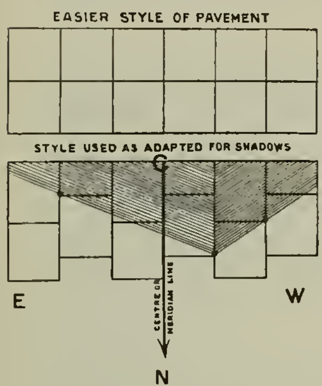


Cotsworth's models show how a square-based pyramid oriented to true north will cast a pointed shadow on the meridan line. A cone, showing no orientation, will not serve the purpose.





With the sun's winter solstice angle of 36° 45′, the Pyramid will throw a shadow of 648 feet. Deduct half the Pyramid's base length of 760 feet, or 380, and the maximum length of the Pyramid's winter shadow will be 268 feet.



Cotsworth found that part of the pavement north of the Pyramid was paved with blocks whose widths were close to the 4 1/2-foot gradation of the sun's shadows on successive days just before the Pyramid consumed its own shadow in the spring.

Cotsworth figured that the dimensions of the Pyramid would be ideal for measuring the six winter months, when the northern slope of the Pyramid is constantly shaded and when the shadow cast at noon onto the northern pavement grows longer up the meridian to a maximum at the winter solstice, gradually decreasing to the point of disappearance at noon on a certain day in March.

To test his theory, Cotsworth made several model pyramids and cones and laid them out on carefully diagrammed paper. On these sheets he marked the outline of the shadow cast by the sun each half hour during a period of several months.

To his satisfaction Cotsworth was able to prove that the pyramid was the best shape for the purpose. The pyramid was more easily oriented to a perfect north, its flat slope was easier to angle, and its sharp edges cast a better shadow. Also, the actual structure would be easier to build to the required height in the form of a pyramid than a cone.

To measure the Pyramid's lengthening and shortening shadows, Cotsworth realized that a wide and perfectly level pavement, or "shadow-floor," should have been constructed on the northern side of the Great Pyramid, presumably with a meridian line running due north, and a pavement laid in some geometric pattern to facilitate the measuring of the shadows.

Cotsworth worked out that a structure 484 feet high, such as the Pyramid of Cheops, would require a "shadow-floor" stretching 268 feet northward of the base in order to include the full length of its shadow at its longest point, at the winter solstice in December.

To verify his theory, Cotsworth sailed for Port Said in November of 1900 aboard the P. & O. liner S.S. *Osiris*. At the Giza plateau he found the north side of the Pyramid of Cheops reasonably clear of rubble and the rocky plateau leveled to the required distance. At the level of the main platform on which the Pyramid rests, he found a pavement, or "shadow-floor," which extended as far as the remains of an old wall which had once surrounded the pyramid complex.

Instead of being paved in adjacent squares, Cotsworth found it laid in alternate half squares, which provided twice the number of junction points by which to measure the daily shadow of the Pyramid along the meridian at noon.

To support his observations, Cotsworth made a series of photographs of these shadows as they grew shorter toward the vernal equinox. To his delight he found that the paving blocks had been cut in widths very close to the 4.45-foot gradation by which each noonday shadow succeeded the former as they approached the vanishing point in March.

Photograph taken by Cotsworth showing shadow cast by the sun close to the base of Pyramid at noon of the last day before the intended equinox. The negative was stolen and the print has suffered in reproduction; but the pattern of shadow can be measured on the northern pavement.

It was only thus, says Cotsworth, "that the ancient priests could have established by physical observation of the shadow on the flagstones, the precise length of a year to .24219 of a day."

William Kingsland, a professor of astronomy, commenting on Cotsworth's conclusions, pointed out that some of the paving stones are actually laid at all kinds of irregular angles and corners; but the corners of these stones are clearly cut out to fit into the adjoining stone—indicating, if anything, an even more sophisticated geometric pattern.*

To make up for the summer half of the year, when there

* According to Kingsland, Cotsworth's leveled rock area did not extend 268 feet north from the northern base of the Pyramid, but ended at a distance of only 33 1/2 feet, where there are the remains of a surrounding wall 9 1/2 feet thick; but there is no way of telling at what time this wall was built, or whether the pavement may not have once continued beyond it, and been dismantled by the Arabs for building blocks.

was no shadow on the northern slope of the Pyramid, Cotsworth figured that the priests could have subdivided and tabulated the intervening months.

In this he failed to realize that the southern face of the Pyramid, being highly polished, could throw a triangle, not of shadow, but of sunlight onto a southern pavement during the summer months, quite as definite as the winter shadows thrown on the northern side.

From May to August the south face would cast a triangular reflection of the sun onto the ground which would shorten as it approached the summer solstice, the shortest being at noon of the solstice, lengthening again till noon of the last day of summer.

Noon reflections would also be projected every day of the year from the east and west faces. But this was to remain for David Davidson to establish.

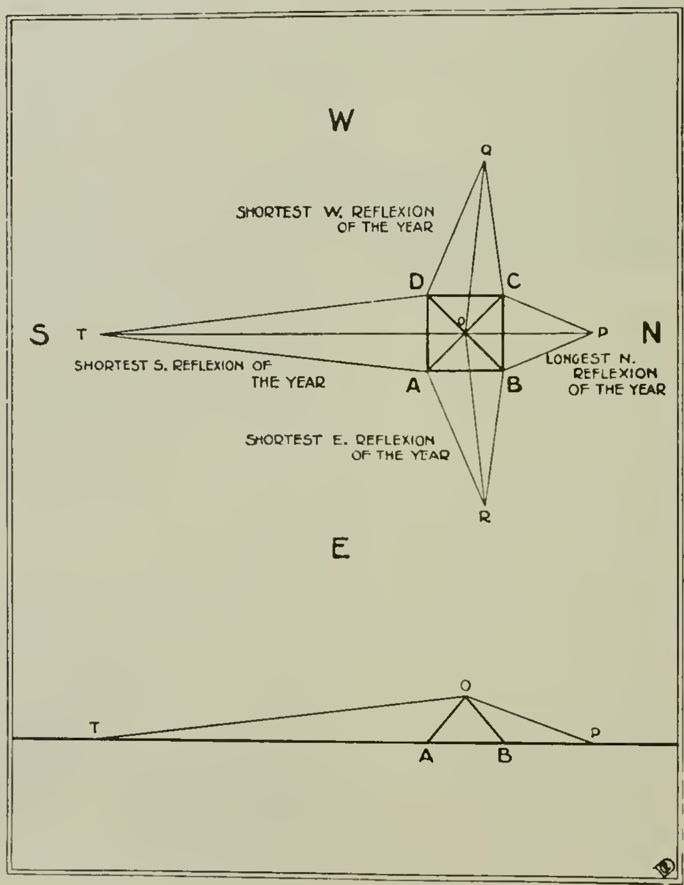
From a study of the sharper slopes of other pyramids, such as of Saqqara, Medûm and Dashur, Cotsworth deduced that their builders may have aimed these slopes not at the equinox, when the sun is midway, but at the summer solstice, when the sun is highest in the sky at noon. Sneferu's pyramid

Deliberately broken pattern of paving stones observed by William Kingsland on the north side of the Great Pyramid, apparently intended for finer mathematical measurement of the sun's shadow on successive days and years.

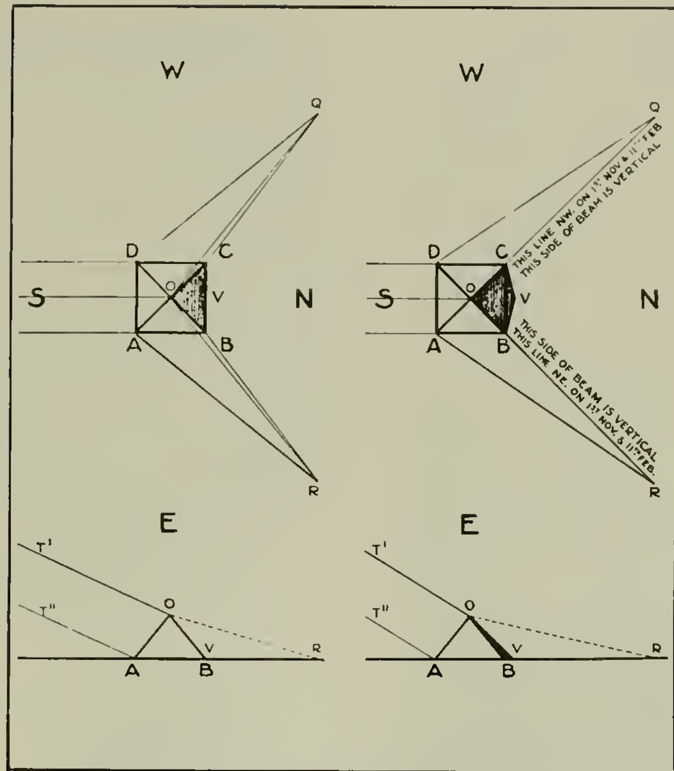
at Dashur, with its milder slope of 43°, may have been aimed at the winter solstice, when the sun is lowest at noon. From the gradually corrected slope of Saqqara and the change in angle in the bent pyramid at Dashur, Cotsworth concluded that the Egyptians may have progressed northward to the "truer" pyramid form, or π-shaped pyramid, at the thirtieth parallel, where morning and afternoon shadows form a series of perfectly straight lines.

In this, Cotsworth was supported by Joseph Norman Lockyer, the eminent British astronomer, who taught astronomical physics at the Royal College of Science. Lockyer noted that pyramids other than that of Cheops appeared to be oriented not to true north but to the rising sun at the solstice, which *changes with the latitude* of the place of construction.

According to Cotsworth the pyramids were originally developed from mastabas or raised terraces built to support an obelisk. To lengthen the shadow, the obelisk was successively raised on higher sloped platforms, which eventually turned into stepped pyramids.



Davidson's diagram of the reflections of sunlight cast by the Pyramid at noon of the summer solstice.



Davidson's diagram of winter shadows and reflections cast by the Great Pyramid. Left figure shows the noon shadow first appearing October 14–15. Other lines indicate reflected sunlight. Right figure shows the noon shadow first disappearing February 27–28. Other lines are pattern of reflected sunlight.

Cotsworth points out that the oldest true pyramid, that of Medûm, was constructed in several stages, as evidenced by the polished casings at each level.

The process, says Cotsworth, was developed to the point where the results no longer increased in proportion to the effort expended. A 60-foot platform which raised a 60-foot obelisk increased its shadow by 100 percent, but an added platform of 40 feet only increased the shadow by 19 percent; eventually the top platform became too small for raising an obelisk. According to Cotsworth, the optimum design turned out to be the solidified Pyramid of Cheops, with its slope set for a particular latitude to swallow the equinoctial shadow. Once this method of establishing the precise length of the year had been found, says Cotsworth, there was no further need for enormous pyramids.

Cotsworth obtained further confirmation of his theory from a comparison of the pyramids with the artificial hills built by ancient inhabitants of Britain who traced the year's end by the longest shadow of the year cast from vertical cones or artificial mounds such as Silbury Hill.

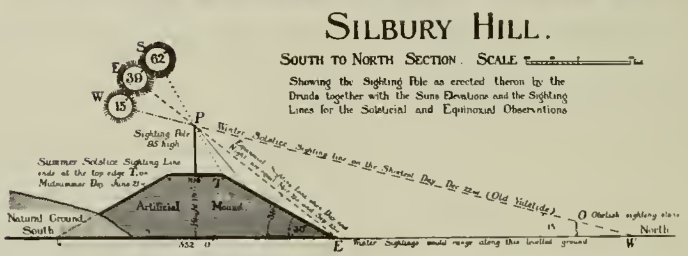
Later inhabitants of Britain, such as the Druids and Goths, continued to count the year's end from Yuletide, the December solstice.

Silbury Hill in Wiltshire, England, covers five acres and is built of over a million tons of hand-moved material. According to archeologists it is at least four thousand years old.

Cotsworth says that Silbury Hill was designed to have a Maypole on top to cast a shadow up and down the truncated hill and onto the level plain to the north, so as to mark the four seasons of the year.

The cone was truncated at a point where the shortest shadow thrown by the Maypole on the longest day of the year indicated the summer solstice. On the level plain north of the hill a stone was placed in the ground to mark the point of the longest shadow cast by the Maypole at the winter solstice, or shortest day of the year.

The juncture at the bottom of the hill, where it touched the plain, marked the spring and autumn equinoxes, when the day was exactly as long as the night.



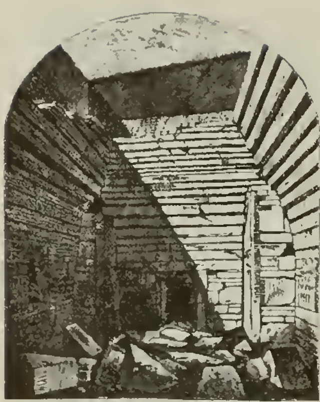
Aerial photograph of Silbury Hill, showing the footpath around the truncated top.

Druid in Old Irish meant "he who knows." Julius Caesar, our earliest source on the subject, considered the Druids highly educated and well organized. In *De Bello Gallico* he commented: "It is especially the object of the Druids to inculcate this—that souls do not perish, but after death pass into other bodies, and they consider that by this belief more than anything else men may be led to cast away the fear of death, and to become courageous. They discuss many points concerning the heavenly bodies and their motion, the extent of the universe and the world, the nature of things, the influence and ability of the immortal gods; and they instruct the youth in these things."

As Cotsworth reconstructed the system, the truncated cone of Silbury Hill enabled the ancient astronomers to measure the length of the seasons and the year by the length of shadow cast by a pine Maypole, which served as an obelisk, atop a hill intentionally truncated so that its edge would also mark the summer solstice, or the shortest shadow of the year.

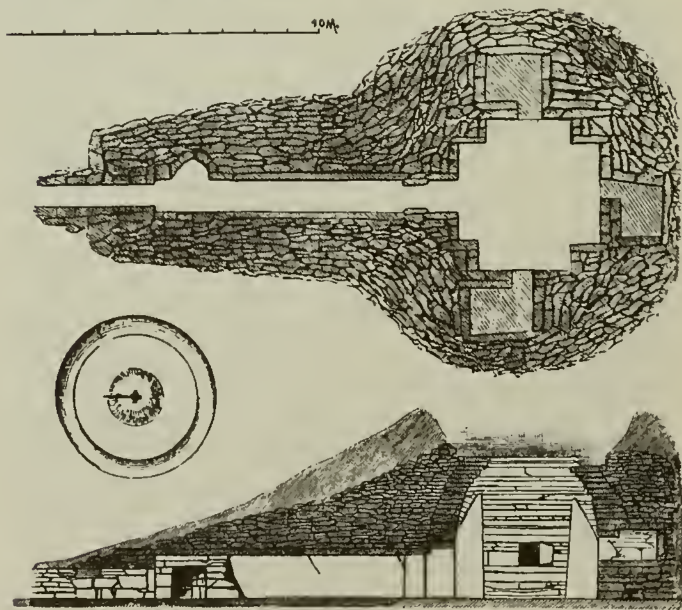
Had these astronomers simply required a great height, says Cotsworth, they would have used the adjacent Abury Hill, with its wide top which could easily have been raised. But this, says Cotsworth, would not do; they required an absolutely level piece of ground on which to mark the progress of the shadow. Hence they had no alternative but to pile up an artificial hill above the level plain. Fortunately, in latitudes of 50° or 60°, such as Brittany or Stonehenge, low mounds would give shadows long enough for detailed measurement. A height of 225 feet in Wiltshire gives a shadow almost equivalent to the shadow of the 484-foot Pyramid of Cheops.

One of the most remarkable of these prehistoric European mounds still exists at Maes-Howe, near Stennes, in the Orkney Islands. It is equipped with a 15-foot square observatory chamber and a 54-foot sighting tunnel. The tube is aimed at a conspicuous man-raised monolith 42 chains (2772 feet) from the entrance, which lines up with a spot on the horizon where the sun now rises 10 days before the winter solstice. Another monolith, to the west, called the Watchstone, indicates the equinoxes. Like the Great Pyramid of Cheops, the observatory chamber is built of huge megaliths and its ceiling is corbeled. There are also three "retiring rooms for the observers," somewhat like the Queen's Chamber in the Great Pyramid.



The main chamber in Maes-Howe, showing corbeled monoliths which could be closed at the top by a single movable slab. The jointing in this prehistoric masterpiece rivals that of the Great Pyramid.

The entrance passage to the Maes-Howe observatory is very similar to that of Egyptian pyramids.

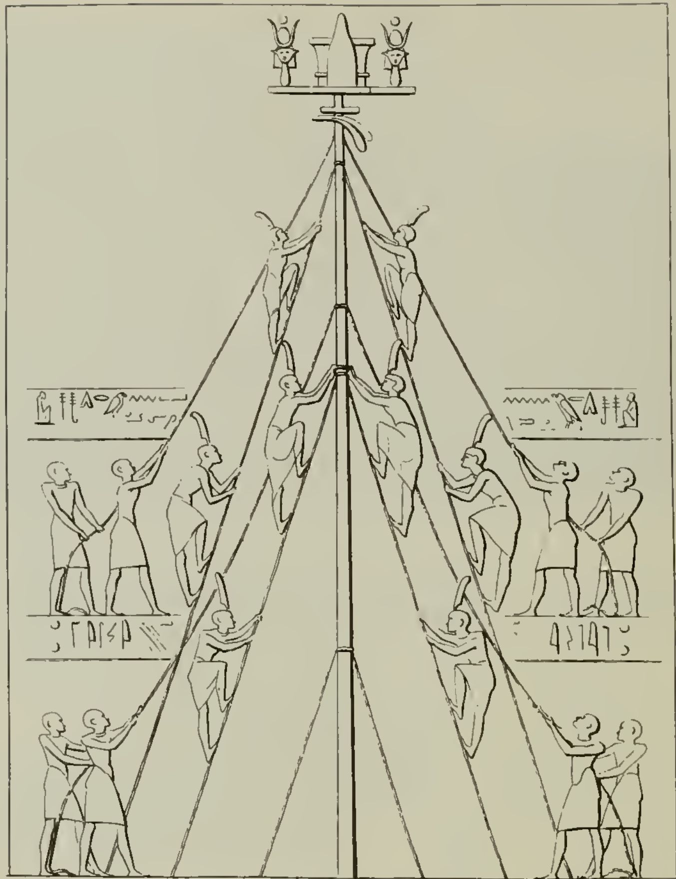


Maes-Howe, near Stennes in the Orkney Islands, is a man-made cone-shaped pyramid 27 feet high and 115 feet across, with an outer circling ditch 45 feet wide and 700 feet in circumference.
It has a 54-foot observation passage aimed like a telescope at a megalithic stone to indicate the summer solstice.
Its central observation chamber, corbeled like the Great Pyramid's Grand Gallery, is built of megaliths weighing 3 tons, carefully leveled, plumbed and so finely jointed they will not admit the blade of a knife.

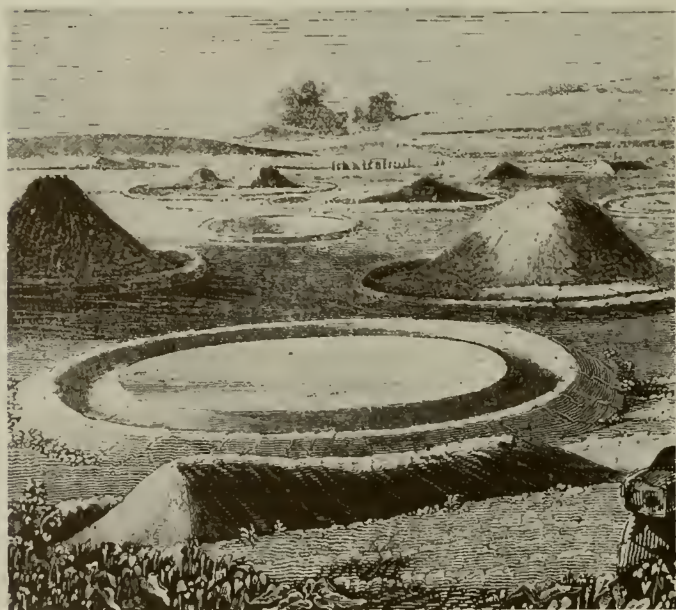
Circular monoliths similar to Stonehenge located at Stennes in the Orkneys near Maes-Howe.

In *Stonehenge, a British Temple Restored to the Druids,* which Piazzi Smyth considered a book "far before its age and perhaps not yet sufficiently appreciated," its author, Dr. William Stukely, attempted to show that such megalithic circles had always been arranged on even and round numbers of the "profane cubit of 20.7 inches nearly," and not in feet or any other known standard of length. Smyth remarked that although the idea "was pooh-poohed by more recent antiquarians, I have never heard of any of them having ascertained by actual measure at the place, that the Stukelian theory would not hold."

Professor Alexander Thom has recently shown they are built on a megalithic yard of 2.72 feet.



An Egyptian Maypole.



Various shaped mounds, or "barrows," were constructed in prehistoric Britain. Cotsworth considered them manmade instruments for observing the movements of heavenly bodies.

Alexander Thom considers Averbury Circle near Stonehenge the greatest and most remarkable circle in Britain, if not in the world. "Its greatness," says Thom, "does not lie in its size alone but in the remarkable manner in which its arcs are built up from a basic Pythagorean triangle so that each retains an integral character, and in the exceedingly high precision of the setting out, a precision only surpassed today in high-class surveying."

The Scottish lairds in residence at Maes-Howe—or Maiden's Mound—still plant a Maypole on the originally flat top, perpetuating the ceremony begun when observations were made of the shadows cast by the pole on the flat terrain to the north of the mound.

In England throughout the Middle Ages and the Renaissance, the Maypole with its tall garlanded and decorated shaft (stowed away for the rest of the year under the eave of a house) was set up on May Day. When Cromwell came to power he banned the Maypole. As the *National Encyclopedia* puts it: "The Puritans, to whom we owe the loss of so many of our public games, and so much of our merriment, ordered all Maypoles to be destroyed by Act of Parliament in 1644, as a 'heathenish vanity, abused to superstition and wickedness,' and fined the constables five shillings weekly as long as they stood."

The custom was revived with the Restoration, and the last Maypole erected in London—all of 100 feet high—stood on the spot where the church in the Strand now stands near Somerset House. It was taken down in 1717 and conveyed to Wanstead Park, in Essex, where it was fixed as part of the support of a large telescope set up by Sir Isaac Newton.

A glance at the outlines and cross sections of the pyramids of Saqqara, Dashur and Medûm will show that, like ancient British observatories, each had a sighting passage, pointed at a northern star. The passage ended in an

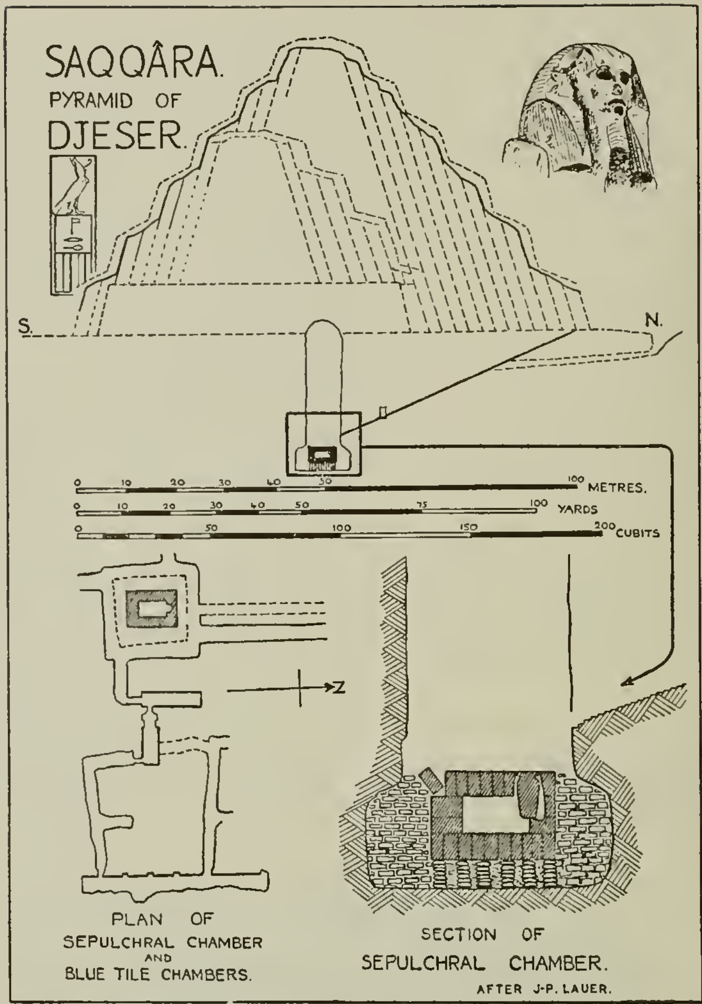
Remains of "Old Sarum," an ancient British stepped pyramid.

The original building of the stepped pyramid was a mastaba 63 meters square built of coarse rubble cased with fine white limestone, above a square pit.

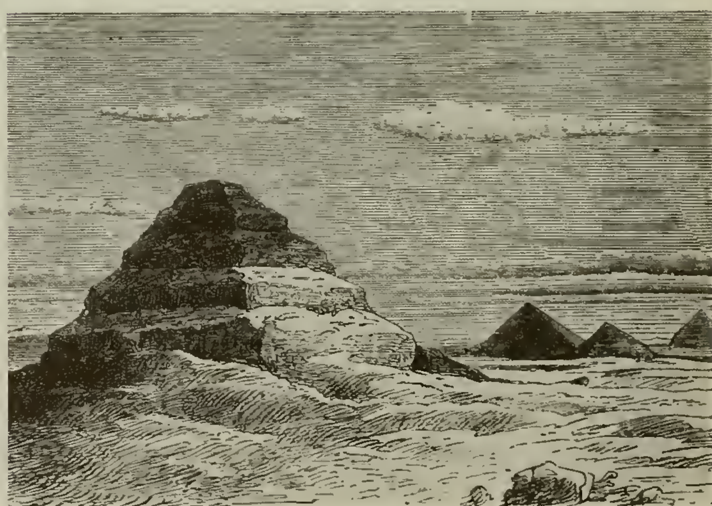
The original entrance was through a hole in the roof directly into a 28-meter shaft lined with granite. The mastaba was subsequently heightened into a stepped pyramid by the superimposition of three more terraces. Extended eastward (ostensibly to include graves for Zoser's family!), the structure was then a rectangle 120 meters by 108. Two more stories were added, so that it became a six-step pyramid, cased with fine limestone, at a slope angle of 72° 30′. A second entrance was placed in the north face leading down a rock-cut flight of steps to a more restricted "sepulchral chamber."

The building was attributed to King Zoser (of the Third Dynasty) on the basis of his cartouche on some stones and is believed to have been erected by his fabulous architect Imhotep.

In 1929 Frith found a bas-relief in the pyramid depicting Zoser, and in the 1950s Prof. Lauer found a mummified foot which he believes to have been Zoser's.



Stepped pyramid of Saqqara, believed to be the oldest Egyptian pyramid.



The pyramid of Medûm, on a square base of 144 meters, rises 92 meters high, and is so situated that it is a landmark for miles in all directions.

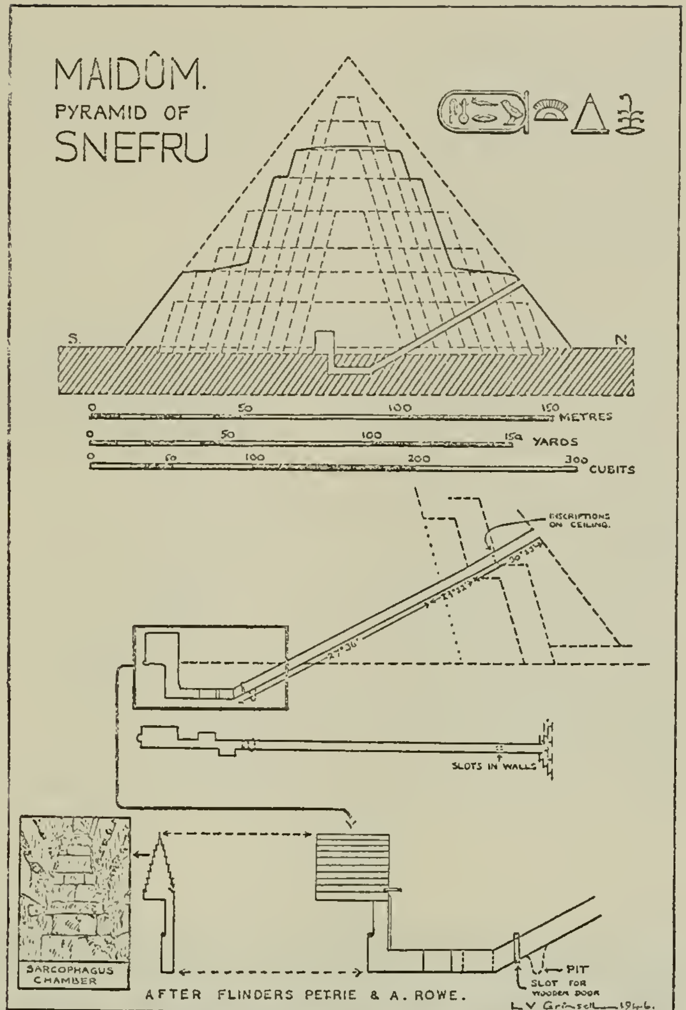
Most of the outside limestone casing, which sloped at 51° 52′, has been removed, showing that the pyramid was built in several stages from an original mastaba about 20 meters long, with slopes of 75°.

The pyramid grew in seven steps by means of a series of accretion walls, each of which was cased in fine white limestone; eventually the spaces between the steps were filled in, and the entire pyramid cased with white limestone, most of which was removed at an early date (possibly during the reign of Rameses II) though portions remain. Three accretion faces are presently visible.

The base is still covered with sand and debris.

An entrance on the north side, 30 meters aboveground, leads down a ramp 57 meters long, sloping at 27° 30′, to two antechambers and a vertical shaft in the center of the building. The shaft rises to the "sarcophagus chamber," which has a fine corbeled roof of limestone built in seven steps.

In 1891 Petrie found fragments of a wooden coffin believed to have belonged to Sneferu; so the pyramid has been attributed to Cheops' father.

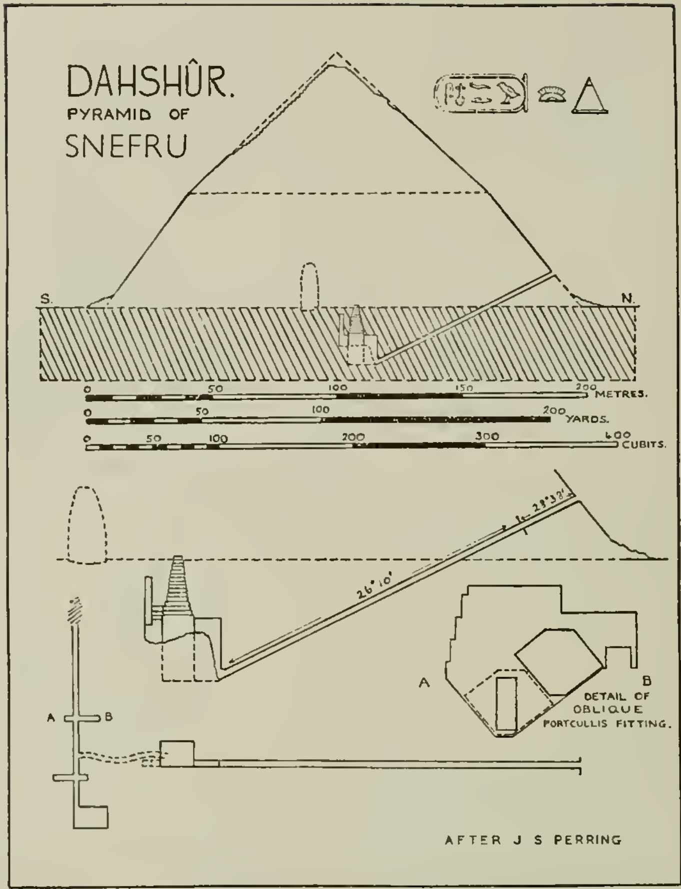


Sneferu's blunted or rhomboidal pyramid at Dashur is 190 meters square at the base and 100 meters high. The lower portion slopes 54° 41′, the upper portion 43°. The casing is of fine white limestone; the body is believed to be of coarser limestone.

There are two entrances, one on the north and one on the west side, leading to two main chambers.

The northern entrance is 11 meters aboveground in the center of the lower face and leads down a ramp inclined at 28° 38′ for the first 13 meters, then at 26° 10′ for the remaining 65 meters. A short horizontal passage 12 meters high leads to a fine chamber whose roof is corbeled on all four sides.

The western entrance, which is 29 meters above the base, leads to a ramp descending at 26° 36′ for 68 meters to a horizontal passage with two portcullis slabs and a chamber with a roughly corbeled roof.

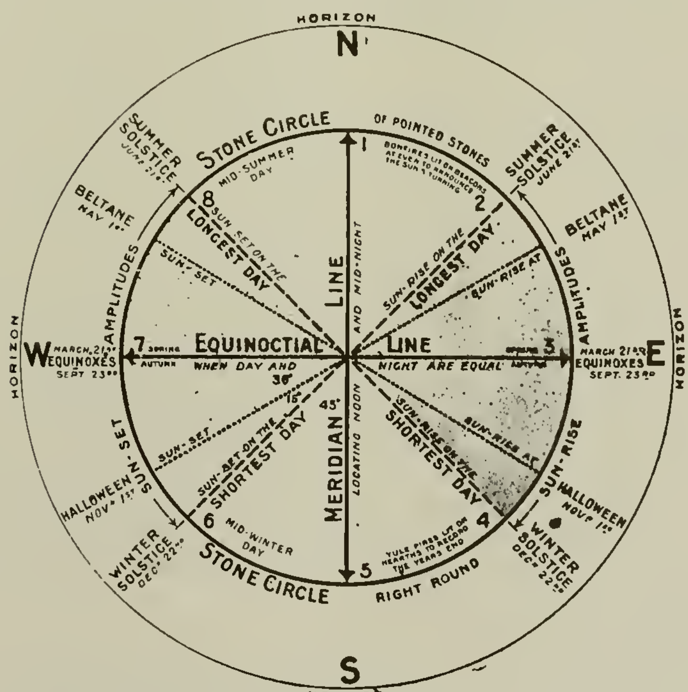


observation chamber with a corbeled roof with a small opening just at ground level, presumably for sighting a star directly overhead at the zenith, or for lowering a plumb line to coincide with a line sighted down the sloping passage. The similarity to the structure at Maes-Howe is indeed amazing. Yet Maes-Howe has also been considered as nothing but a burial chamber. A recent writer on Maes-Howe discarded the theory that the mound might have had astronomical significance, saying that the belief is accepted by no "serious students of archeology."

Scientists of other disciplines are in disagreement, and have produced interesting data on the orientation and purpose of megalithic monuments.

In his *Megalithic Sites in Britain,* published in 1967, Professor Alexander Thom, who for many years held the chair of Engineering Science at Oxford, shows how the stone and wood henges of Britain of the second millennium B.C. were aligned on certain stars, were planned on the basis of a geometry which anticipated Pythagoras, and were uniformly built on a unit of measure which he calls a megalithic yard of 2.72 feet or .829 meter.

According to Thom, megalithic sites in Britain served the purpose of calendars and clocks. During the long winter nights the only indicators of time were the stars. By observing the rising and setting of stars of the first magnitude, or their



Cotsworth's explanation of Druidical circles such as Stonehenge.

transit over the meridian, it was possible to tell the hour of night.

Thom says that in Britain between 2000 and 1600 B.C. there were about ten or twelve stars of the first magnitude whose rising and setting could be clearly observed. Thom also found a great number of stones set to indicate the point of rising and setting of first magnitude stars, and many slabs and alignments which accurately marked the meridian.

For such pointers to be accurate the observer also had to know the date. This was obtained from the sun calendar arrangement of the stones.

As for the accuracy of the alignments, Thom says the ancient engineers managed to raise perhaps ten thousand megaliths from one end of Britain to the other, and set them with an accuracy of 0.1. When they wanted to, says Thom, they could measure with an accuracy of 1 in 500.

R. J. C. Atkinson, professor of archeology at University College, Cardiff, an authority on Stonehenge, and a severe critic in this field, concludes from Thom's data that a high degree of competence in empirical astronomy existed in Britain 4000 years ago.

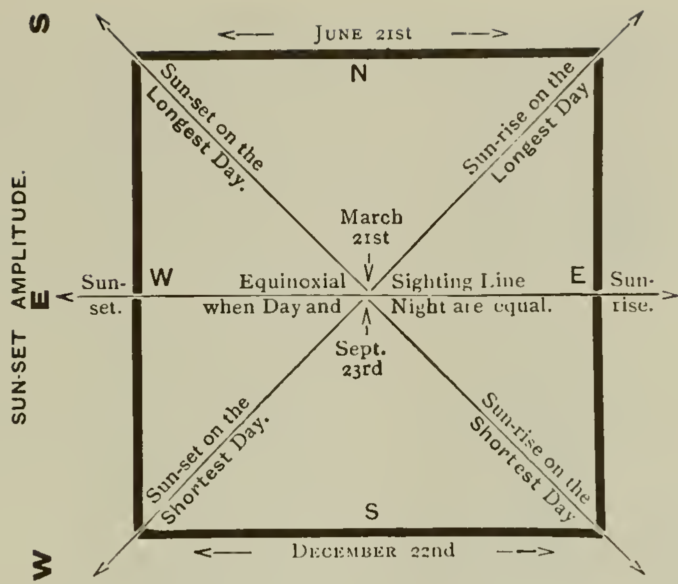
This supports the data of the contemporary Greek astronomer C. S. Chassapis, whose analysis of the Orphic Hymns indicates that the Greeks of the second millennium B.C., also had an advanced knowledge of astronomy.* These ancient Greeks, says Chassapis, knew that the seasons were caused by the earth's rotation around the sun along the ecliptic, and had determined the torrid, temperate and frigid zones. They had established the equinoxes and solstices, and knew that the apparent daily rotation of the stars in the heavens was due to the earth's rotation on its axis, which formed a northern pole in the sky. This knowledge, says Chassapis, was taught by the Orphics to the initiate who distinguished between the "fiery" stars and the seven planets which they called by today's names. The second millennium Greeks used a calendar of twelve conjuctive months from full moon to full moon, and accepted the presence of mountains on the moon. They believed that all phenomena were governed by a universal law, and conceived that space was filled with ether.

Lyle B. Borst, professor of astronomy and physics at New York State University in Buffalo, in an article in *Science* (November, 1969), notes that more than forty churches, mosques and temples have now been identified from Norway

* *Greek Astronomy in the Second Millennium B.C. according to the Orphic Hymns.* Athens, 1967.

Many churches in Europe continued to build with their towers oriented to the cardinal points, or to mark the solstices and equinoxes. Others were oriented to the sunrise of the saint for whom they were named.

St. Peter's Basilica in Rome is oriented due east so that at the vernal equinox the great doors can be thrown open at sunrise and the sun-rays passing through the nave will illuminate the high altar.



to Egypt, all laid out in megalithic yards of .829 to .840 meter.*

Professor Borst, who went to England to make a model of Stonehenge to demonstrate to his students how astronomy was practiced before there were telescopes, suggests that the axes of many early Christian churches in Britain are laid out on top of megalithic foundations originally determined by an alignment with stars; he suggests that Canterbury Cathedral was aligned with the equinoctial rising of Betelguese about 2300 B.C.

Borst also shows that the geometric plans of the megalithic monuments were obtained by means of 3–4–5 triangles and other right-angled triangles laid along the axis of stellar observations.

Alfred Watkins, in his *The Old Straight Track,* published in 1920, pointed out that many churches in England were situated on sight lines between beacon points and that ancient man was inclined to travel in a straight line from beacon to beacon. The churches served as relay points.

Watkins suggested that where topographical features were lacking, observation towers were built, and such geodetic points, initially guarded by the surveyor priesthood, remained hallowed spots even after the reason for them had been forgotten. Later arrivals built churches on these spots, as is indicated by Bede who reports that Pope Greg-

* If .840 meter is taken as a megalithic yard, there are exactly 275 such yards in a 231 meter base of the Great Pyramid of Cheops, 220 in the apothem and 175 in the height.

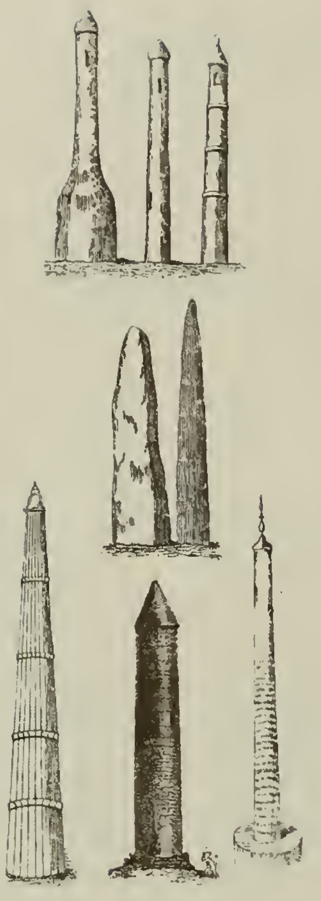
ory I explicitly ordered Bishop Miletus to build churches on pagan shrines.

In the Middle Ages in Ireland, Catholic monks still used tall conical towers with carefully oriented openings at the top to observe the skies and record the passage of the days, months and years by shadows on the walls and floors.

These "Round Towers," as they were called, were fitted for Polaris observations at the north window, for transit observations at the south window, and for noting the moment of the rising and setting of heavenly bodies at the east and west windows. H. G. Wood in his *Ideal Metrology* says that by threads drawn across the openings, like the spider lines in a telescope, the exact position of a star could be noted. The walls being two or three feet thick, the solar shadows of the jamb and lintel cast upon the floor within would show the hour of day and the time of the year. Every month could have its transit floor-mark.

Similar structures have been found in France. In a booklet oddly entitled *Falicon,* privately printed in 1970, the author Maurice Guignaud, a French artist and ceramist, describes a small pyramid in the south of France built in the thirteenth century by Knights Templar on their return from the Middle East.

Guignaud observed that at solar noon of the autumn equinox of September 21, 1969 (which in that region occurs at 12:53 P.M.) the pyramid projected no shadow on the ground around it. Guignaud also noted that a raised area in the doorway caused the sun to cast a shadow that precisely split the end of the entranceway.



Examples of Irish and other round towers.

There are remains of some 120 observation towers in Ireland, twenty of them still in good condition, ranging in height from 60 to 132 feet. The tower at Killcullen is the highest.

Built near churches between the eighth and thirteenth centuries, the towers have door and window jambs that are narrow like the doors of ancient Egyptian temples, which served to measure the shadow of the sun in its daily and seasonal movements.

At the equinox Guignaud measured the shadow of a meter stick held vertical at noon and found it to be exactly one meter long, whereas on June 21 it cast a shadow of .80 meter and on December 22 a shadow of 2.52 meters.

Guignaud found that this exotic truncated pyramid, which is known by the weird name of *Ratapignata* or "The Bat," was also built directly over two subterranean pits, one almost above the other, and that carved signs on its walls indicated it had been used for astronomical and astrological observation.

According to Cotsworth, the value of ancient astronomical observatories cannot be overestimated. The importance of establishing the exact length of the year so as to know when to plant and when to harvest crops could mean the difference between famine and plenty.

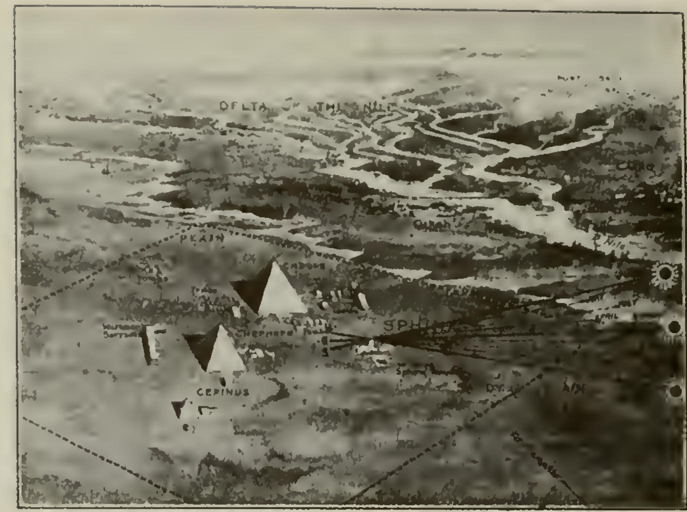
Far from being Professor Barnard's "stupendous monument of folly," the colossal effort employed by the ancients in building the Great Pyramid (or the million-ton mounds of the Britons) would have had a vital effect on the citizenry, redounding to the benefit not only of the builders, but of countless generations to come.

Cotsworth took several more photographs at the Great Pyramid to illustrate his thesis, but most of these were stolen from his carriage and irretrievably lost. This particular photograph, taken in 1900 by a third party, shows Cotsworth seated on a camel with the Sphinx and the Great Pyramid as a background. The white-whiskered Arab at the extreme right is none other than the indefatigable Ali Gabri, now over seventy, who added Cotsworth to the list of Great Pyramid explorers he guided round Giza since the time of Caviglia and Howard-Vyse in the 1830s.

Archeologists give varying opinions as to the age of the Sphinx. Petrie considered it possibly prehistoric. Budge refutes its being prehistoric. Most Egyptologists assign it to Kephren's reign in the Fourth Dynasty.

The Sphinx faces due east, which indicated to Cotsworth that it was used as a sighting device by priests who could stand on the flat platform of its rump and sight the rising sun in a direct line to the horizon marked by the point of the asp on the crown on the Sphinx. Cotsworth also found a series of ancient lines fanning out from the neck of the Sphinx which could have served to indicate the point of sunrise at different dates from solstice to equinox.

It has repeatedly taken several hundred men several years to clear the sand from its base and reveal a six-tiered obelisk against its chest (now missing), which Cotsworth believes was used for sighting the midday sun. Each time the base was cleared, windstorms filled it again with sand, indicating that when the Sphinx was originally built the Sahara was almost certainly not a desert.



Lancelot Hogben in *Science for the Citizen* says that "the continuity of careful observations which preceded, and the precision involved in settling the exact length of the year, entitle this achievement to be regarded as one of the half-dozen great cultural feats in the history of mankind."

With the present availability of cheap watches, radio signals and published almanacs, one is likely to underestimate the value to ancient people of a reliable system for telling the day, the season, the year, and, most important in Egypt, where the entire system of agriculture depended on the swamping of the arable land, the forthcoming flooding of the Nile.

For three-quarters of the year the Egyptian peasants would leave their protected villages on the hillsides and move into the flatland with their families, livestock and most of their belongings, to plow, seed and harvest the fields.

When the time came to move their families and belongings back to the hills, they required at least a fortnight's warning lest they linger too long and be cut off and drowned by the yearly rising of the waters.

According to Cotsworth, all efforts at tracing the number of days in the year by purely seasonal signs would have given imperfect and variable results.

In the early dynasties the flooding of the Nile was said to have been heralded by the annual heliacal rising of Sirius, known to us as the Dog Star. Once a year, with the first glimmer of dawn, Sirius, a bright star of the first magnitude, would appear in the eastern sky and dominate the heavens till its sparkle was eclipsed by the splendor of the risen sun. This stunning phenomenon was taken by the Egyptians as a sign that the Nile would be flooding in about twenty days.

But the flooding of the Nile is governed not by the stars but by the sun melting the snows and the rain falling in the Ethiopian highland sources of the Blue Nile. To have continued to date the flooding by the rising of Sirius would have gradually brought the phenomenon out of phase.

O. Muck, in his *Cheops and the Great Pyramid,* postulates that as a result of a series of disastrous inundations during the reign of Cheops, the Egyptians were obliged to change from a stellar calendar of 365.2563 days to a solar calendar of 365.2422 days, and that the historic Cheops introduced a new calendar by which an extra day was added every four years of 1460 days to account for the differing fraction.*

* According to Muck the new calendar was designed for Cheops not by an Egyptian but by a light-skinned European who brought to Egypt an older, more accurate calendar such as that of Dardanie. Muck says there is archeological evidence that Cheops married a light-eyed, white-skinned European with reddish-blond hair who bore him a blond, blue-eyed daughter whom Cheops gave in marriage to a European known as Didoufri who reformed the calendar and redesigned his pyramid. Other Egyptologists suggest that Cheops' wife, who is represented as a blonde in the Giza tomb of her daughter Meresank III, may be merely wearing a wig. Such divergencies give a slight idea of the general lack of concurrence among historians of Egypt. But there is no doubt that the Egyptians developed two basic calendars, a civil calendar of 365 days, and a sothic calendar one-quarter day longer. The extra quarter day caused the sothic New Year to fall back one full day every four years so that each and every day of the civil calendar coincided with the New Year over a period of 365×4, or 1460 years, until the New Year once more fell on its original July 19. Hence was generated what was known as the sothic cycle of 1460 years.

The double dating of sothic and civil years appears in many Egyptian documents, so that it has been possible to reconstruct the years in which the sothic new year coincided with the original new year and establish that sothic cycles began in A.D. 140, 1320 B.C., 2780 B.C., and 4240 B.C.

Muck and others believe the foundation of the sothic calendar occurred in the 2780 cycle, but Schwaller de Lubicz is convinced from his study of ancient texts and hieroglyphs that the year was 4240. He says that tradition always placed the heliacal rising of Sirius in the constellation of the Lion, and that this was so from 4240 on. The main objection to such an early date is the conviction of Egyptologists that the ancient Egyptians were not yet equipped for such careful astronomical observation.

That the Egyptians handled astronomical cycles of even greater duration is indicated by inscriptions recently found by Soviet archeologists in newly opened graves during the period of their work on the Aswan Dam. Here the cycles appear to cover periods of 35,525 years, which would be the equivalent of 25 cycles of 1461 years. The apparent discrepancy of one year in this recording of cycles is due to the sothic cycle of 1460 years being the equivalent of a civil cycle of 1461 years. According to Muck there were three main cycles: one of $365 \times 4 = 1460$; another of $1460 \times 25 = 36{,}500$; and a third of $36{,}500 \times 5 = 182{,}500$ years.

Dürer's woodcut of the zodiac. In the course of a year the earth makes a 360° circle round the sun. Seen from the earth, the sun appears to move through a circular belt of constellations. These are the stars of the zodiac. For convenience, the zodiac is divided into twelve constellations, so that every month at sunrise a new one appears to the earth viewer in the eastern sky; and every year the sequence is repeated, with a slight precession owing to the earth's wobble on its axis.

Schwaller de Lubicz in his *Le Temple de l'Homme* maintains the pharaonic Egyptians adopted neither the sidereal nor the solar tropical year, but a Sothic year based on the cycle of the fixed star Sirius, which is exactly 365.25 days. According to this archeologist and philosopher, who spent twelve years at Luxor measuring and studying its temples, tombs and hieroglyphs, the mere fact that the Egyptians were able to note that Sirius is the *only* fixed star with an unvaried cycle of 365.25 days denotes an extremely long period of previous careful observation.

From the texts it is clear, says Schwaller de Lubicz, that long after the heliacal rising of Sirius was no longer a visible phenomenon, it continued to be accurately computed by the priests of Heliopolis, who then broadcast their observations to the other temples of Egypt, there being a difference of as much as 4 days between the heliacal rising as noted at Thebes and at Memphis.

Muck suggests that to dramatize the importance of the 1460 cycle the figure was built into the pavement around the Pyramid of Cheops in such a way that a cortege of priests dressed in white could liturgically march round the pyramid rythmically counting out 1460 paces—which were subdivided into 25 inches, and again subdivided by 5.

By coincidence, Muck's pace of 25 inches is the same length as Newton's and Piazzi Smyth's sacred cubit, one hundred of which form the side of an English acre.

One incontestable deduction was drawn by Schwaller de Lubicz from the existence of the sothic calendar and the shifting of the annual festivals of the civil calendar: the ancient Egyptians must have been cognizant of and able to measure the phenomenon known as the precession of the equinoxes.

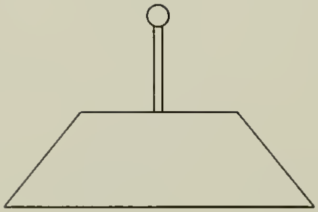
To obtain a simple picture of the precession, an earth observer in the northern hemisphere should be looking due east just before sunrise at the spring equinox. As the dawn tints the sky the observer will see a constellation on the eastern horizon: nowadays it is Pisces. In 2000 B.C. it was Aries. In 4000 B.C. it was Taurus. In A.D. 2300 it will be Aquarius.

The entire circle of the zodiac appears to be slipping back in relation to the sunrise at the equinox, at the slow rate of about 1 degree in 72 years; 30°, or one constellation, in 2160 years; and 360° in 25,920 years.

This *pre*cession of the equinox is said to have been discovered by Hipparchus in the second century. But a number of ancient representations of the zodiac bear the note: "The Bull marks the beginning of spring." This has been interpreted to indicate that astronomical observations of the constellations at the equinox were being made at least as early as 4000 B.C.

The phenomenon of the precession was not explained till Newton postulated that the earth's tilted axis was wobbling as it spun, causing the celestial pole of the earth's axis to draw a slow circle in the heavens around the fixed pole of the solar system, the pole of the ecliptic. To an observer on earth watching the sunrise at the equinox, this slow circling has the effect of making the equinoxes occur about 20 minutes earlier each year in relation to the zodiacal constellations then visible in the sky.

To have figured out the slow rate of the precession of the equinoxes, the ancient Egyptians must have had an appropriate system and equipment. According to Cotsworth, to devise an accurate *star* calendar to record the apparent movement of the stars around the heavens, someone first had to devise a structure that would provide a perfectly oriented meridian for the observation of stars in relation to a fixed point on earth.



According to Muck, to have an accurate *sun* calendar, with which to establish the solstices and equinoxes, someone would have had to build an enormously high obelisk.

Sir Gaston Maspero, director of the Department of Antiquities of the Cairo Museum, found a curious hieroglyph in inscriptions around Saqqara for which he could find no explanation: an obelisk atop a truncated pyramid, with a solar disk balanced on top of it. For Cotsworth he kindly made a drawing of it.

To Cotsworth the similarity of Maes-Howe, the Silbury Hill Maypoles and the obelisks atop a mastaba or unfinished pyramid was inescapable. Only, how did this fit with the Pyramid of Cheops?

XII. ASTRONOMICAL OBSERVATORY

That the Great Pyramid had originally been designed as an astronomical observatory and that it had contained reproductions of the celestial spheres was repeatedly reported by Arab historians; yet none could put forward a sensible solution as to how its steep polished sides could be climbed as an observatory, or its interior passages employed for observations; that is, until the appearance of a book shortly before the turn of the century by the British astronomer Richard A. Proctor, called *The Great Pyramid, Observatory, Tomb, and Temple*. Proctor found a reference in the works of the Roman neo-Platonic philosopher Proclus to the effect that the Pyramid had been used as an observatory *before* its completion. Analyzing the report, which appears in Proclus's commentary on Plato's *Timeaus*, Proctor theorized that the Pyramid might have made an excellent observatory at the time it had reached the summit of the Grand Gallery, which would have given onto a large square platform where the priests could observe and record the movements of the heavenly bodies.

Richard Anthony Proctor.

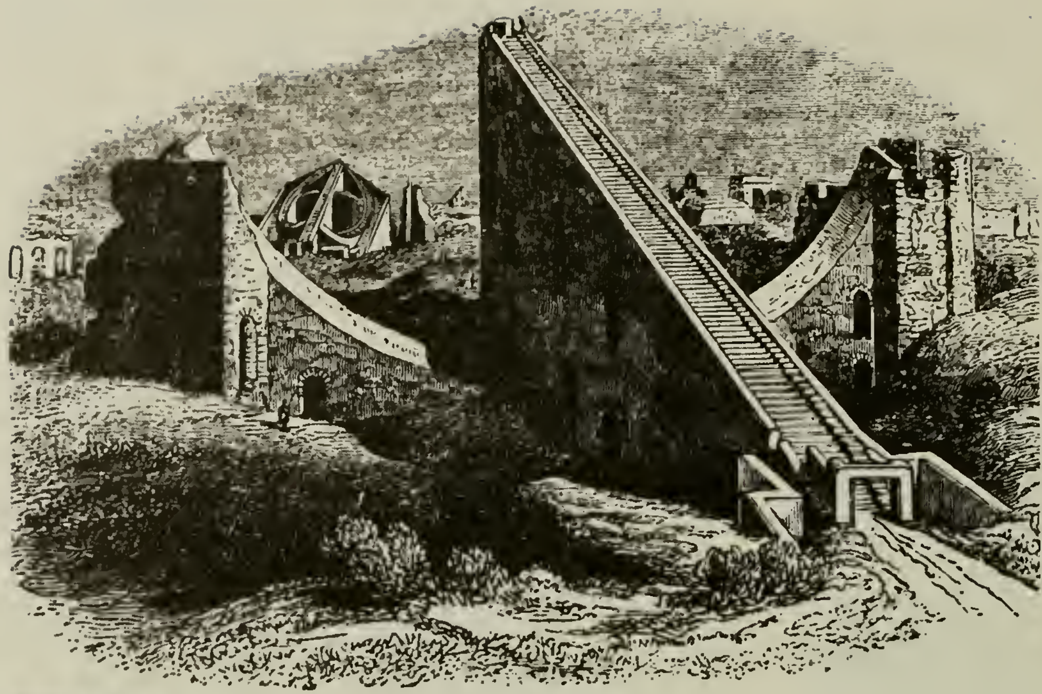
Proctor's theory was so shockingly simple that it was quickly ignored by academic Egyptologists, who were as skeptical of its astronomical value as they were of the value of Stonehenge or the other megalithic observatories scattered about Europe.

In order to create a firm body of astronomical data, the ancients needed a true meridian on the solid earth from which to extrapolate a meridian across the heavenly vault, so as to detect the precise moment when stars, sun, planets and moon transited this meridian in their apparent rotation through the heavens.

In Proctor's analysis the builders of the Great Pyramid had accomplished such a feat by building what he, as a modern astronomer, considered the only sensible instrument short of a great modern telescope.

On the Giza plateau, in the heart of the Great Pyramid, they first built a huge graduated slot, perfectly aligned on the meridian. Through this slot they could observe the apparent movement of the panoply of stars, accurately noting their several transits.

Proctor describes in detail how the ancient architects would have gone about building such an observatory. To



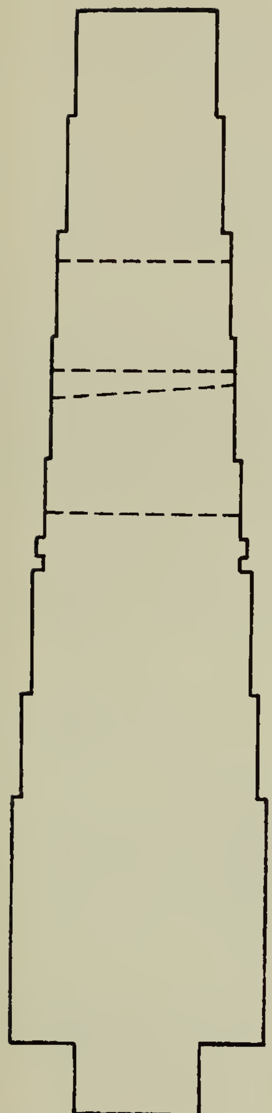
Indian astronomical observatory erected at Delhi by the Maharajah of Jaipur consists of a 56-foot triangular structure which casts a shadow onto an arc of masonry calibrated in hours, minutes and seconds (top).

Another Indian observatory at Benares, known as Yantra, provided fixed angles to check the position of the stars.

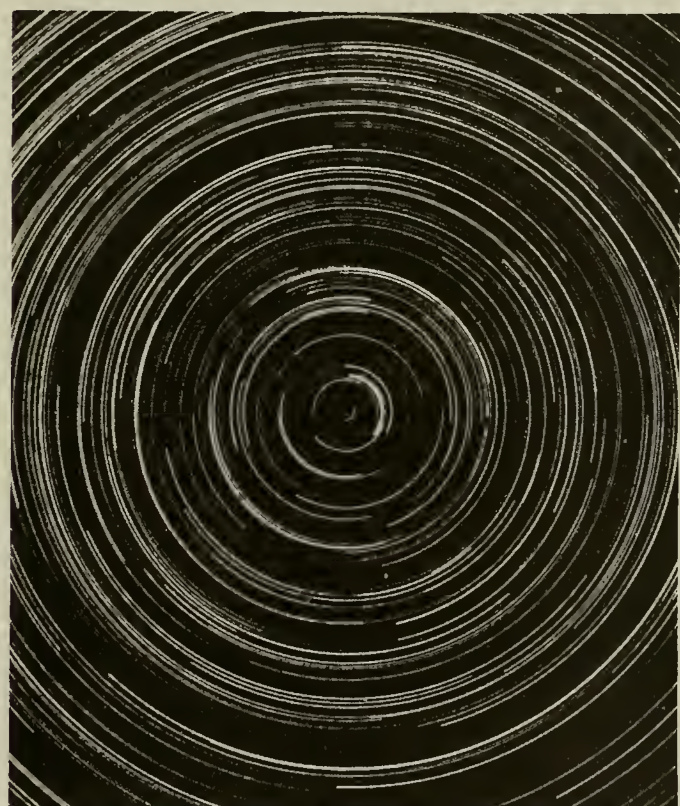
obtain a true north-south line for their terrestrial meridian, they would have observed across the tops of a couple of upright pillars whatever star was closest to the celestial north pole (the point around which the stars appear to wheel in their daily motion), then found the star's culmination, or the top and bottom of its circular path. A line through these two points, which could be measured with an ordinary plumb line, would be true north; and any such northern star would do, as all move in a small circle round the celestial pole.

Following the suggestion of Sir John Herschel, Proctor concluded that it might have been alpha Draconis, which was 3° 43′ from the pole in 2160 B.C. and again in 3440 B.C. The French astronomer A. Poge suggests that the ancients could have used Xi Mizar of the Great Bear any time before 1500; but alpha Draconis fits the rest of Proctor's theory quite adroitly.

The question of the method of orienting the pyramids has been the object of a detailed study by the Egyptologist Zbynek Zaba in a recent monograph for the Czechoslovakian Academy of Sciences entitled *L'orientation astronomique dans l'ancienne Egypte et la précision de l'axe du monde*. Far from considering the pyramids monuments to the



Meridian slot for observing the transit of the stars.



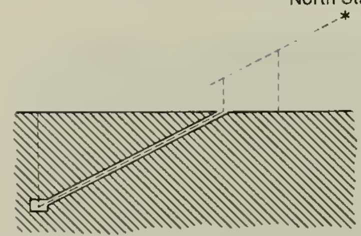
The stars appear to be carried around the pole of the heavens as if they were fixed points in the interior of a hollow revolving sphere. It is therefore possible to determine the position of the pole, even though no bright star actually occupies that point. Any bright star close to the pole revolves in a small circle whose center is the pole.

megalomaniac pride of some theocratic despot, Zaba considers them monuments incorporating the culture, science and technology of the times in which they were built.

The documents adduced by Zaba prove beyond question that the initial operation in erecting an important structure in Egypt was the ceremony of the "stretching of the cord," by which, through the observation of the culmination of some circumpolar star, the north-south direction was determined and marked out on the ground.

An inscription, translated by Johannes Dümichen, describes this royal ceremony: "Looking up at the sky at the course of the rising stars, recognizing the *āk* of the Bull's Thigh Constellation (our Great Bear), I establish the corners of the temple. . . ." "Dümichen says the word *āk* represents the star's culmination as it passes the meridian.*

Having transferred a true meridian from the sky to the ground, the ancient architects, says Proctor, could have begun to consolidate this line by digging it into a descending passage through the live rock, using their polar or circumpolar star to guide the tunnel downward at precisely the angle of its rays.



Proctor's design of how the North Star was sighted along the Descending Passage.

Such a cream-white tube, says Proctor, would have given perfect stability to this fundamental directional line, and the longer the passage the truer its orientation.†

For alpha Draconis, at 3° 43′ from the pole, to have shone directly down a passage at the thirtieth parallel, the passage would have had to be inclined at an angle of 26° 17′—just the angle of the Descending Passage beneath the base of the Great Pyramid.

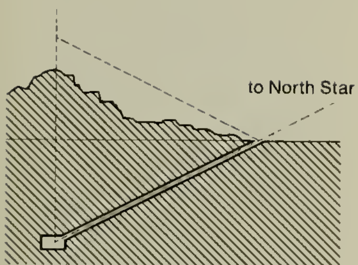
Proctor points out that there would have been no question about the advantage of taking the lower culmination of such a star in preference to its upper one; using the bottom of its circular path as a fixed point would have required far less depth of boring to reach a point directly beneath the center

* The meridian, or great circle through the earth's celestial poles, is the plane in which all the heavenly bodies culminate, or obtain the highest point in their passage midway from the eastern to the western horizon as seen from the earth. Circumpolar stars have a high and a low culminating point on the meridian above and below the celestial pole.

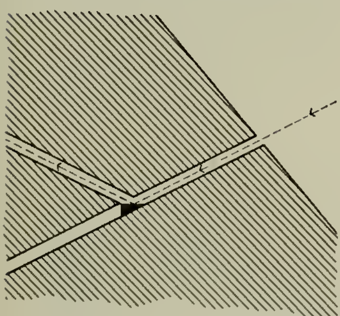
† The advantage of digging such a tunnel is obvious when compared with what would have been needed to achieve the same result aboveground. Someone would have had to hold a plumb line 100 yards high standing at a distance of 200 yards from the observer, who in turn would have had to line up the top of the plumb line with the polar star by night at a slant distance of 260 yards—without benefit of a telescope.

of the proposed building, which was the next object of the operation.

The theory provides an explanation for the quite extraordinary straightness of the walls of the Descending Passage, as measured by Petrie, who was astounded to find a mean variation from a central axis along the entire length of 350 feet of less than 1/4 inch in azimuth—from side to side—and only .1 inch in altitude—up and down. In the part nearest the aperture, which was to be the most important, the exactness is even greater, the mean error amounting to less than 1/50 inch!



How the central point of the Pyramid base could be located by knowing the angle of the Descending Passage.



Reflecting pool at the juncture of the Descending and Ascending Passages.

Once the ancients had measured the length of the Descending Passage and its angle of descent, it would have been simple, by elementary trigonometry, to locate a central spot immediately above the end of the Descending Passage as a center for the proposed pyramid—even if this were on roughly elevated ground.

With a central spot and a true meridian, the architects could set about laying the socket holes for a square base and begin to lay courses on a leveled platform. To obtain true levels, Proctor surmises that the ancient builders used water troughs in conjunction with the light rays from the star.

By continuing the tunneling up through the lower tiers of the growing pyramid, they could maintain a precise orientation for at least the first ten courses, or until the tunnel debouched from the narrowing side of the growing pyramid.

Thereafter their polar star would no longer serve directly, and a new system would be needed to continue the meridian alignment upward in the Pyramid. For this, says Proctor, the builders hit upon the idea of creating an Ascending Passage at precisely the reflecting angle of another 26° 17′. By plugging the Descending Passage and filling it with water, they could reflect the polar star back up an Ascending Passage and continue to keep the passage truly aligned and the building level as it rose another score or more of courses.

For the Descending Passage to have held water, says Proctor, its masonry at the point of juncture would have had to be of hard rock, carefully joined. For no other apparent reason, the stones at this particular point are quite different from the rest of the passage, much harder and smoother and more finely jointed. In fact, the feature escaped observation till 1865.

As Proctor expressed it in his Victorian style: "By using the known properties of liquids combined with the known property of light rays, the ancient builders were able to orient and level a building to a very great height."

But to what purpose? Of a sudden the constricted Ascending Passage changes to an overlapping gallery 28 feet high, in no way essential, or even desirable, to increase or maintain accuracy in orientation for the mounting courses. Yet so extraordinary an architectural design, so carefully executed, must, says Proctor, have served some definite purpose.

Analyzing the problem from the point of view of the astronomer rather than the architect, Proctor came up with an answer. Had an ancient astronomer wished for a large observation slot precisely bisected by a meridian through the north pole, so as to observe the transit of the heavenly bodies, what would he have requested of an architect? A very high slit with vertical walls, says Proctor, preferably narrower at the top, a gallery whose aperture, thanks to the reflected light of the polar star, could be designed so as to be exactly bisected by a true meridian.

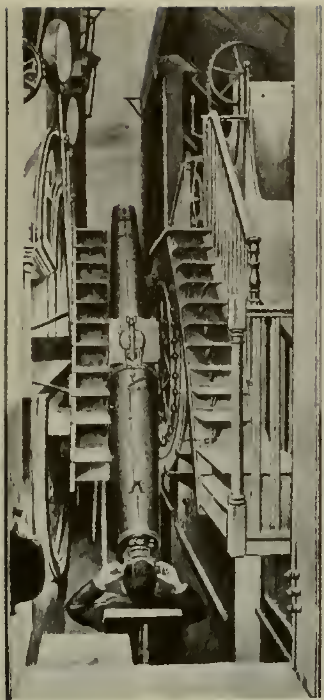
Interior of the Grand Gallery (about one-quarter of its length) showing how it could have been used to observe the stars circling in the southern sky.

Looking up through such a slot, an observer could watch the passage of the entire panoply of the zodiac, easily noting the transit of each star across a perfect meridian—precisely what is done today by the modern astronomer when he sets his transit circle to the vertical meridians. As Proctor points out, such a Grand Gallery might well be described as the *only* very accurate method available for preparing an accurate map of the sky and of the zodiacal cyclorama—before the invention of the telescope in the seventeenth century of our era.

With various observers in the Grand Gallery, placed one above the other on the slanted incline, the southing—or transit across the meridian—of every key star in an arc of about 80° could be observed with remarkable accuracy. As Proctor points out, the most important object of transit observation is to determine the exact moment at which the observed object crosses the meridian. This might have been best accomplished by noting the moment when the star was first seen on the eastern edge of the vertical sky space, and then when it disappeared past the western edge; the instant midway between these two would be the true time of transit.

Proctor surmises that someone in either the Queen's Chamber or on the flat platform of the truncated pyramid above the Grand Gallery could keep time by hourglass or water clock in coordination with the observers in the Gallery, who would signal the beginning or end of transit across the Gallery's field of view.*

* A container with a small hole which drips one drop at regular intervals makes a satisfactory timer. Ancient Chinese astronomers had a system of three such containers in a series to minimize the effect of resistance.



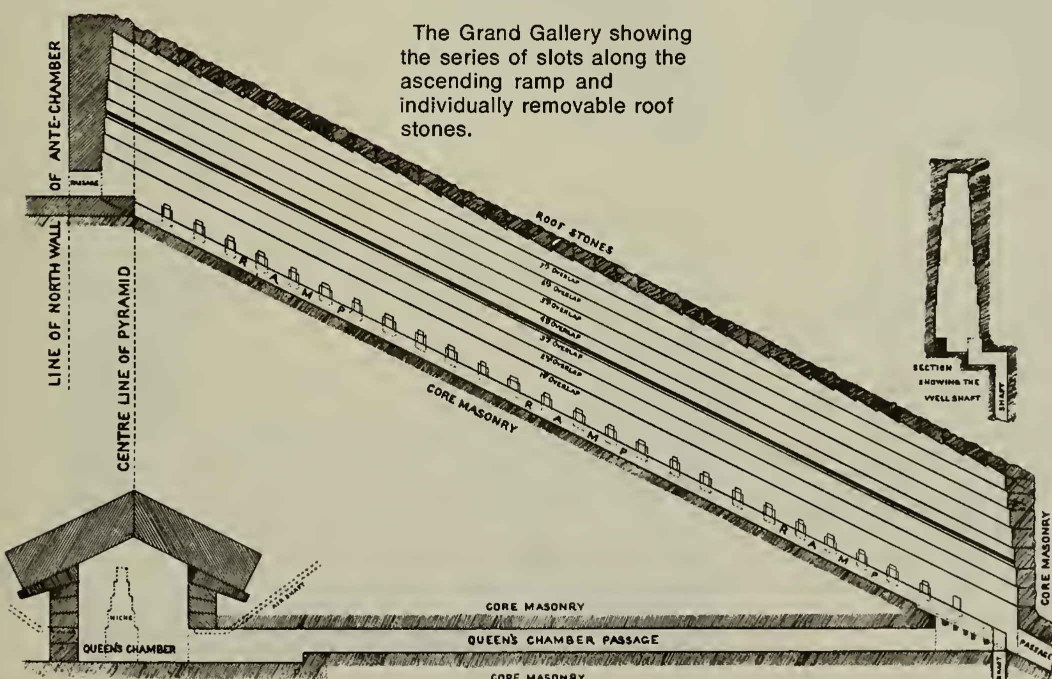
The Transit Circle, Royal Observatory, Greenwich.

By looking down the Descending Passage into a reflecting pool, an ancient astronomer could have noted the exact second of a star's transit, because only at that moment will its rays be reflected. The very same system is used today at the U.S. Naval Observatory in Washington, D.C., where the daily transit of stars is noted to a split second by their reflection in a pool of mercury.

The slope of the Gallery and the corbeling of its walls would also have made it remarkably easy to note the declination of a star—its distance above or below the celestial equator. By combining the observations made by several of what Proctor calls "watchmen of the night," stationed at different levels of the Grand Gallery, a very close approximation of true sidereal time could have been obtained. For such observers to function effectively, cross ramps or reclining benches of some sort would have had to be positioned at different levels of the Gallery.

In support of this theory, there is the series of 27 oblong holes cut vertically along the walls and into the ramps to a depth of 8 or 11 inches. They served to hold some sort of scaffolding across the Gallery. Proctor postulates that there were benches for observers at regular intervals up the Gallery.

The fact that the walls of the Gallery are corbeled like those of the earlier mastabas and of the megalithic observatories, whose top stones could be readily removed, and that each of the roofing stones of the Grand Gallery



The Grand Gallery showing the series of slots along the ascending ramp and individually removable roof stones.

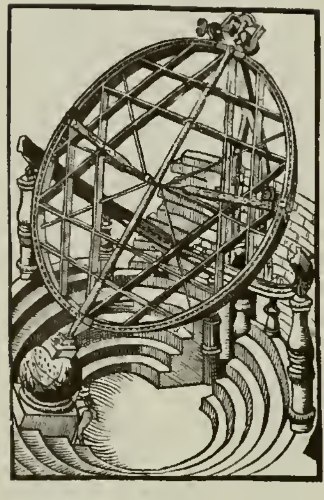
was independently removable (none presses down on its neighbor) may indicate that by the removal of these stones almost as much again of the northern arc of sky could be observed as was visible of the southern sky through the upper end of the Gallery. The movement of particular stars could be pinpointed by the removal of single stones.

Proctor surmises that the method used to determine the declination of a star involved a very practical use of the odd grooves that appear along the walls of the Gallery. At approximately half the height of the Gallery, just above the third overlap on each wall, a narrow groove runs the whole length of the gallery, 6 inches wide and 3/4 inch deep.

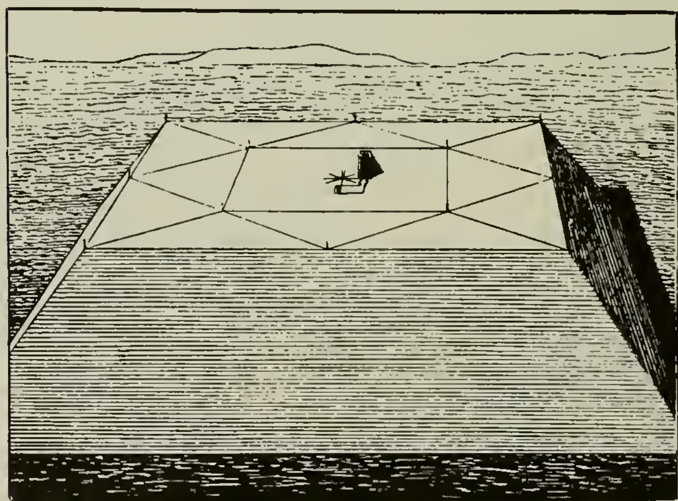
Proctor suggests that horizontal bars carrying vertical rods at suitable distances, perhaps with horizontal lines on them, were held between these grooves, and could be slid to any convenient position. The vertical rods could also have been adjustable.

To locate a star correctly, the transit observers would also have to determine what is called its "right ascension," or distance measured parallel to the equator from a certain assigned starting point on that circle. Knowing the time of transit, it is simple to position the celestial object in its "right ascension."

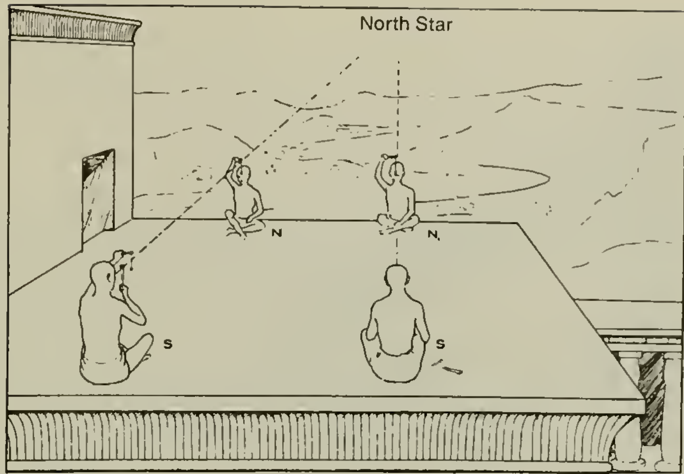
By placing observers not only in the Gallery but outside at the cardinal points of the great truncated pyramid, Proctor says that the entire visible sky could be accurately plotted. The ancient astronomers, says Proctor, would doubtless have made even more observations *off* the meridian, once they had established the meridian observations as their guide marks. They would certainly have made multitudinous observations of the risings and settings of stars at the



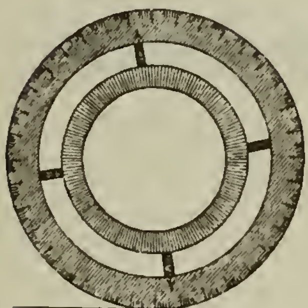
Ancient polar astrolabe.



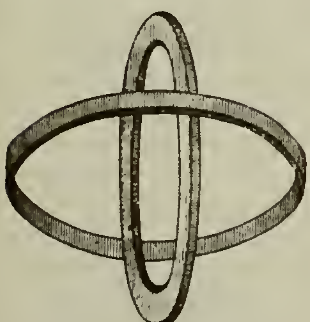
The truncated pyramid, as depicted by Proctor, would have made an observation platform 142 feet high and 175 feet square.
The cardinal points, or compass rose, could have been marked by upright posts on the periphery of the platform. To locate the rising and setting of stars east and west, azimuth observers could occupy the center of the square from which they could command the entire compass.



Ancient method of observing stars with rings and rods.



Late Egyptian armillary disk for measuring solstices.



Equinoctial armillary disk.

horizon, and especially their heliacal risings and settings just before dawn and just after sunset.

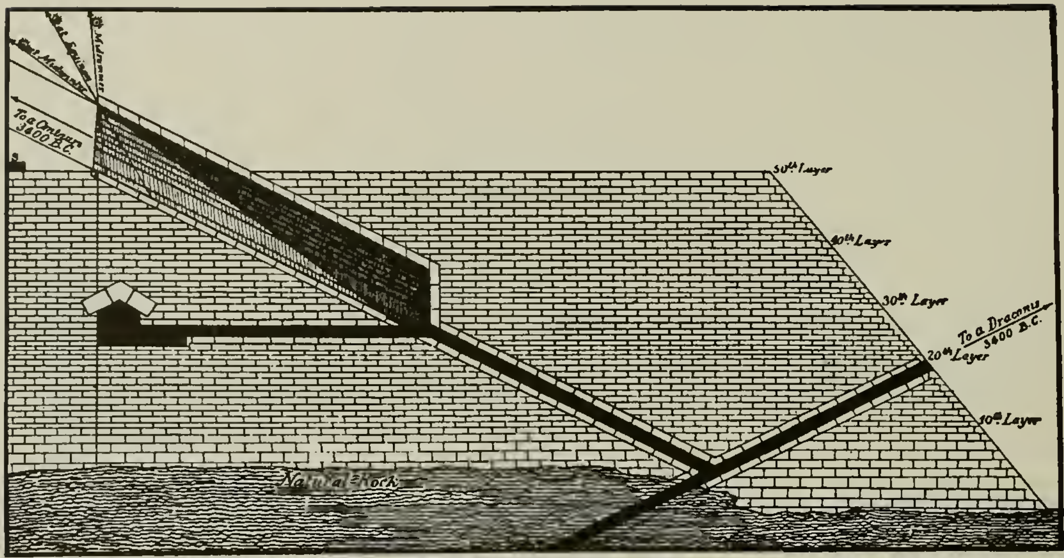
Proctor suggests that there were at least thirteen observers for azimuthal directions around the horizon, whose work could be combined with that of at least seven transit observers at different levels of the Grand Gallery.

The azimuthal observers would be supplied with astrolabes, armillary spheres of reference, direction tubes, or ring-carrying rods. Together with the transit watchers they would be able to make observations which, in Proctor's opinion, would be inferior only to those made in our own time with telescopic adjuncts.

George Sarton, professor of the history of science at Harvard, says the astronomical ability of the early Egyptians "is proved not only by their calendars, tables of star culminations, and tables of star risings, but also by some of their instruments such as ingenious sundials or the combination of a plumb line with a forked rod that enabled them to determine the azimuth of a star."

Proctor adds that for a greater knowledge of the sun's motion, the Grand Gallery slot could have been used to better effect than an obelisk or a sundial by noting the sun's shadow cast by the edges of the upper opening against the walls, sides and floor of the long Gallery. To make observations of the sun more exact, Proctor envisaged the use of screens: by placing an opaque screen at the upper end of the Gallery with a small aperture to receive the sun's light upon a smooth, white surface at right angles to the sun's direction, a much magnified image of the sun would be formed on which any sunspot could hardly have failed to appear. The movement of the spots would have indicated the sun's rotation on its axis.

The moon's monthly path and all its changes could have



Proctor's direction lines show the midday sun at midsummer, midwinter, and the equinoxes as they would strike the Grand Gallery of the Great Pyramid, forming light and shadow marks even more effective than those of obelisks.

He also shows the alignment of alpha Draconis with the Descending Passage, as it was in 3400 B.C. and a line to alpha Centauri, which was then on the meridian, from the Grand Gallery. Proctor believes that through such a sighting tube as the Grand Gallery, alpha Centauri could have been seen transiting in broad daylight.

It is noteworthy that the Grand Gallery debouches at precisely the fiftieth course of masonry, and that at that level the square platform is exactly half the area of the base of the Pyramid.

been dealt with in the same effective way, as indeed the geocentric paths of the planets or their true orbits around the sun: these could have been determined very accurately by combining the use of tubes or ring-carrying rods with the direction lines determined from the Gallery's sides, floor, etc.

Once the diurnal pattern of the stars' apparent rotation past a fixed meridian had become clear to the observers, they could more easily plot the irregular and sometimes apparently retrogressive path of the planets and the moon in relation to the "fixed" stars. The heliocentric pattern of our solar system could well have been extrapolated from a study of the relative motions of these planetary satellites, anticipating Copernicus by several thousand years.

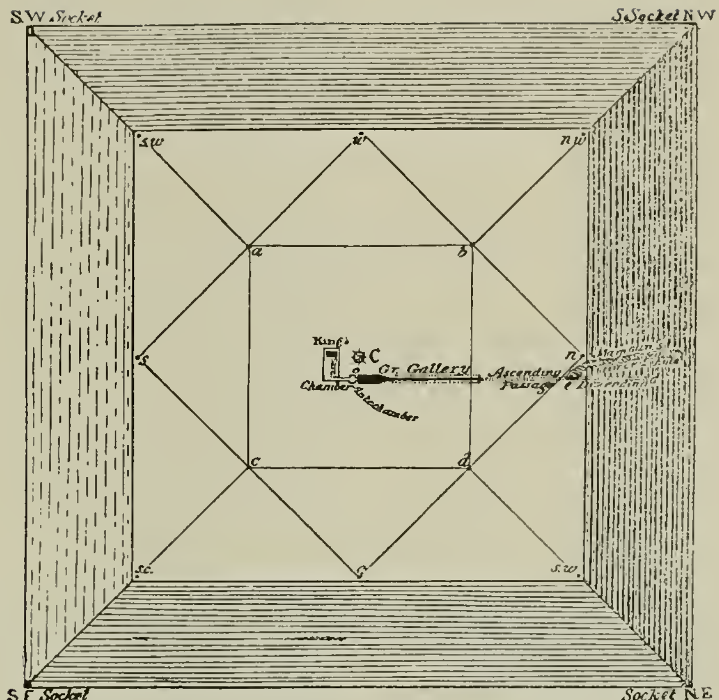
To Proctor, the Great Pyramid thus constructed would have been the greatest observatory and the most perfect till the art of the telescope could reveal a way to more exact observation without the need for such a massive structure.

That the flat top of the truncated pyramid served as the plan for mapping the zodiac is supported by the zodiacal maps of the early astrologers. Even Kepler and Galileo, when making a chart for someone's horoscope, used square charts for their zodiacs, which are the shape of the truncated pyramid.

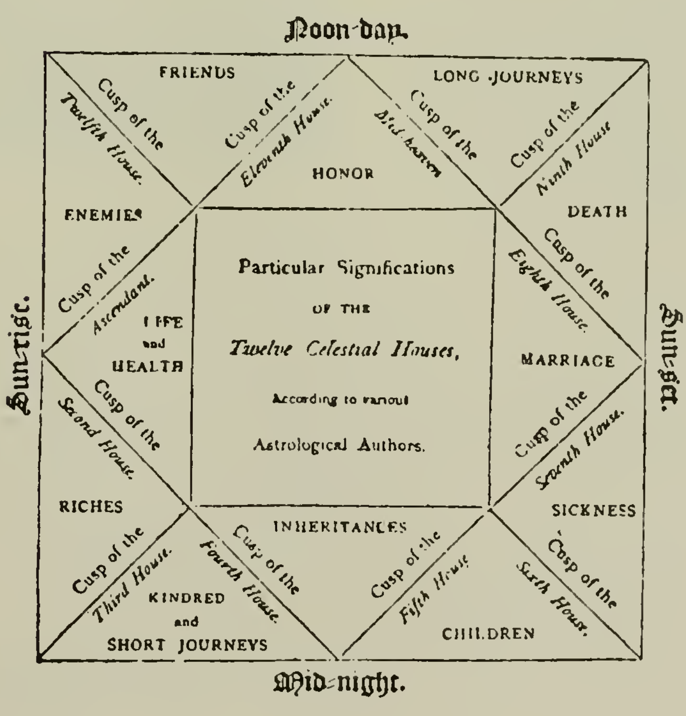
The French mathematician Funk-Hellet even suggests that the 24 holes in the sides of the Grand Gallery once supported, two by two, movable panels with symbolic figurations of the zodiac.

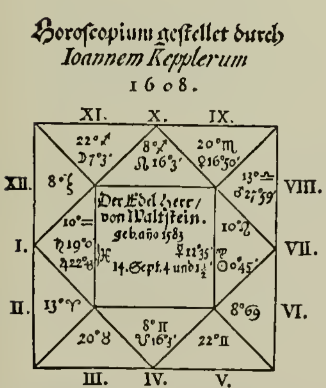
At the end of a few years' observation it would have been obvious to the ancient astronomers at the moment of the

By placing the gallery slightly to the east of the north-south axis of the Pyramid, the ancient astronomers could make their observations from the center of the truncated square, and a gnomon, or shadow pole, could be raised in dead center. That such a square was the prototype for astrological as well as astronomical computations is strikingly illustrated by the format for horoscopes which persisted into the seventeenth century.



The twelve celestial houses of the zodiac according to astrological authors.





Horoscope prepared by Kepler.

equinox that the whole stellar caravan was returning to its original position just a fraction later—hence each year the equinox itself appeared to move forward. By fine observation of the circumpolar stars, the ancient astronomers could have measured the angle of this precession and deduced its rate to be about 1° in 72 years, making a grand cycle of 25,920 years to cover a full circle of 360°.

Proctor's astronomical analysis of the Grand Gallery was discounted by Egyptologists on the grounds that they had no evidence the ancient Egyptians were capable of making accurate astronomical observations. But in 1934 Proctor received strong support from another professional astronomer, Eugene Michel Antoniadi, who was also an Egyptologist, attached to the Egyptian Observatory of Medûm, in a serious work dealing with the various branches of ancient Egyptian astronomy.* Antoniadi agreed that the Great Pyramid had been used as an observatory before the closing of its inner corridors. He also agreed with Proctor's theory of the alignment and use of the Grand Gallery.

Astronomer E. M. Antoniadi added a refinement to Proctor's theory, showing that the ancients might have used a temporary trestle to help start the alignment of the Descending Passage. However, such a trestle would have had to be 300 feet high and 600 feet long, with a slant height of 780 feet, merely to serve a function that could be better performed by digging the Descending Passage directly. It is more likely the builders avoided the scaffold.

Antoniadi figured that the Grand Gallery would have permitted priests to observe 80° of the sky. He says they should have been able to note the declination of all visible stars from —50° below the celestial equator to +30° above it, and that with the use of clepsydras (water clocks) they should have been able to measure hour angles and deduct the right ascension of stars and planets.

These two data are all that is required for constructing a star map or planisphere. "From a star map," says Lancelot Hogben, "it was a very short step to the recognition that the Earth itself could be divided into similar zones with simple relations to the fixed stars—hence the first world maps with latitude and longitude."

* *L'Astronomie égyptienne depuis les temps les plus reculés, jusqu'à la fin de l'époque alexandrine* (Paris, Gauthier-Villars, 1934).

XIII. ASTRONOMICAL TEMPLES OF EGYPT

In his avant-garde book *The Dawn of Astronomy,* written at the turn of the century, Sir Norman Lockyer minutely demonstrated how the Egyptians built and used their temples for astronomical observations from the very remotest antiquity. Lockyer showed how Egyptian solar temples were so arranged that at sunrise or sunset on the longest day of the year, a ray from the sun shot through a skillfully contrived passage into the dark interior of the inner sanctum of the temple. The illumination from the sun was cut off by means of pylon screens so that a concentrated shaft of light cut through the gloom.

Lockyer was the first English astronomer to conclude that Stonehenge had been accurately aligned in about 1680 B.C. to catch the first gleam of the midsummer sun at its solstice, a fact which was recently corroborated on the basis of computerized data by the astronomer Gerald S. Hawkins in *Stonehenge Decoded.*

Both of Lockyer's conclusions were ignored.

The difference between the megalithic and the Egyptian systems lies in the fact that anyone who can set up a circle of well-placed stones with a sighting avenue can note the farthest points north and south on the horizon where the sun rises at the summer and winter solstices; by taking the halfway mark along the semicircle of stones, the day of the equinox, when the sun is due east at the equator, can be geometrically fixed. To obtain a more precise length of the year—to within a matter of hours and minutes—requires a more sophisticated system.

Lockyer—whom Hawkins describes as "an extraordinary man whose true worth as an astronomer and theorizer concerning the history of astronomy has not yet been adequately appraised"—shows how the esthetically incomparable Egyptian temples scattered along the Nile were astronomical instruments designed like a modern telescope aimed at a specific point on the horizon.

Within the Egyptian temples the light of the sun, or other heavenly body, was funneled between two rows of delicately carved columns which ran through a chain of variously dimensioned halls, like the light of a heavenly body being funneled through the gradually narrowing diaphraqms of a telescope.

Temple at Luxor (above) drawn by a member of Napoleon's expedition, showing a row of columns oriented as an astronomical observatory. Temples usually contained a pylon, forecourt, hypostyle hall, and sanctuary.

Astronomical temple at Edfu, later known as Appolonopolis Magna, half buried in the sand as it was found and drawn by Dominique Vivant, one of Napoleon's savants.

Sir Norman Lockyer.

The longer the temple's axis, the longer and narrower the beam, and the greater the accuracy in measuring it. The darker the sanctuary, the more obvious the path of light on the end wall.

The purpose, says Lockyer, was to narrow the beam of light to the point where it could indicate the precise moment of the solstice.

According to Lockyer, a beam of light coming through a narrow passage some 500 yards all the way to a properly oriented sanctuary would remain there no more than a couple of minutes, then pass away. What's more, it would come in a crescendo and go in a diminuendo with an observable peak at the precise solstice.

This would enable the priests to determine the length of the year to within a minute, or four points of decimal—or 365.2422: an otherwise very difficult feat because the sun appears to linger several days around the point of solstice, and its movement of a mere 50″ a day is almost imperceptible without some refined instrumental aid.

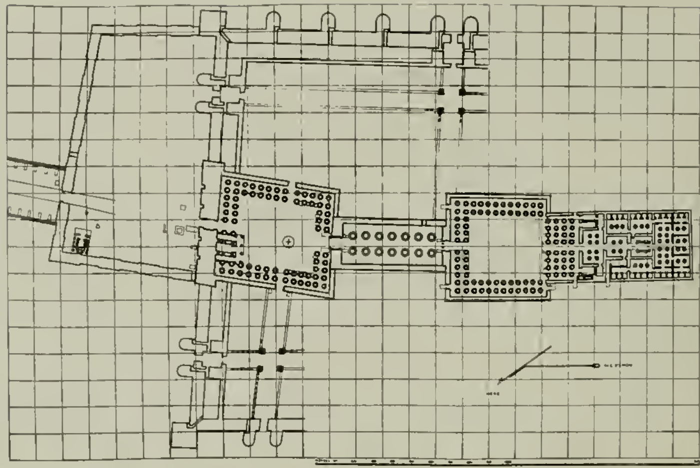
Lockyer, who went to Egypt regularly in the summer holidays, found that the sun temple of Amen-Ra at Karnak was built in such a way that at sunset at the summer solstice —the longest day in the year—the sunlight entered the temple and penetrated along the axis to the sanctuary. In Lockyer's words it was "a scientific instrument of very high precision, as by it the length of the year could be determined with the greatest possible accuracy."

Extrapolating backward from the present orientation of the building, and taking into account the small but gradual shift in the tilt of the axis of the earth, Lockyer applied the

(*Overleaf*)

Colonnade to the temple of Amon-Ra at Karnak as it was discovered by members of Napoleon's expedition. Lockyer found that the temple's axis was accurately oriented to the summer solstice and considered it "beyond all question the most majestic ruin in the world."

Reconstruction of the temple of Amon-Ra at Karnak showing how the colonnade was aimed like a telescope toward the sunset of the summer solstice. This romanticized etching was produced by the French savants for the *Description de l'Egypte*.



Rendering of the temple at Luxor by Schwaller de Lubicz, showing three successive changes in orientation.

Chiseled orientation line on subflooring of the temple at Luxor noted by Schwaller de Lubicz. The line was then hidden from view by superimposed finished flooring.

system he had used for Stonehenge and estimated the temple to have been originally laid out about 3700 B.C.

Lockyer found sun temples oriented to catch the sun at the solstice or equinox, and star temples oriented to frame a star rising on the horizon just before sunrise at the solstice or equinox, so as to give warning of the imminent solar event.

Herodotus describes two pillars of gold and green stone in the temple of Tyre which shone at midnight. According to Lockyer, "there can be little doubt that in the darkened sanctuary of an Egyptian temple the light of Alpha Lyrae, one of the brightest stars in the northern heavens, rising in the clear air of Egypt, would be quite strong enough to throw into an apparent glow such highly reflecting surfaces as those to which Herodotus refers."

Maspero suggests that the priests were not above "pious frauds" accomplished by means of statues which were animated, spoke, moved and acted. For those not in on the secret, the priests may have achieved quite stunning effects by having a large jewel in the breastplate of a statue suddenly and mysteriously sparkle with light.

Lockyer realized that temples oriented to the sun could provide a useful calendar for thousands of years because the tilt of the earth's axis shifts no more than a degree in six or seven thousand years. But temples oriented to stars could function only for a limited 200 or 300 years because each year the rising or setting of stars just before sunrise or after sunset at the solstice or equinox would occur a little later because of the precession of the equinoxes. The stars' lag behind the sun along the circle of the zodiac—a barely noticeable 1/72° each year—could become as much as 3° in 200 years, superannuating the usefulness of the temple. The temple would then need to have its axis reoriented, or another temple would have to be built. "This change of direction," says Lockyer, "is one of the most striking things which have been observed for years past in Egyptian temples."

Luxor, for instance, has four definite, well-marked changes in orientation. Lockyer measured temples at Karnak and found they were changed to match the precessional change of the stars' declination so that the priests could continue to observe it. Pylons were added, more courts were added, the sanctuary was moved eastward, the front of the temple westward.

As Maspero pointed out, "all the Ptolemaic temples and most of the Pharaonic temples have been reconstructed" during the period of their use.

Gunther Martiny, who tabulated the orientation of Assyrian temples for which the dates of foundation can be established

Small stones inserted in the regular masonry indicated a hidden line of orientation for the temple at Luxor.

(the oldest being about 1800 B.C.), found that the orientations also varied according to the angle of the precession of the equinoxes.

Nevertheless, says Lockyer, a temple once oriented to pick up the heliacal rising of a star could be *refitted* at a later time to mark the rising of some other heavenly body.

Lockyer drew up a stellar map with the positions of all the great stars along the sun's zodiacal path for the last 10,000 years, and he named a series of stars which could have been used to herald the solsticial dawn in different temples at different periods. In the course of centuries, according to

Reconstruction of the temple compound at Karnak showing the variation in axis of different buildings and colonnades.

Lockyer, the Egyptians oriented temples to alpha Ursa Major, Capella, Antares, Phact, and alpha Centauri. As early as 6000 B.C. they may have used Dubhe before it became a circumpolar star, and Canopus before 6400 B.C.

Professor Lockyer says that the earliest civilization in Egypt built temples at Annu or Heliopolis oriented to the heliacal rising of northern but noncircumpolar stars at the summer solstice. However, "the Great Pyramids were built by a new invading race representing an advance in astronomical thought" who used northern stars on the meridian and stars rising due east at the equinoxes.

The subsequent break in Egyptian history between the Sixth and the Eleventh Dynasties is associated by Lockyer with conflicts between these and two other races, which ended in a victory of the representatives of the old worship of Annu reinforced by supporters from the south, so that the north-star and south-star cults combined against the equinoctial cult.

Lockyer's deductions about the refurbishing of temples was to rekindle interest in the zodiac of Dendera found by Napoleon's General Desaix, and subsequently dynamited from the ceiling of the temple. It was purloined after a series of incredible adventures, to be sold to Louis XVIII for 150,000 francs and end up on display in the Louvre, where it resides today.

It was clear to Lockyer that there had been two temples of Dendera, one dedicated to Hathor and the other to Isis, both mythological personifications of heavenly bodies. Lockyer says the evidence is overwhelming that these two temples were also horizontal telescopes with the same number of pylons gradually getting narrower toward the holy of holies, so that a beam of horizontal light coming through the central door might pass uninterruptedly into the sanctuary to mark the rising of a celestial body. The columns, says Lockyer, shielded the eye from the sunrise light, so that the rising could be precisely indicated. According to Lockyer the present temples of Dendera were renovated in Ptolemaic times, but were built on much older sites.

The French astronomer Jean Baptiste Biot staked his academic reputation on his analysis of the circular zodiac. He said it represented the skies in Egypt in 700 B.C., and that it had probably been copied from older drawings made on papyrus or stone.

Lockyer confirmed that the Isis temple had been directed at Sirius in 700 B.C., when Sirius rose "cosmically," or in unison with the sun, at the Egyptian new year. But Lockyer quoted an old inscription which described a temple of Hathor at Dendera in the time of Khufu (Cheops) in the Fourth Dynasty (which he dated at 3733 B.C.) "when the star shone into the temple and mingled with the light of her father Ra."

Another inscription in a crypt of the temple indicated it had been built according to the plans of Imhotep, son of Ptah, who was the fabulous architect of the Third Dynasty King Zoser.

In Lockyer's opinion the temple of Dendera may have been rebuilt at least three times since then, once in the reign of King Pepi I (which Lockyer gives as 3233 B.C.), once again by Thothmes III in 1600 B.C., and finally by the Ptolemies about 100 B.C.

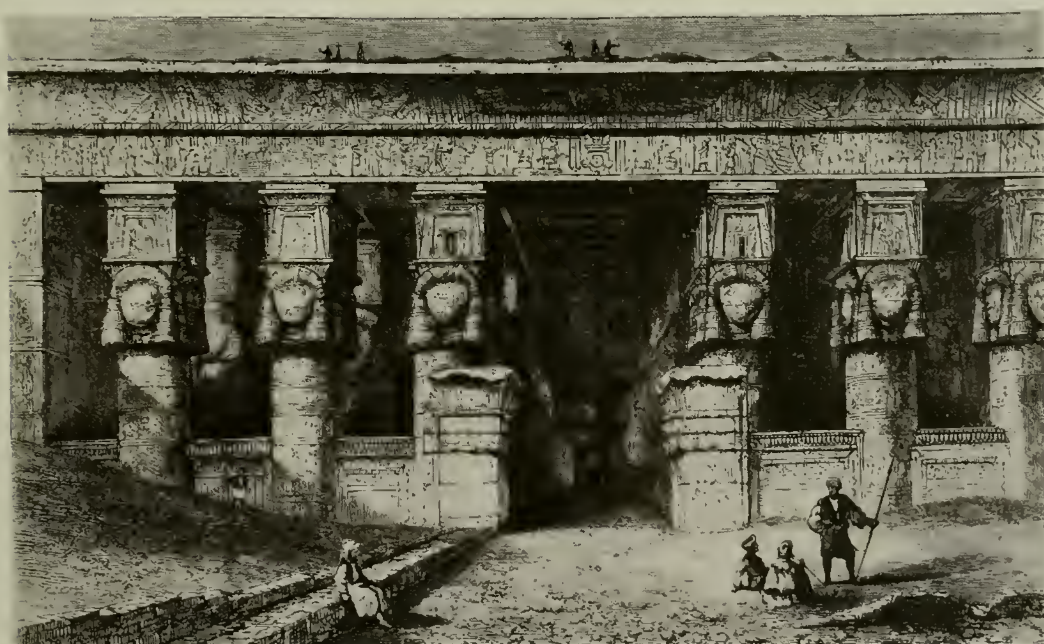
According to Lockyer the temple may previously have been directed at Dubhe, which ceased to be circumpolar about 4000 B.C., and before that at gamma Draconis, which ceased to be circumpolar in about 5000 B.C.

Egyptologists greeted Lockyer's astronomical theory about Egyptian temples with the same reserve they treated his theories about Stonehenge—which a computerized age has now shown to be correct. The Egyptologists objected to Lockyer's dragging in astronomy to straighten out the chronology of history, and dismissed his theory "with good-natured laughter, advising the cobbler to stick to his last"; so *The Dawn of Astronomy* dropped out of sight and became very hard to find, until reprinted in 1964 by Giorgio de Santillana at the Massachusetts Institute of Technology.

At the time of publication only Sir Gaston Maspero was impressed. He spent an Easter holiday at the sea studying Lockyer's theory, and he grudgingly agreed that "except for matters of detail I feel that on the whole your demonstration is conclusive, and in principle you must be correct."

Schwaller de Lubicz now supports Lockyer's conclusion, saying there can be no doubt about the orientation of temples or the fact that the ancient Egyptians understood the precession of the equinoxes, which brought a new constellation into position behind the rising sun at the vernal equinox every 2200 years. The mere fact that the cult of the Bull preceded the cult of the Ram in Egypt, and that the dates of these cults correspond with the equinoctial positions

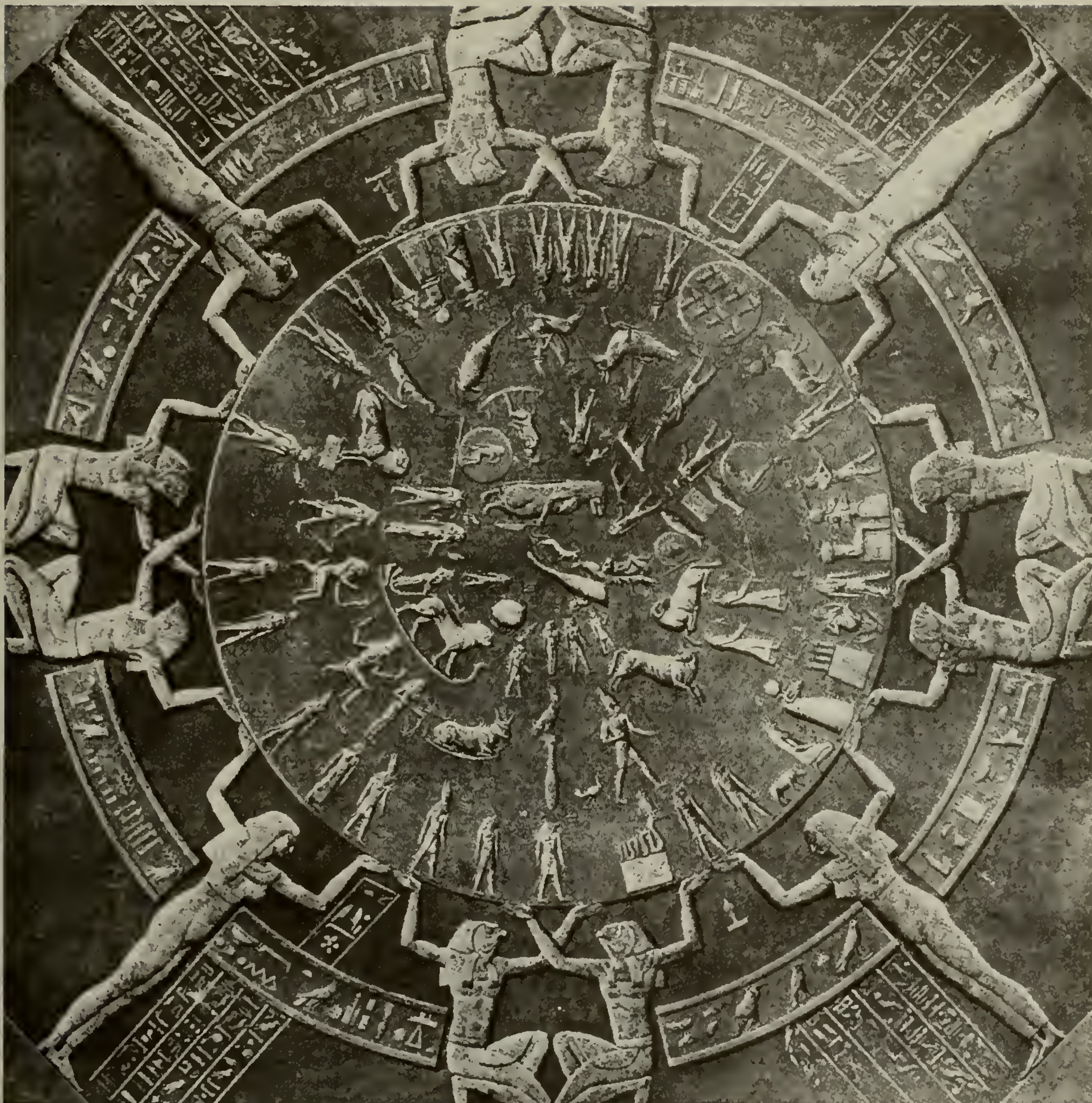
Temple of Hathor at Dendera, as drawn by Denon, showing main axis possibly oriented to gamma Draconis before 5000 B.C., according to Sir Norman Lockyer.



Interior of the temple of Hathor at Dendera as conceived by the French savants.

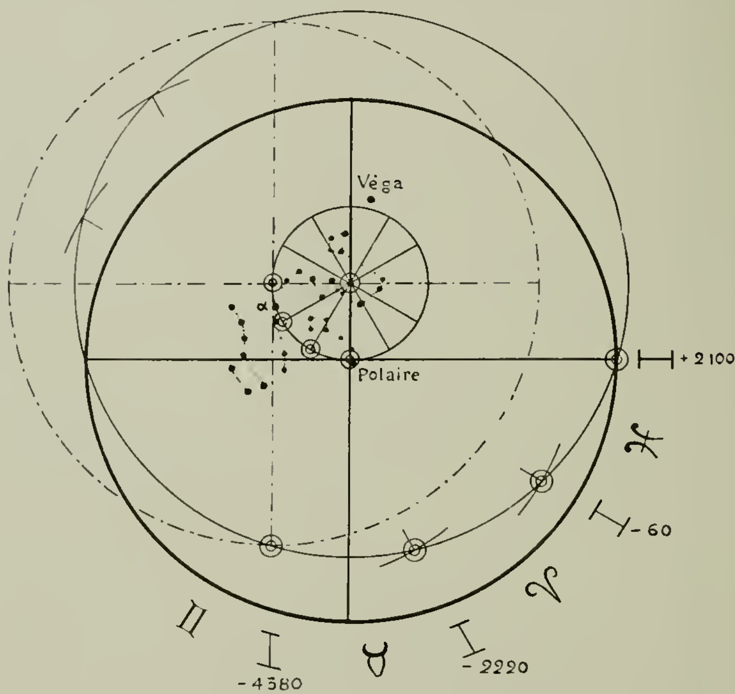
The circular zodiac of Dendera was on the ceiling of an upper room of the temple believed to have been used as an observatory.

The outer circle of figures, moving counterclockwise like the stars, represent the 36 *decans,* or 10-day weeks of the Egyptian year; the twelve arms of the supporting figures, the twelve months of the year.



of their constellations at the appropriate time—approximately 4000 and 2000 B.C.—is conclusive in his opinion. Furthermore, says Schwaller, an emphasis on duality in the Predynastic Period indicates a cult of Gemini coincident with the dominance of that constellation at the vernal equinox.

Schwaller also agrees with Lockyer that the temple of Hathor at Dendera is built on the remains of much older temples. To prove his point he produced a solution to the arrangement of the constellations in the circular zodiac which has been such a problem to archeologists for well over a hundred years. Schwaller shows that the zodiac discovered by General Desaix was indeed carved in Ptolemaic times, but incorporates a palpable demonstration



Zodiac showing the overlap of the circuit of the earth's celestial pole around the pole of the ecliptic, indicating different dates in the past.

of the precession of the equinoxes as well as three important historical dates.

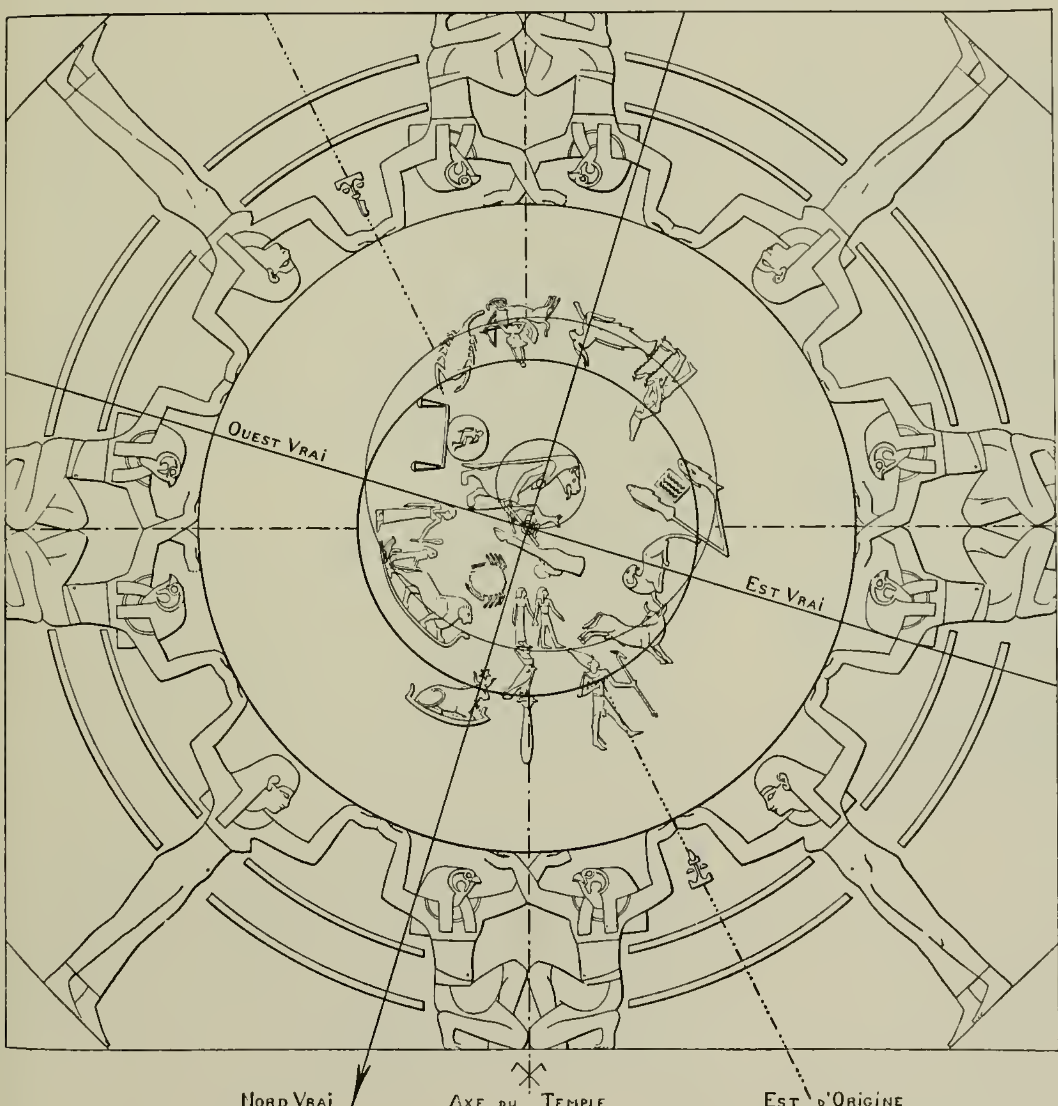
The zodiac is about 8 feet across, carved in relief on hard stone. The constellations are arranged in a spiral and the symbolic figures are marching counterclockwise in the diurnal direction of the stars as seen from the earth. Recognizable mythological figures for the constellations near the pole are a jackal for the Little Bear, an ox-leg for the Great Bear, and a hippopotamus for Drago. Sirius is depicted as a cow in a boat with a star between her horns.

The zodiac is in a circle at the center of which is our

The inner circle of spiraling figures shows the zodiacal constellations such as Gemini (the Twins hand in hand) and Taurus (the Bull) circling around our celestial north pole correctly situated in the Jackal (or Little Bear) which in turn circles around the celestial north pole of the ecliptic, situated in the breast of the Hippopotamus or Drago. Schwaller's lines show that the zodiac of Dendera correctly indicated earlier historical dates when different constellations appeared in the east at the equinox.

north pole. This circle is in a square oriented with the walls of the temple—or about 17° east of north. Our north pole is correctly located in the constellation of the jackal, or Little Bear, as it was at the time when the zodiac was carved, sometime about the first century B.C. But the zodiac also shows the pole of the ecliptic, located in the breast of the hippopotamus, or constellation of Drago.

To Schwaller this explains the spiral formation of the constellations. The mythological figures representing the constellations are entwined in two circles—one around the north pole and one around the pole of the ecliptic. Where these two circles intersect marks the point of the equinox, or due east. The zodiac thus becomes a calendar going back to remote antiquity.



A line due east, which runs between the end of the Ram and the beginning of Pisces, indicates the time when the temple was rebuilt, about 100 B.C. An earlier east line runs right through the Ram, indicating a date about 1600 B.C., at the height of the Amonian domination, during the Twelfth Dynasty.

A special hieroglyph on the ring of the zodiac indicates an equinoctial line running through the end of Gemini and the beginning of Taurus—the date of the founding of the empire of Menes and the beginning of the cult of the Bull and the adoption of the new calendar, sometime in the third or fourth millennium B.C.

In other Egyptian charts of the constellations there appears the figure of a hawk-headed man holding in his outstretched arms a line which ends against the figure of the ox-leg, representing the constellation of the Great Bear.

Hawk-headed man holding a spear (pointing at the Great Bear constellation) indicates the meridian through the pole of the ecliptic, according to Stecchini.

According to Zaba this line held by the hawk-headed man indicates the meridian through our north pole. But Professor Livio Stecchini points out that Zaba did not notice that this line always ends at a very specific position, at times with an arrow point, which divides the seven stars of the Great Bear into four and three. This line, says Stecchini, does not indicate the meridian passing through the north pole, but the meridian passing through the pole of the ecliptic. In Stecchini's opinion, the ancient Egyptians not only understood the precession of the axis of the earth but considered the true meridian the one passing through the pole of the ecliptic of the solar system. Lockyer added that the Babylonians had distinguished the pole of the equator from the pole of the ecliptic, naming the former Bil and the latter Anu.

The evidence leaves little doubt that the ancient Egyptians knew there were two poles in the sky, a north pole, which shifted round a fixed pole, or "open hole" in the heavens; they also knew that this slow circling brought about the precession of the equinoxes. That the phenomenon of the precession was the matrix from which a thousand myths were developed is abundantly illustrated by the work of Giorgio de Santillana and Hertha von Dechend in *Hamlet's Mill.**

There is no doubt in Santillana's mind that the ancient Egyptians were aware of the precession. In his preface to a recent reprint of *The Dawn of Astronomy,* Santillana, then professor of the history and philosophy of science at MIT, remarked that "when a stellar temple is oriented so accurately that it requires several reconstructions at intervals

* Published by Gambit Inc., Boston, 1969.

of a few centuries, which involve each time the rebuilding of its narrow alignment on a star," and "when zodiacs, like that of Dendera, are deliberately depicted in the appearance they would have had centuries before, as if to date the changes," it is not reasonable to suppose the Egyptians were unaware of the precession of the equinoxes.

Santillana was even more forceful in his condemnation of modern archeological scholars who refuse to accept the idea that the phenomenon of the precession was known in Egypt thousands of years before it was *re*discovered by Hipparchus. In *Hamlet's Mill,* Santillana accuses the scholars of having "cultivated a pristine ignorance of astronomical thought, some of them actually ignorant of the precession itself."

The precession was considered the basic mechanism of the universe by the Egyptians, controlling not only astronomical phenomena but all human and biological development.

Since the beginning of history, the spring equinox has moved through Taurus, Aries and Pisces, or almost one-quarter of a whole cycle. Santillana points out that the Copernican system, which for us explains the precession as the wobble of the earth's axis, has stripped the phenomenon of its awesomeness:

"But *if,* as it appeared once, it was the mysteriously ordained behavior of the heavenly sphere, or the cosmos as a whole, then who could escape astrological emotion? For the precession took on an overpowering significance. It became the vast impenetrable pattern of fate itself, with one world-age succeeding another, as the invisible pointer of the equinox slid along the signs, each age bringing with it the rise and downfall of astral configurations and rulerships, with their earthly consequences."

XIV. GEODETIC AND GEOGRAPHIC LANDMARK

The strongest evidence that the ancient Egyptians were capable of accurate astronomical observations comes from the fields of geodesy and geography, sciences whose object is to determine the size and shape of the earth, and to locate landmarks upon it. Until the development of radio and laser beams, coordinates of latitude and longitude with which to locate a spot on this planet could only be obtained by means of accurate astronomical sightings. When a temple or observatory or the remains of a city are found in a geographical location, either of latitude or longitude, or both, specifically related to other established locations, it is clear that its founders must have been able to make the required astronomical observations.

Professor Stecchini—who obtained his doctorate at Harvard in the science of classical mensuration—has now established that the ancient Egyptians not only developed an advanced system of astronomy and mathematics, but an equally advanced system of geography and geodesy.

From ancient hieroglyphs, hitherto neglected, Stecchini has been able to show that from the earliest dynasties in the third millennium B.C., the Egyptians could measure latitude to within a few hundred feet and do almost as well with longitude—a feat which was not repeated on this planet until the eighteenth century of our era.

The ancient texts and hieroglyphs vindicate Jomard in full, and show that at least as early as the unification of Egypt (ca. 2800 B.C.) the ancient Egyptians knew the length of the circumference of the earth very precisely, the length of their country almost to the cubit, and the geographical coordinates of all the main points in their realm from the equator to the Mediterranean. To do so the Egyptians must have been able to make astronomical observations with almost the exactness afforded by the modern telescope and chronometer.

From a twenty-year study of the mathematical and astronomical data contained in the cuneiform tablets of the ancient Sumerians and Babylonians, Stecchini has derived the evidence that astronomical observations of great

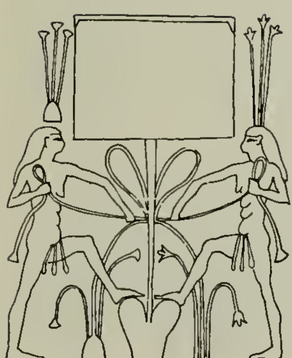
accuracy could be, and were, performed in Mesopotamia as well as Egypt in the third millennium B.C.

From his analysis of the pyramids and stepped ziggurats of the Middle East, Stecchini has demonstrated that they not only incorporate the basic techniques for projecting and mapping the hemisphere of the heavens but for mapping the terrestrial hemisphere; they also reveal a high level of mathematics, capable of resolving and simplifying the problems of trigonometry.

Stecchini points out that Herodotus, who has been ridiculed by scholars for his reported dimensions of Egypt, and accused of having lied about his travels there, turns out to have described ancient Egypt with great accuracy in terms of meridians and parallels carefully worked out by ancient Egyptian astronomers.

Stecchini found a glyph carved on the thrones of virtually all the Pharaohs since the Fourth Dynasty which contained geodetic data and hence astronomical data of extraordinary subtlety, enabling him to determine that the Egyptians used three figures for the tropic of Cancer: a simplified one of 24°, a precise one of 23° 51′, and one of 24° 06′ required for observing the sun's shadow at the summer solstice.

The sophistication of the ancients is demonstrated by the fact that they placed their observatory near Seyne on the island of Elephantine, 15′—or half a diameter of the sun—north of the actual tropic because they understood that it was not the center of the sun but its outer rim which had to be observed.



The most important Egyptian text deciphered by Stecchini was a set of three identical hieroglyphs on the back of standard Egyptian measuring rulers found at the temple of Amon at Thebes, the geodetic center of Egypt since the Middle Kingdom. These, says Stecchini, give the clue to the exact dimensions of ancient Egypt.

Ludwig Borchardt, an eminent German Egyptologist, who first published the texts in an article in *Janus* in Vienna in 1921, assumed *a priori* that the figures could not refer to actual latitudes computed astronomically, and did

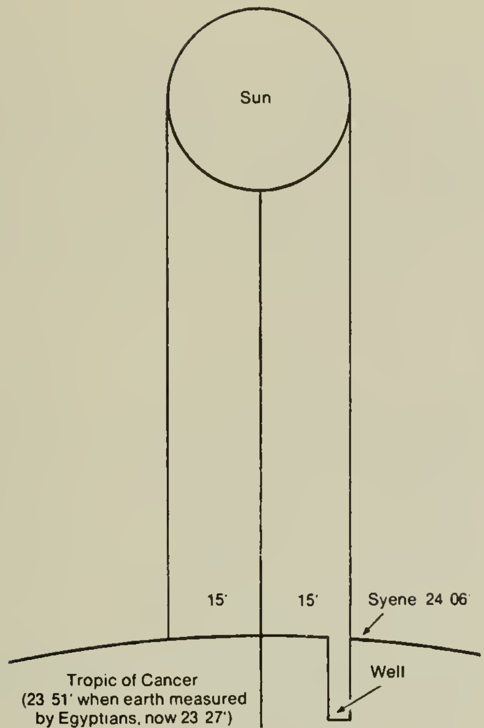
Knotted ropes beneath Pharaoh's throne are used to symbolize the union of Lower and Upper Egypt at the thirtieth parallel, where the apex of the Delta crosses the prime meridian of Egypt, just north of the Great Pyramid.

Three pairs of short horizontal lines at the bottom of the picture are symbols of three distinct values given by the ancient Egyptians to the tropic of Cancer, basic to the geodetic mensuration of Egypt. The central one of these three lines represented the conventional latitude of the tropic at 24°; the lower line represented the actual latitude at 23° 51′; and the upper line a latitude of 24° 6′, which was 15′ north of the true tropic, at Syene, where astronomical observations were made.

not even bother to test them: "One must absolutely exclude the possibility that the ancients may have measured by degrees." Succeeding Egyptologists also failed to compare the texts with actual parallels and meridians. Stecchini found them to apply with astonishing precision.

The texts—which for stylistic reasons have been assigned to the Old Kingdom (third millennium B.C.)—state the length of Egypt to be 20 *atur* from Behdet on the Mediterranean to Pi-Hapy (the apex of the Delta just north of the Pyramid of Cheops) and another 86 *atur* south to the First Cataract of the Nile.

This means that 106 *atur* would span an arc of 7° 30′ from the Mediterranean to Syene. From a composite of texts and geographic evidence an *atur* is the equivalent of 15,000 royal cubits or 17,000 of Jomard's cubits of .4618 meter. This would make Egypt from Behdet at 31° 30′ to Syene at 24° 00′ a length of 1,800,000 of Jomard's cubits, or 831,240 meters. The *Smithsonian Geographical Tables* give the distance from 31° 30′, to 24° 00′ as 831,002 meters. Computing from the third millennium B.C. text, the mean length of a degree of latitude in Egypt would be 110.832 meters. The modern estimate is 110.800 meters.

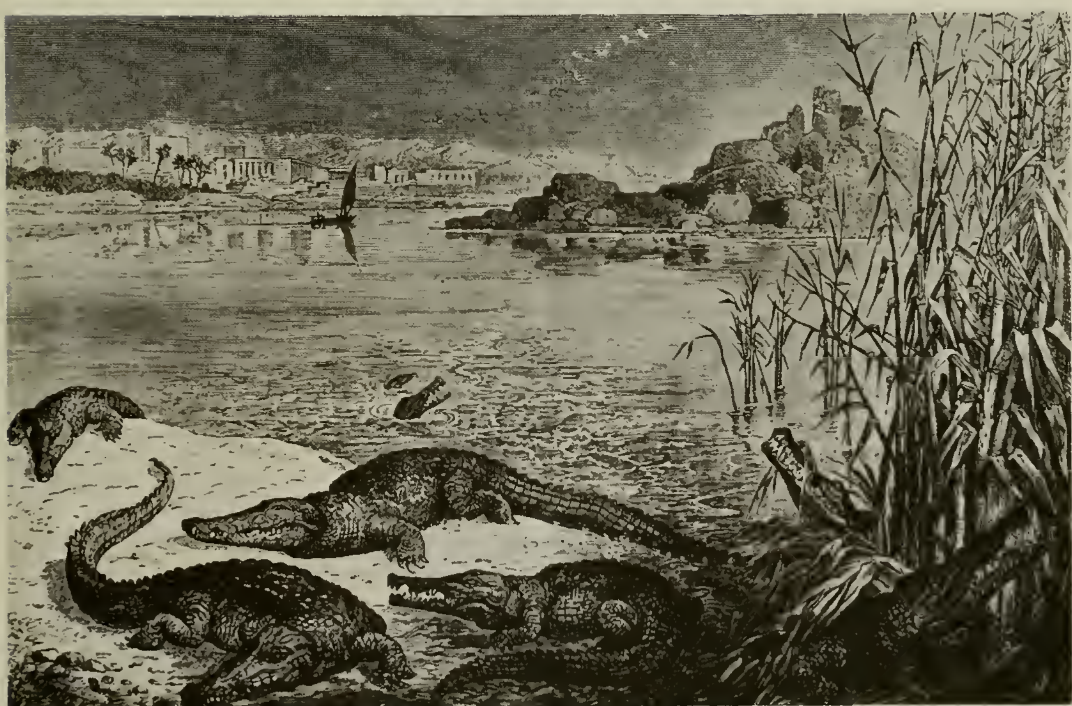


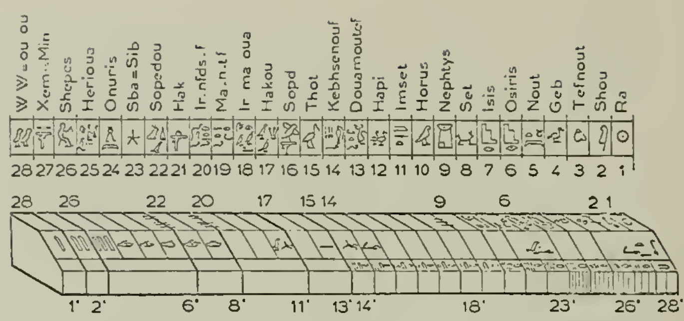
To observe the exact moment the sun fills a well without shadow as it reaches its farthest point north, at the summer solstice, the observation would have to be made under the northern rim of the sun, 15′ further north than the line of the tropic.

When the tropic was at 23° 51′, the ancient Egyptians observed it at Syene at 24° 06′.

Today the tropic is at 23° 27′. By establishing the moment of solstice at the tropic, the ancient astronomers were able correctly to compute the circumference of the earth by the use of deep wells and obelisks.

The island of Elephantine in the Nile near Syene, where the ancient Egyptians had an astronomical observatory and a nilometer to gauge the flood of the Nile.





Royal Egyptian cubit of Memphis. It was divided into 7 palms of 4 fingers each, for a total of 28. The basic unit from which this cubit is derived is the foot of 300 millimeters. One and a half of these feet made a cubit of 450 millimeters, divided into 6 palms of 4 fingers, for a total of 24 fingers. The royal cubit was obtained by the addition of one extra palm, for a total of 7, or 28 fingers, the equivalent of 525 millimeters.

Stecchini points out that a septenary unit was common to Mesopotamia, Egypt and Greece, because it allowed simple solutions to problems of practical measurement. With a π of 22/7, it was simpler to have a septenary cubit; a square of side 7 was considered to have a diagonal of 10, and a square of 10 as having a semi-diagonal of 7.

According to Stecchini, once the Egyptians were in possession of the true proportions of their country, they devised a means of simplifying their geodetic data into a geography that was easily committed to memory without recourse to portable maps, using such obvious natural landmarks as the cataracts on the Nile and the extremities of the Nile Delta as geodetic points for rectangles and triangles with easily remembered angles.

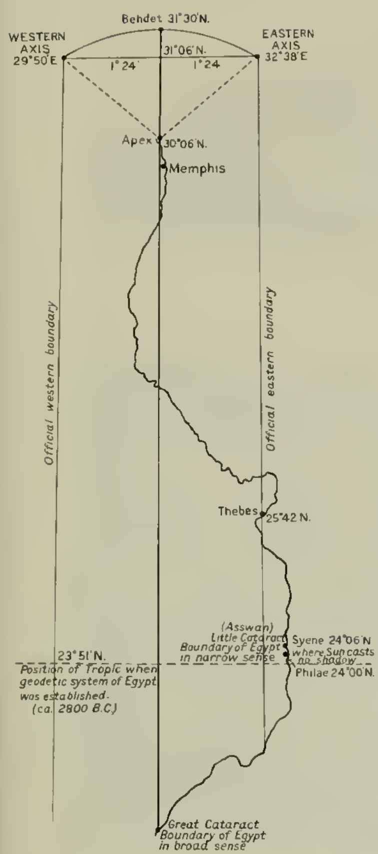
The prime meridian of Egypt was made to split the country longitudinally precisely in half, running from Behdet on the Mediterranean, right through an island in the Nile just northeast of the Great Pyramid, all the way to where it crossed the Nile again at the Second Cataract.*

To simplify the dimensions of Northern Egypt, the Egyptian geographers accurately marked it as a triangle exactly 1° deep, with its apex where the Nile splits (just north of the Pyramid of Cheops), fanning out 1° 24′ east and west to where its widest branches flow into the sea. This became an actual Δ-shaped delta, whose angles were designated by the shadows cast by the northeast and northwest corners of the Great Pyramid.

Southern Egypt was made to run precisely 6° to the First Cataract of Aswan on the tropic of Cancer. Two lines drawn parallel to the prime meridian, starting at the side mouths of the Nile in the Delta, running to the tropic, made a simple rectangle of Lower and Upper Egypt.

Stecchini says that when this particular geodetic system of ancient Egypt was established, the tropic of Cancer was at 23° 51′, which corresponds to a place on the Nile just south of the First Cataract called Parembole in Hellenistic times. On the island of Elephantine—15′ farther north—was the famous "well," whose bottom was said to be completely

* Close to the Mediterranean the meridian may have been marked by a northern pyramid. In 1800 the French Expedition saw the remains of a pyramid near Benha in the Delta, but its superstructure has since disappeared.



illumined once a year when the sun stood directly overhead at the solstice.

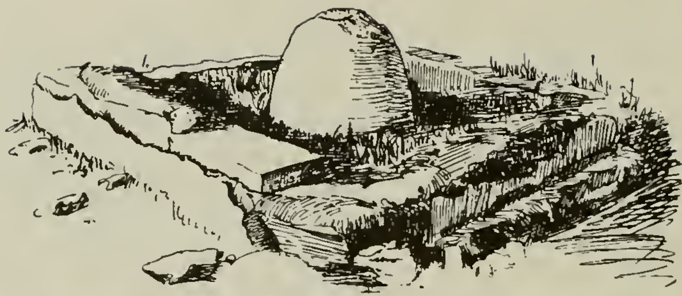
Were it possible to reconstruct exactly when the tropic was at 23° 51′ it would give a firm date for the establishment of the ancient system of geography; unfortunately no astronomer has yet been able to calculate mathematically the exact rate at which the tropic has moved since ancient times to its present 23° 27′. Schwaller de Lubicz figures it was at Elephantine between 2500 and 3000 B.C.

Cities and temples, says Stecchini, were deliberately built at distances in round figures and simple fractions from the tropic or the prime meridian. The predynastic capital of Egypt was set near the mouth of the Nile at Behdet, right on the prime meridian, at 31° 30′. This gave a length to Egypt of 1,800,000 geographic cubits. Memphis, the first capital of united Egypt, was again laid out on the prime meridian and at 29° 51′, precisely 6° north of the tropic. The northern limit of the Two Kingdoms was set at 31° 6′, and the country was measured by a newer unit, the royal cubit, of which there were 1,500,000 in the length of Egypt.

The geodetic point determining the location of Memphis was called Sokar after the god of orientation (whose name and location are preserved in the present village of Saqqara),

The first cataract, near Syene on the Upper Nile, was fabled to have been a land of the deaf because of the constant roaring of the waters over the outcroppings of granite.

This ancient boundary of Southern Egypt was the source of the hard pink granite from which the monolith beams of the King's Chamber were chiseled, as well as the many great obelisks, weighing as much as a thousand tons, which were set up in Egypt as sundials and geodetic markers.



Omphaloi, or "navels," used as geodetic markers.

Geodetic omphalos found by Reisner in the great temple of Amon.

which is exactly on the main axis of the meridian of Egypt, in the necropolis of Memphis.

As each of these geodetic centers was a political as well as a geographical "navel" of the world, an omphalos, or stone navel, was placed there to represent the northern hemisphere from equator to pole, marked out with meridians and parallels, showing the direction and distance of other such navels. In Thebes the stone omphalos was placed in the main room of the temple of Amon, where the meridian and parallel actually cross.

To obtain such precision in their geodesy, says Stecchini, the ancients must have made remarkable astronomical observations.

For the ancient Egyptians to have laid out an absolutely straight meridian of 30° of latitude from the Mediterranean to the equator, over 2000 miles, and drawn two more, equidistant, east and west, as boundaries of the country, must have required an enormous amount of personnel and careful astronomical sightings. Even more sophisticated was their method of establishing longitude, as reconstructed by Stecchini.

With the aid of an elementary system of telegraphy, consisting of a series of beacons, the Egyptians, says Stecchini, were able to note what star was at its zenith at a certain moment, and flash the data, via a string of flares, to other observers so many degrees to east and west.*

H. G. Wood, author of *Ideal Metrology,* assumes that if the Great Pyramid was originally an observatory, signal stations east and west of it once existed which are now in ruins or altogether lost. Wood quotes a Dr. Lieder's description of a little pyramid far to the west in the Libyan desert which could once be seen from the top of the Great Pyramid as the sun went down, but is now lost.

Traveling farther afield, the ancient geographer could establish his longitude with great precision on the basis of accurate tables of the nightly transit of celestial bodies as observed at the Pyramid.†

Fragmented data obtained from such accurate tables, says Stecchini, percolated to the Alexandrine Greeks such as Eratosthenes and Ptolemy, who mixed the accurate data with the inaccurately estimated coordinates of their own period, creating a hodgepodge of good and bad geography. It was not possible to disentangle and correct their work until the development of the chronometer in the eighteenth century of our era.

Because of the advanced geodetic and geographic science of the Egyptians, Egypt became the geodetic center of the known world. Other countries located their shrines and capital cities in terms of the Egyptian meridian "zero," including such capitals as Nimrod, Sardis, Susa, Persepolis, and, apparently, even the ancient Chinese capital of An-Yang.

All of these localities, says Stecchini, were set and oriented on the basis of the most exact sightings. The same applies to the centers of worship of the Jews, the Greeks, and the Arabs.

According to Hebrew historians the original Jewish center of worship was not Jerusalem, but Mount Gerizim, a strictly geodetic point 4° east of the main axis of Egypt. It was only moved to Jerusalem after 980 B.C.

The two great oracular centers of Greece—Delphi and Dodona—were also geodetic markers according to Stecchini.

* Fires such as were lighted by the Druids at the moment of the midsummer solstice may have been the origin of the "midsummer fires" and the Beltane fires of May Day, described in *The Golden Bough.*

† Because every observable star comes to the meridian of every place on the globe once in 24 hours, the interval which elapses between the same star coming upon the meridian of two different places is the difference in longitude of the two places.

Delphi is 7° and Dodona 8° north of Behdet, the northernmost part of Egypt, on the prime meridian of Egypt.

The Moselm shrine of Mecca is 10° east of the western meridian of Egypt and 10° south of Behdet. According to Stecchini the sacred black stone of the Kaaba was originally part of a set of four, placed in what he calls a pyramidical triangle from which the trigonometric functions of the shrine could be derived.

Islamic tradition stresses the point that the Kaaba was originally a geodetic center. The essential element of the Kaaba consisted of four stones marking a square with diagonals running north-south and east-west. The diagonal north-south with the northeast and southeast sides formed what the Egyptians called a pyramid. The angle formed by the diagonal with the southeast side was 36°, from which Stecchini concludes that the trigonometric functions of the shrine were measured along the northeast side.

The northwest side of the building of the Kaaba is completed by a semicircular wall: according to tradition this semicircular wall existed since the very beginning. Most likely, this was used, says Stecchini, as a sighting device.

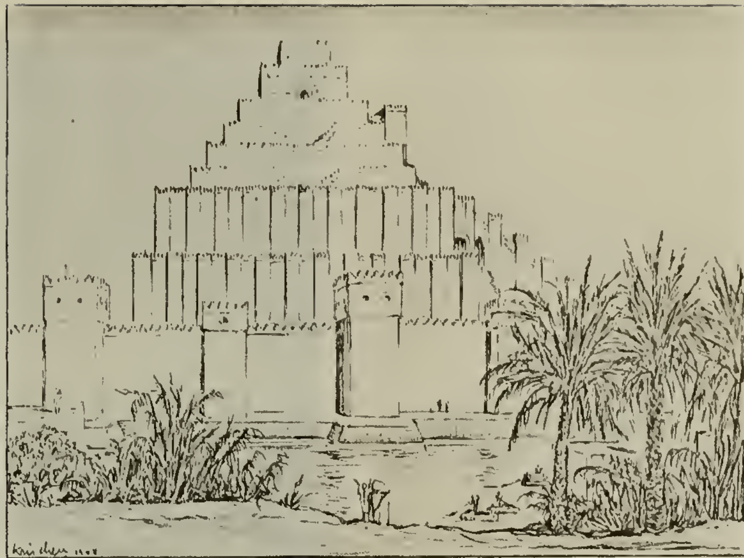
To make a map projection of the northern hemisphere, the ancient Egyptians found a simple mathematical and geometrical means of reducing the curved surface of the globe to a flat surface suitable for mapping, and with a minimum of distortion: they used the stepped pyramid, or ziggurat, each face of which could represent a 90° quadrant of the hemisphere, and each level of which could represent a mappable zone between two parallels of latitude.

Professor Maspero describes the ziggurats of Mesopotamia as "miniature reproductions of the arrangement of the universe." Professor C. P. S. Menon in his *Early Astronomy and Cosmology* says of the ziggurats: "We can deduce that the shape of the Earth, which appears to have served as a model for the temples, was a terraced pyramid with corners pointing to the South, West, North and East."

Ziggurats at Ur, Uruk, and Babylon reached a height of three hundred feet. The ziggurat of Nabu at Barsipki was called the "House of the Seven Bonds of Heaven and Earth" and was in seven stages said to have been painted in seven "Planetary colors."

The sophistication of the ancients, says Stecchini, is illustrated by the ziggurats of Babylon. These stepped "Towers of Babel," long a mystery to mankind, turn out to incorporate a series of Mercator projections, several thousand years before the advent of the Flemish cartographer.

For the purpose of mapping, the northern hemisphere was reduced to a series of flat surfaces represented by the



Reconstruction of Babylonian stepped pyramid or ziggurat. According to H. G. Wood, the ziggurat of Jupiter Belus at Babylon had an ideal basis in the number 360. In his *Ideal Metrology* it is described as a seven-staged pyramid in which each of the six upper stages is 360 inches shorter than the one next below it; the base side was 3,600 inches, and the total height of the structure was 3,600 inches. According to Wood, the entire system of ancient Babylonian metrology appears to have been derived from 360 × 360 × 100, or 12,960,000.

faces of the stepped ziggurat. The area between the equator and the pole was divided into seven bands or "zones" as the Greeks called them, each diminishing in width to correspond to the shrinking degree of longitude. The base line represented the equator, the first step the thirtieth parallel. Thus, each façade represented a 90° quadrant of hemisphere.

Stecchini says the limits of these four quadrants were established with great precision. Egyptian texts, Greek mythology (including the *Argonautica* and the *Odyssey*), and Greek and Roman writers from Herodotus onward unanimously agree in setting this western limit of the Mediterranean quadrant at 9° 54′ East. Another limit, says Stecchini, was known as the Golden Chersonnesos, that is to say, the peninsula of Malaya at meridian 99° 54′ East at a point where the equator cuts the western coast of the island of Sumatra.

Cuneiform tablets indicate that each level of the ziggurats had a specific area corresponding to standard units of land measure.

Nineteenth-century authors illustrated the ziggurats as astronomical observatories, with bearded Babylonians gazing from the battlements; but John Taylor maintained that such high terraces afforded no better vantage than the ground.

On the other hand, a square or tubular shaft of several hundred cubits, built into their interiors, would have made first-rate telescopes for observing the skies. In Mexico the Pyramid of Xochicalco near Cuernavaca contains a tubular well down which the sun shines perpendicularly without a shadow on a specific day of the year.

Nineteenth-century idea of Babylonian astronomers atop a ziggurat, published by the French astronomer Camille Flammarion.

Sir John Herschel pointed out that "from the bottom of deep narrow pits, such as a well, or the shaft of a mine, such bright stars as pass the zenith may even be discerned by the naked eye."

John Taylor indicated the reference in Ezekiel (XXIX: 10 and XXX: 6) to a "Tower of Syene," suggesting that perhaps the famous well at Syene was inside a sighting tower.

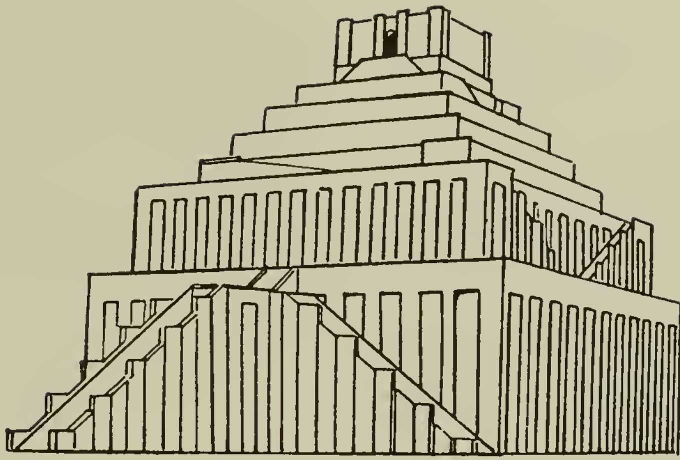
Reconstructing the ziggurat of Babylon on the basis of the cuneiform text known as the Smith tablet, Stecchini established that it rose in seven diminishing steps, each face of which was smaller than the one below it. For mapping, this allows meridians to cross the parallels at right angles, as in Mercator's projection, but avoids his distortion by shrinking each rectangular face in proportion to the shrinking degree of longitude as it approached the pole.

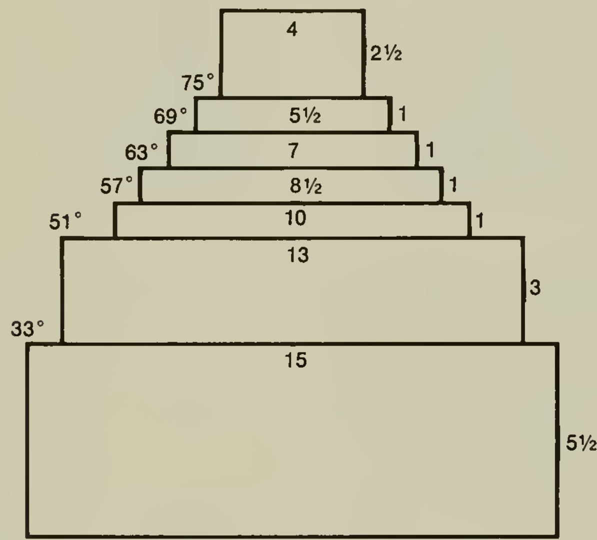
The ziggurat of Babylon, says Stecchini, would have been perfect trigonometrically if the height of the first three steps had been as originally conceived: 30, 48 and 55 1/2 degrees. But the Babylonians raised the first step to 33°, the approximate parallel of Babylon.

The cuneiform description of the ziggurat, known as the Smith tablet, specifically indicates that each level of the ziggurat has an area corresponding to standard units of land surface. Particularly important in Mesopotamian land surveying was the square with a side of 60 double cubits—the surface of the third step.

The slope angles at various heights also give important angles, such as $\sqrt{5} - 1$, which is also incorporated into the Great Pyramid. Such triangles, and the number $\sqrt{5} - 1$ (in common practice taken as the magic series 1–2–3) were fundamental in the operations of land surveying.

The third, fourth and fifth steps of the ziggurat make triangles with sides related as the Pythagorean 3–4–5 triangle.





In the original design, says Stecchini, the first step of the ziggurat was intended to represent the thirtieth parallel, but in Mesopotamia it was raised to 33°, the approximate latitude of Babylon. Thereafter the Babylonians made each step rise in units of 6° of latitude. This made it possible for them to obtain an easily remembered cosine value for each step by simply dividing its length by two thirds.

As the Babylonians liked to count by sixes, with a hexagesimal ana sexagesimal system, the steps of the ziggurat rose in multiples of 6°. Further to simplify their accounting, the degree of parallel represented by each step could be obtained by multiplying the height of each step by 6; e.g., $6 \times 5\ 1/2$ (first step) $= 33°$.

The system gave the Babylonians an extremely simple way of remembering the trigonometric value of each parallel.

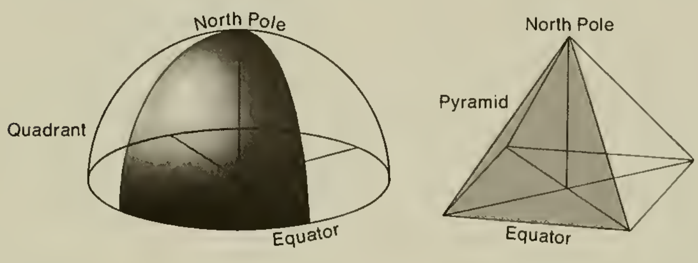
All they had to do was divide the length of each step by .666 (or 2/3). Thus, 2/3 of 15 (width of first step) is 10.000, which is the cosine value of the equator. Thereafter the operation produced a simple progression: 8.666, 6.666, 4.666, 3.666, 2.666 for the cosine value of the angles indicated by each step.

The top step, says Stecchini, was rectangular instead of square, because the average of its sides gives 2.5833, which is the cosine of 75° 01′.

XV. THE GOLDEN SECTION

In the Great Pyramid the Egyptians produced a system of map projection even more sophisticated than the one incorporated in the ziggurats.

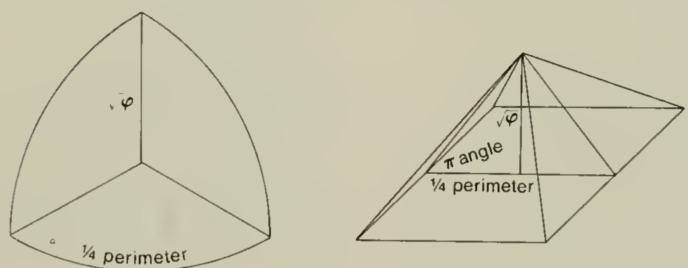
The apex of the Pyramid corresponds to the pole, the perimeter to the equator, both in proper scale. This fact was inherent in Jomard's conclusions, but got lost in the babble of cubits.



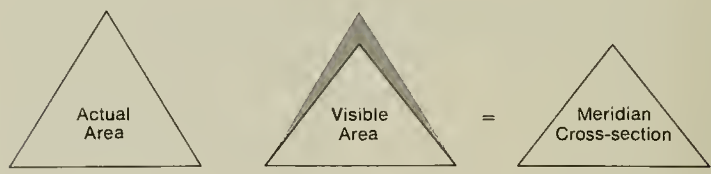
Each flat face of the Pyramid was designed to represent one curved quarter of the northern hemisphere, or spherical quadrant of 90°.

To project a spherical quadrant onto a flat triangle correctly, the arc, or base, of the quadrant must be the same length as the base of the triangle, and both must have the same height. This happens to be the case *only* with a cross section or meridian bisection of the Great Pyramid, whose slope angle gives the π relation between height and base.

John Taylor intuitively suspected something of the sort, but was unable fully to formulate it.

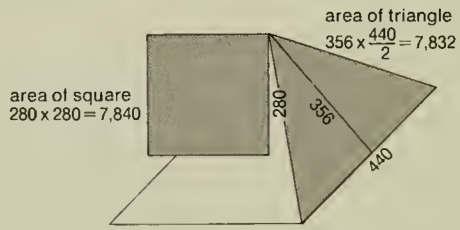


The subtlety of the Pyramid's projection lies in the fact that when viewed from the side, the laws of perspective reduce the actual area of a face (mathematically oversized) to the correct size for the projection, which is the Pyramid's *cross section.*



What the viewer saw, and sees, with the aid of perspective is the correct triangle.

The key to the geometrical and mathematical secret of the Pyramid, so long a puzzle to mankind, was actually handed to Herodotus by the temple priests when they informed him that the Pyramid was designed in such a way that the area of each of its faces was equal to the square of its height.



This interesting observation reveals that the Pyramid was designed to incorporate not only the π proportion but another and even more useful constant proportion, known in the Renaissance as the Golden Section, designated in modern times by the Greek letter φ (pronounced *phi*), or 1.618.*

φ, like π, cannot be worked out arithmetically; but it can easily be obtained with nothing more than a compass and a straightedge.

With the incorporation of the Golden Section, the Great Pyramid provides an effective system for translating spherical areas into flat ones.

Anyone who is not anxious to follow the simplified mathematics in this chapter may more simply skip to the following chapter—which contains the answer to the riddle. But he will miss some odd conceits about the relation of

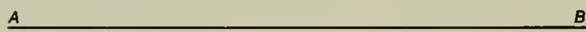
* If the 356 cubits of the Pyramid's apothem are divided by half the base, or 220 cubits, the result is 89/55, or 1.618.

mathematics to the cosmos and to the creative function of life as embodied in the science of the builders of the Pyramid. The pharaonic Egyptians, says Schwaller de Lubicz, considered φ not as a number, but as a symbol of the creative function, or of reproduction in an endless series: to them it represented "the fire of life, the male action of sperm, the *logos* of the gospel of St. John."

The Golden Section, or φ, is obtained by dividing a line

at a point C

in such a way that the whole line



is longer than the first part

in the same proportion as the first part

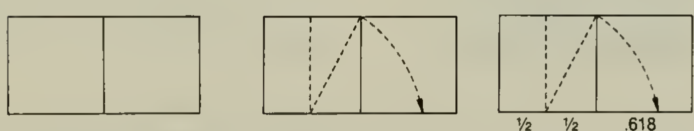
is longer than the remainder.

This will mean that $\frac{AB}{AC} = \frac{AC}{CB} = 1.618$.

This equation, which appears so simple, turns out to be loaded with meaning. Plato in his *Timaeus* went so far as to consider it, and the resulting Golden Section proportion, the most binding of all mathematical relations, and makes it the key to the physics of the cosmos.

In the Great Pyramid the rectangular floor of the King's Chamber (which consists of two equal squares, or a 1×2 rectangle) also serves to illustrate and to obtain the Golden Section.

If you split one of two squares in half and swing the diagonal down to the base, the point where the diagonal touches the base will be φ, or 1.618 in relation to the side of the square, which is 1.*

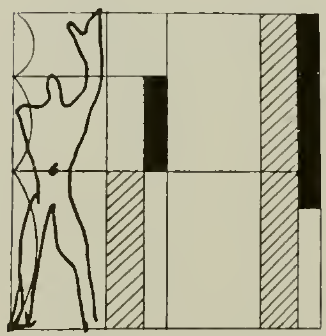


* Pythagoras' theorem will also show that the value of φ will be $1/2 + \sqrt{5/2}$, or 1.618, and that $\varphi - 1$ will be .618.

The odd, if not unique, mathematical fact that $\varphi + 1 = \varphi^2$ and that $1 + 1/\varphi = \varphi$ leads to an additive series, known as a Fibonacci series, in which each new number is the sum of the previous two: 1-2-3-5-8-13-21-34-55-89 . . . etc., and their ratio comes closer and closer to φ.*

In Egypt Fibonacci got wind of the additive series and popularized its mystical quality by bringing to Europe the story of the "rabbit problem," or how to find the number of rabbits born in one year, starting with an original pair. Assuming the rabbits to be enclosed by a wall and that every month they produce a pair of rabbits, and that each new pair in turn produce another pair each month, the answer could be obtained by the additive series 1-2-3-5-8-13-21. . . . In this case it is 377 pairs of rabbits.

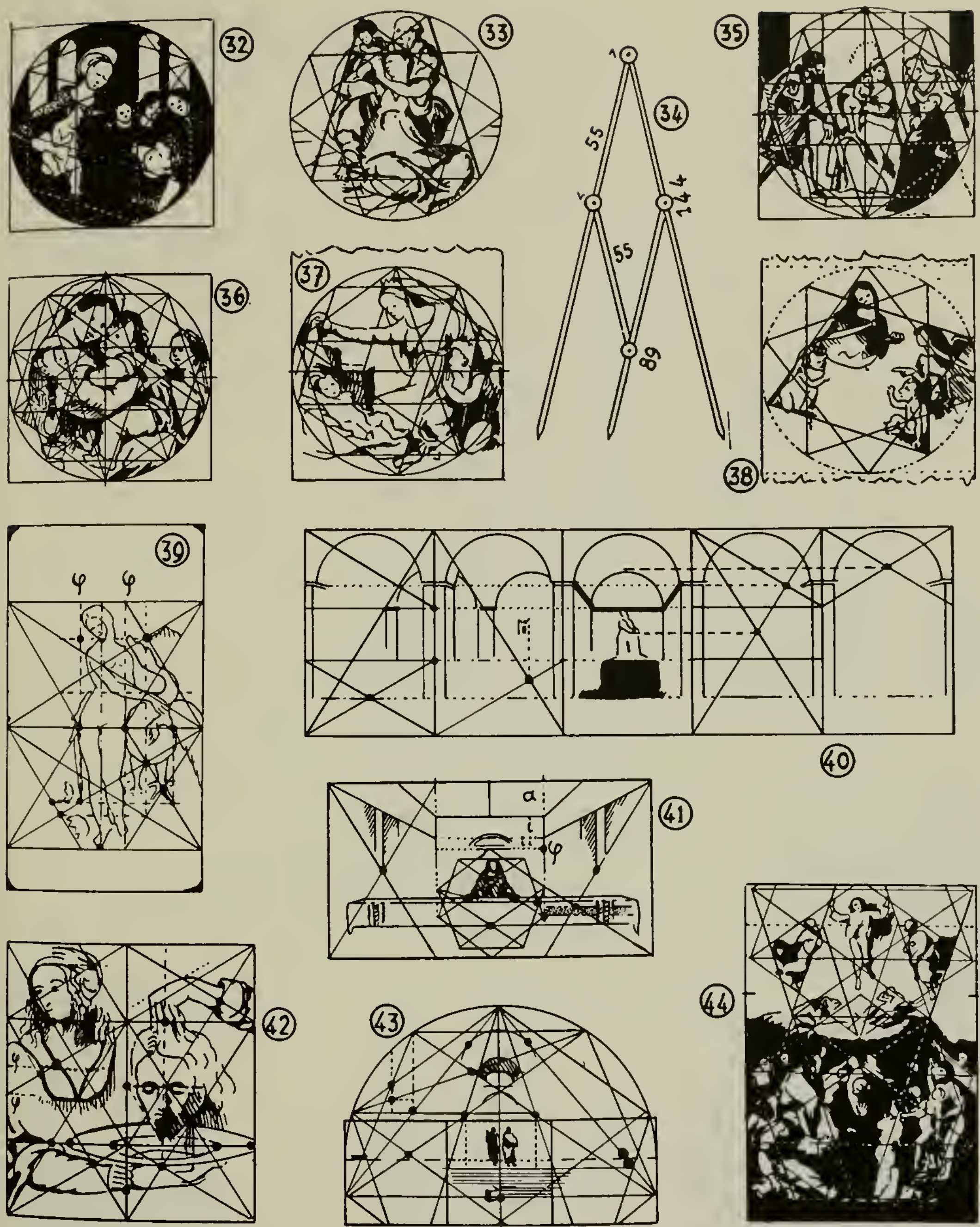
This mathematical grid, based on the Golden Section, was to become the backbone of the architectural system developed by the great French architect Le Corbusier for his construction of anything from the United Nations building in New York to the closets in a bathroom.



Le Corbusier's "modulor" based on the φ relation in the human body.

The Fibonacci series can be visualized geometrically as a mathematical grid growing larger (or smaller) in which each new unit always bears the relation of φ to its predecessors and successors.

* Leonardo Bigollo Fibonacci, known as Leonardo da Pisa, was perhaps the greatest mathematician of the Middle Ages. Born in 1179, he traveled to Algiers with his father, who acted as consul for the Pisan merchants. From the Arabs Fibonacci learnt the Hindu system of numerals from 1 to 9, which he is credited with having introduced to Europe, where calculations were still being made by the clumsy means of Roman numerals and Greek letters.



Funk-Hellet's analysis of (32) Mainardi, (33) Michelangelo, (34) Golden Section compass: note 55/89 relation, (35) Veronese, (37), (42), (43) Raphael, (38), (39), (41) Leonardo da Vinci, (40) Fra Lippo Lippi.

In the Renaissance the φ proportion, or Golden Section, as it was called by Leonardo da Vinci, served as the hermetic structure on which some of the great masterpieces were composed. Leonardo illustrated a book on the Golden Section for Luca Pacioli, known as "the monk drunk on beauty," which was published in Venice in 1509.

Funk-Hellet has analyzed the φ proportion in a score of masterpieces, including Titian's *Presentation of the Virgin,* Luini's *Sleep of the Infant Jesus,* and Veronese's *The Wedding at Cana.*

The conclusion that the Egyptians of the Old Kingdom were acquainted with both the Fibonacci series and the Golden Section, says Stecchini, is so startling in relation to current assumptions about the level of Egyptian mathematics that it could hardly have been accepted on the basis of Herodotus' statement alone, or on the fact that the φ proportion happens to be incorporated in the Great Pyramid. But the many measurements made by Professor Jean Philippe Lauer, says Stecchini, definitely prove the occurrence of the Golden Section throughout the architecture of the Old Kingdom.

Professor Lauer, for many years the architect for the Egyptian Department of Antiquities, has made thousands of measurements of ancient Egyptian buildings.

Schwaller de Lubicz also found graphic evidence that the pharaonic Egyptians had worked out a direct relation between π and φ in that $\pi = \varphi^2 \times 6/5$.*

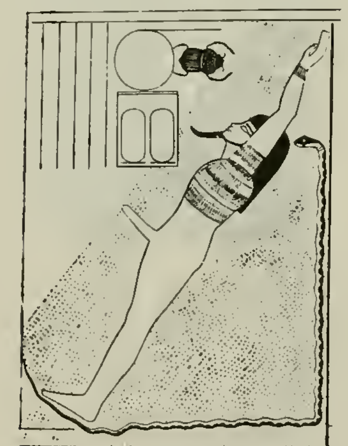
In the tomb of Rameses IX there is a strange figure of a royal mummy with one arm raised and an erect phallus. The mummy is lying at the hypotenuse of a sacred 3–4–5 right-angled triangle indicated by a snake.

The length of the body, says Schwaller, is clearly 5 cubits and that of the upright arm is one more cubit, for a total of 6. At the same time the body is divided by the phallus in the proportion of 1 and φ, for a total of φ^2.

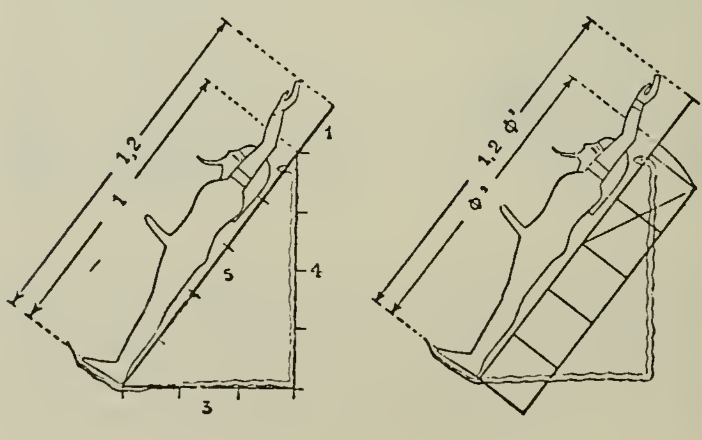
This, says Schwaller, makes the outstretched arm give a value for π of 6/5 of the body, or φ^2, which is 3.1416.

On the east side of the temple of Luxor, Schwaller also

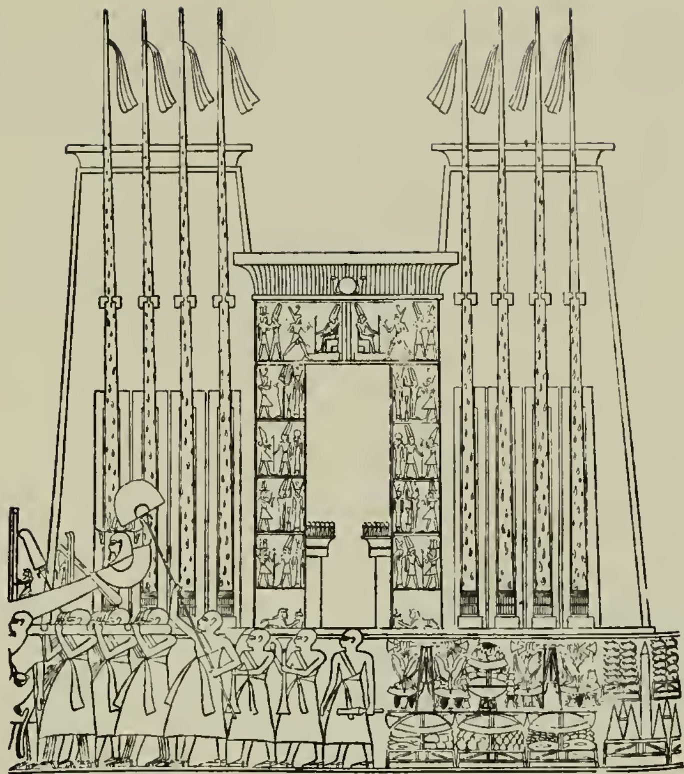
* $2.168 \times 6/5 = 3.1416$.



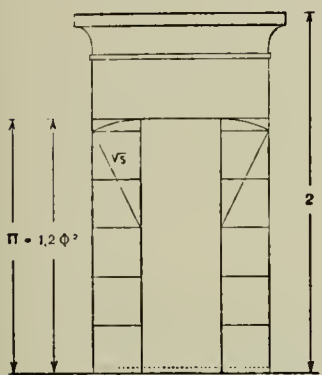
Egyptian king as the hypotenuse of a sacred 3–4–5 triangle formed by a snake.
Schwaller de Lubicz shows the king as φ^2, split into a $\varphi + 1$ proportion by the phallus. The king's raised arm gives a 6/5, or $1.2 \times \varphi^2$, proportion, which is exactly 3.1416, or π.



Priests exiting from third pylon of the Great Temple of Karnak bearing the king's barque.



Schwaller de Lubicz shows how the value of π correct to four decimals, or 3.1416, was incorporated into the great gate whose basic measurement was 1 × 2.



found a relief depicting a cortege of priests exiting from the great temple of Karnak, carrying the king's "solar barque." Schwaller points out that if the width of the gate of the temple, from outside wall to outside wall, is taken as 1, its full height will be 2, and the doorway $\varphi^2 \times 1.2$, or 3.1416; again the value of π, correct to four decimals.

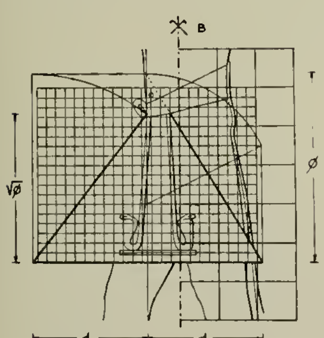
En passant, Schwaller notes the curious coincidence that the Greeks should have adopted for the relation of diameter to circumference the symbol of π, which looks just like the Egyptians' doorway.

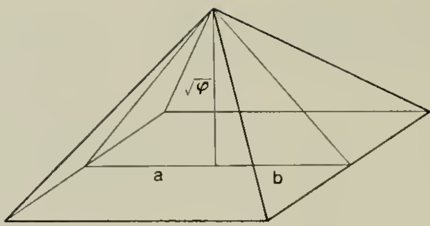
Even more extraordinary is Schwaller's resolution of the symbolic meaning of the triangular loincloth worn by the Pharaohs. Schwaller checked several score of these royal napkins for hermetic significance and found that they invariably gave two angles whose values were respectively φ and $\sqrt{\varphi}$.

Because of the location on the body of the royal napkin—similar to the Masonic apron of today—its phallic character, says Schwaller, was unmistakable.

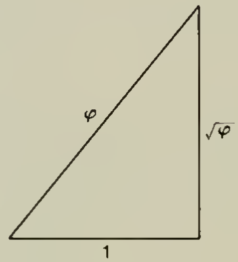
In the Great Pyramid the φ relation is found in the triangle formed by the height, the half base, and the apothem; that is to say, in the basic *cross section* of the structure.

Schwaller de Lubicz measured scores of triangular royal napkins and found that lower angles were invariably φ and $\sqrt{\varphi}$.

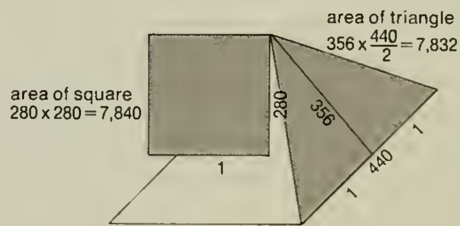




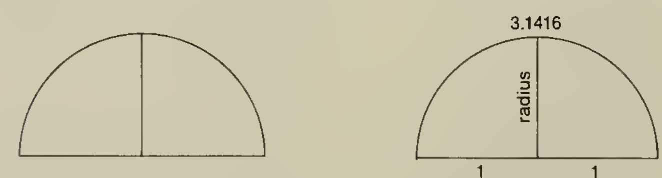
These proportions create a relation between the sides of the triangle such that if the half base is 1, the apothem is φ and the height is $\sqrt{\varphi}$.



This relation shows Herodotus' report to be indeed correct, in that the square on the height of the Pyramid is $\sqrt{\varphi} \times \sqrt{\varphi} = \varphi$, and the areas of the face $1 \times \varphi = \varphi$.



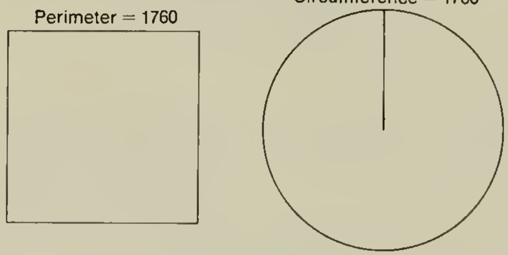
The simplicity of the system incorporated in the Pyramid makes child's play of the complexities of mathematical map projection. All one need understand is that π is the unchanging value which links a straight diameter to a curved circumference.*



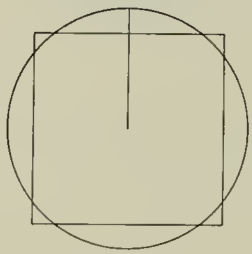
* π times the diameter of a circle will equal its circumference. π times one-half the diameter squared will equal the area of the circle.

Although the squaring of a circle is an insoluble problem if you use the irrational number of π, it is nevertheless practically resolvable as a function of the Golden Number φ. Because $\pi/2 = 2/\sqrt{\varphi}$ to within a thousandth part, π can usefully be taken as $4/\sqrt{\varphi}$.*

The Pyramid is so designed that for all practical purposes it accomplishes the squaring of the circle. The Pyramid's base is a square whose perimeter is equal to the circumference of a circle whose radius is the Pyramid's height.†



Superimpose the square on the circle and you get not only an interesting but an extremely useful diagram consisting of the perimeter of the Pyramid and the circumference of the circle it represents.



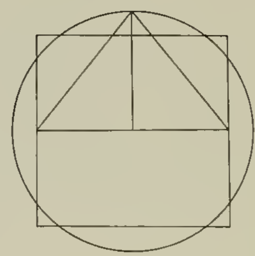
* The following examples are included for the sake of those who might doubt the mathematics; they are not essential to the narrative.

Because π also equals $\varphi^2 \times 6/5$, it is possible to use the Fibonacci series to obtain an accurate relation for the diameter of a circle to its circumference without recourse to π. In the Fibonacci series of 21–34–55, if 21 is taken as the diameter of a circle, its circumference will be $55 \times 6/5$, or 66, accurate to one-thousandth part, giving the Great Pyramid value for π of 22/7, or 3.14285.

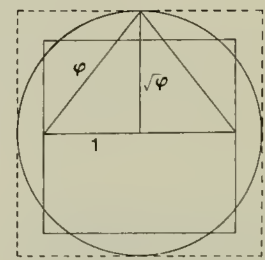
Higher numbers in the Fibonacci series provide increasingly finer values in whole numbers accurate to one ten-thousandth part. Prolonging the series, which goes . . . 89–144–233–377–610 . . . a diameter of 144 gives a circumference of $377 \times 6/5$, with a value for π of 3.1415; a diameter of 233 gives a circumference of $610 \times 6/5$, with a value for π of 3.1416; and so on.

† Four times the base of 440 cubits equals 1760 square cubits. The height of 280 cubits $\times\ 2\pi$, or twice 22/7, equals 1760 square cubits.

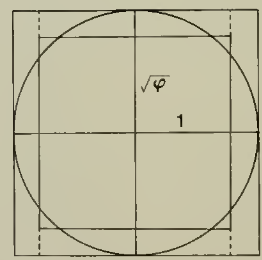
Three more lines will provide the mathematically correct cross section of the Pyramid of Cheops.



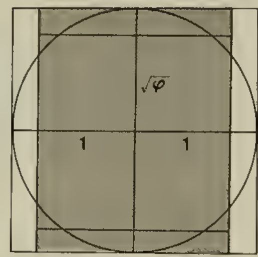
By simply enclosing the diagram in another square, and inserting the φ relationship as it exists in the Pyramid, a key is obtained for readily translating spherical surfaces into flat ones of equal area.



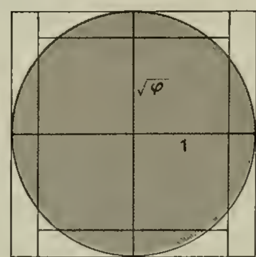
To obtain a rectangle equal in area to the basic circle, two sides of the smaller square need merely be prolonged till they touch the sides of the larger square.



The area of the rectangle is its length times its width, or $2\sqrt{\varphi} \times 2$, which is $4\sqrt{\varphi}$.

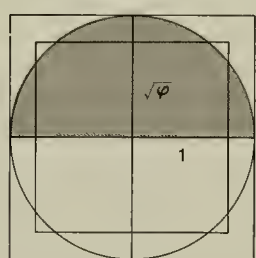


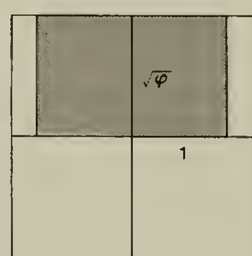
The area of the circle is πr^2, or $\pi\varphi$ in this case, the radius being $\sqrt{\varphi}$. But since $\pi = 4/\sqrt{\varphi}$, the area is also $4\sqrt{\varphi}$, the same as the rectangle.



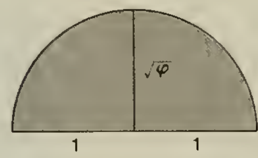
Thanks to the Pyramid's structure it is thus possible, with virtually no mathematics, to draw a rectangle (from the base of the Pyramid and twice its height) which will be equal in area to a circle on its height. This leads directly to being able to draw a rectangle or triangle equal to a spherical quadrant, resolving the main problem of the map maker with the same simplicity.

As the whole circle equals the whole rectangle, half the circle is equal to half the rectangle.

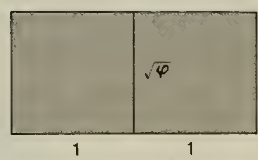




But half a flat circle is also mathematically rigorously equal in area to the spherical surface of a quadrant of 90°.



Thus a rectangle of height $\sqrt{\varphi}$ and a base of 2 is equal to a quadrant of height $\sqrt{\varphi}$ and an arc of 2.



Area = $2\sqrt{\varphi}$

Area = $2\sqrt{\varphi}$

It is thus possible to translate a spherical quadrant of 90° of longitude onto a flat Mercator surface of equal area or onto an undistorted triangle of exactly half that area.

With the Pyramid, the ancient Egyptians had not only squared the circle but effectively cubed the sphere.

XVI. SCIENTIFIC SURVEY GIVES GEOGRAPHICAL PROOF

That the Pyramid of Cheops was intended to represent a geographical rendition of the northern hemisphere was indicated repeatedly in the ancient texts, as Jomard had noted. From a careful analysis of classic Greek authors, Stecchini narrowed the sources of information on the Pyramid —other than Herodotus—down to a single Greek writer, Agatharchides of Cnidus, a peripatetic philosopher who was guardian to the king of Egypt at the end of the second century B.C.

Agatharchides reported that the length of one side of the base of the Pyramid corresponded to 1/8 minute of degree, and the apothem to 1/10 of a minute.

Jomard had hit upon this information and used it to find an almost exact solution: his apothem of 184.722 meters multiplied by 10 gave a minute of 1847.22 meters, which is almost precisely the length of a minute of latitude at the twenty-ninth parallel. This led Jomard to assume that the builders of the Pyramid had chosen to use the mean latitude value for all Egypt, which he figured to be 27° 40′.

What Jomard could not know was that the most ancient geodetic center of Egypt had been placed at 27°45′, precisely halfway between Syene on the Tropic, and Behdet on the coast of the Delta. He could not have known this because the site of the new capital of the young pharaoh Akhnaten called Akhtaten or "Resting point of Aten" had not yet been discovered near the modern Tell el-Amarna, nor had the young Champollion yet deciphered the hieroglyphs.

A stone text found in the ruins of Tell el-Amarna relates to the foundation of the capital. One of the surviving copies is about twenty-five feet high. It gives the length of the new capital as being limited by two boundary stones meticulously set "for eternity" at the extraordinary distance of 6 *atur*, 3/4 of a stadium and four geographic cubits. This indicates an intended accuracy of one in ten thousand. As Stecchini interprets the text, it not only specifically indicates 27° 45′ as the ancient geodetic center of Egypt, but gives the length of the *average* degree of latitude between the equator and the pole to be 240,715 cubits of 111,136.7 meters. The modern estimate is 111,134.1 meters.

As Stecchini points out, Akhnaten's geodetic reform was a return to the predynastic system of computing the length of Egypt in geographic cubits rather than royal cubits.

Had Jomard been able to measure all four sides of the base of the Pyramid with the precision of modern surveyors, he would have realized that the ancient Egyptians intended—quite logically—for the *base* of the Pyramid to indicate the value of a degree at the equator (where they apparently considered the earth to be a true circle and a degree of latitude to be equal to a degree of longitude).

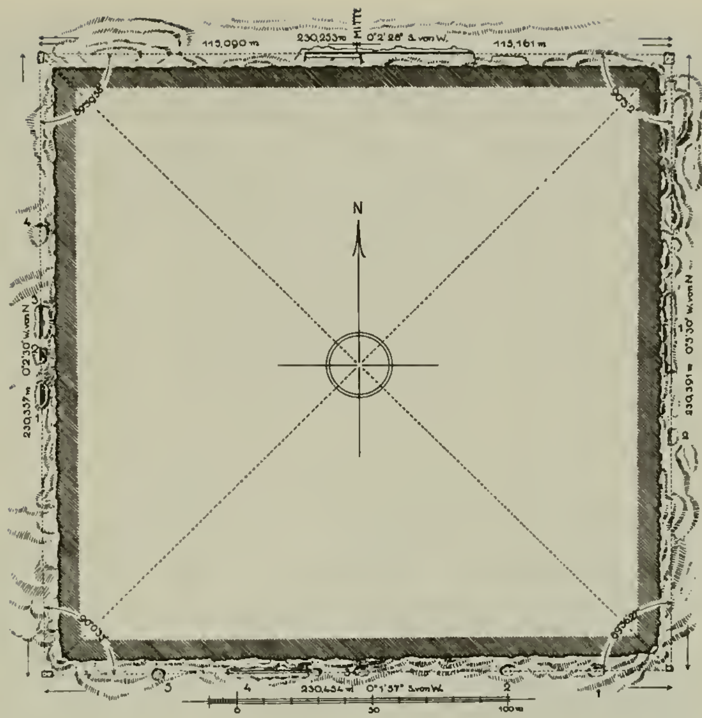
Up until the time of World War I there still remained considerable doubt as to the actual lengths of the four sides of the base of the Pyramid. Petrie had encountered great difficulty in delimiting the exact position of the corners, from which several blocks had been removed. But in 1925, Ludwig Borchardt, then director of the German Institute of Archeology in Cairo, asked to borrow the instruments of the Government of Egypt in order to make a new survey of the Great Pyramid. Borchardt hoped that a really accurate set of measurements might at last separate the strands of fact from fiction in the matter of the geometry of the Great Pyramid.

The Egyptian government agreed to make the survey on condition that Borchardt first clear all the remaining debris from around the base. When this was accomplished, an engineer named J. H. Cole was employed to make a thoroughly scientific survey. Cole used an extensive sounding of the foundations, and was finally able to ascertain to within millimeters the original position of each of the four corners.*

* These were published in *Determination of the Exact Size and Orientation of the Great Pyramid of Giza* (Survey of Egypt, paper 58). Cole gives 230.215 meters (± 6 millimeters) for the south side; 230.454 meters (± 10 millimeters at the west end and ± 30 millimeters at the east end) for the north side; 230.391 for the east side; and 230.253 for the west side.

Stecchini surmises that the apparent discrepancies of a few inches in the lengths of the four base lines might not have been errors on the part of builders who could set casing stones with the precision of a modern optician and dig a descending passage of over 350 feet with a mere 1/4 inch error in azimuth, but *intentional variants* for a definite purpose.

Were the difference in length of the sides to be explained not as the result of imprecision, but as intended skill, it would be possible to explain the lack of squareness in the angles of the base of the Pyramid. In Stecchini's opinion, the Pyramid's sides may have been deliberately planned with angles differing from a right angle in multiples of 15″ in order to correspond to a second time in the apparent motion of the stars.



Ludwig Borchardt's measurements of the angles of the base of the Great Pyramid.

If the base of the perimeter is intended to be 1/8 minute of degree, twice the perimeter will equal one minute.

Cole's mean figure for twice the perimeter is 1,842.91 meters. The modern figure for a minute of latitude at the equator is 1,842.9 meters.

From the figures it is evident that the ancient Egyptians knew that a degree of latitude is shortest at the equator and lengthens as it approaches the pole.

Schwaller de Lubicz arrived at the same conclusion by noting that the Egyptians counted a minute of arc as being 1000 brasses, or 1000 fathoms of 6 feet. According to Schwaller the brasse was a strictly geodetic measure that varied between 1.843 meters and 1.862 meters, depending upon the degree of latitude at which it was figured. The concordance is remarkable in that a minute of latitude is 1,842.9 meters at the equator, and 1,861.65 at the pole.

Stecchini's analysis of the ancient texts also helps resolve the problem of the apothem of the Pyramid which was said to be 1/10 of a minute, or 600 feet.

Pyramidion, or capstone, from the pyramid of Amenemhet III (1849–1801 B.C.) at Dashur. It is of polished black granite with winged sun disk of gold and carved hieroglyphs.

Agatharchides of Cnidus reported that the Pyramid of Cheops was topped by a pyramidion, or capstone, of four cubits which could be included in a calculation or excluded depending on the problem to be resolved. Like the obelisks, most pyramids were capped by a pyramidion of precious metal that would sparkle in the first rays of sunlight.

Discounting 4 royal cubits for the pyramidion leaves an apothem of 352 cubits of .525 meter each, and solves the whole riddle of the cubits in the Pyramid.

It gives an apothem of 600 geographic feet of .308 meter, or 400 cubits of .462 meter. It also gives an apothem of 500 remen, 220 megalithic yards, 320 *pyk belady* cubits, 100 brasses, 60 decapodes, 40 cannes, 10 short schoenia, 6 plethra, or 1 stadium. It is one tenth of a minute of latitude measured at the parallel of the Great Pyramid.

Jomard had been lucky when he found 600 feet to the apothem of the Pyramid. He had measured short, not knowing about the pyramidion, and come up with a very close 184.72 —which was derided by his colleagues.

Six hundred feet of .308 meter is 184.8 meters. The modern estimate of 1/10 minute of latitude at the parallel of the Great Pyramid is 184.75.

But Jomard had been absolutely right when he said he found 500 old Egyptian cubits of .4618 meter in the base of the Pyramid, and 400 larger *pyk belady* cubits of .5773 meter. These cubits are based on what Stecchini found to be the oldest foot in antiquity, the geographic foot which was still used in classical Greece and which survived in Europe down to our Middle Ages: in Egypt it was still common when Jomard arrived. Stecchini found evidence of this foot in temples in Mesopotamia in the preliterate era as early as 3500 B.C. The same geographic foot forms the edge of a cube or *artaba* which was the standard unit of grain measure in the Near East down to the Persian Empire.

It is now clear that the minute differences that appear in this foot in Persia, Greece, Mesopotamia and Egypt are due to the fact it was computed astronomically, varying a mere fraction of a millimeter depending on the latitude at which it was measured.

The façade of the Parthenon is 100 geographic feet of .3082765 meter, or 1 second of arc at the latitude of Athens, which is 37° 58′. At the equator a foot is a millimeter less, or only .30715 meter; at the mean latitude of Egypt, at 27° 45′, it is .307795. At the latitude of the Great Pyramid it is what Jomard found it to be: .3079. One and one-half of these feet made a geographic cubit of .4618, the same cubit Jomard found in current use when he arrived in Egypt, and which had been current since the time of Al Mamun (by means of which the Arabs could have correctly computed the circumference of the earth).

If you divide the earth into 360 degrees, and again into 60 minutes of 60 seconds, the result is one second of arc, or 100 geographical feet. Translated into meters by multiplying by .308 the result is 39,916.8 kilometers, which is within one quarter of one percent of our modern earth circumference of 40,000 km. By Akhnaten's average degree it was an even closer 40,009.32 kilometers.

Taylor had come within a hair of resolving the problem when he correctly postulated that the builders of the Pyramid had taken a great circle of 360 degrees and divided it first into 60 minutes and then into 60 seconds for a total of 1,296,000 seconds of arc.

Searching for a unit among the ancient measures that would fit this total, Taylor came up with what he called the short Greek foot, or Ptolemaic foot, which was 1.0101 of an English foot. One hundred of the Ptolemaic feet to a second of arc gave an earth circumference of 129,600,000 Ptolemaic feet, or 130,908,960 English feet, which was a bare one thousandth short of the estimate of the earth's circumference in Taylor's day.

Taylor's Ptolemaic foot was, of course, none other than Jomard's foot of .3079, from which was derived the cubit of .4618 meter, 500 of which fit the base of the Pyramid.

But Taylor couldn't make the sums come out because he was using the base computed by Le Père and Coutelle, which was about six feet too long, and into which neither the Ptolemaic foot nor the cubit would fit.

For lack of Cole's precise survey, poor Taylor, who was hot on the scent, was obliged to discard Jomard's thesis that 500 cubits of .4618 fit the base of the Pyramid along with the idea that it was intended to represent 1/8 minute, or 1/480 of a geographical degree. That Taylor was loath to do so is clear from his comment that he was sure that "it is in this direction, if any, that we may hope to find a satisfactory answer to the question: why was the Great Pyramid built?"

Instead, Taylor pursued the confusing idea that the Pyramid had been intended to indicate a polar axis for the earth of 500,000,000 Pyramid inches, and that the Egyptians had measured the base of the Pyramid in units to fit a solar year of 365.2322 days.

Piazzi Smyth, who also sensed there was truth in Taylor's probings, followed him into this apparent cul-de-sac.*

* Even so Taylor and Smyth may have been on the track of a solution. Taylor suggested that the circumference of the earth had been measured in Ptolemaic feet and common cubits, whereas the *polar* axis had been measured in inches and sacred cubits. In his recent *Historical Metrology*, Algernon Berriman supports Taylor's hypothesis by showing that whereas a "sacred" cubit of 25.064 inches is the ten millionth part of the earth's polar radius, a "royal" cubit of 20.6265 inches is a fraction of the circumference of the earth in that it is 206,265 sexigesimal seconds of arc: in other words the radius laid along a circumference of 1,296,000 seconds becomes a radian of 206,265 seconds.

Why Taylor, Smyth, Petrie and Davidson could not, or would not, avail themselves of Jomard's figures is a mystery. The twenty-one volumes of the *Description de l'Egypte* are bulky, hard to come by, and harder to handle (they are in leatherbound folio and double [Atlantic] folio, weighing as much as fifty pounds), and the information is scattered, without an index, through hundreds of pages of text, mixed with thousands of incongruous or irrelevant facts and figures; but the hard facts and figures are there; and Jomard's handling of them is lucid.

More surprising is the dogged determination of Egyptologists and writers on the Pyramid to continue to overlook or deny these facts. Even so eminent an Egyptologist as Jean Philippe Lauer, architect for the Egyptian Department of Antiquities, who certainly had ready access to *Description de l'Egypte* (his father was a curator of the Biblioteque Nationale) continued to dispute Jomard's conclusions even as late as after World War II.

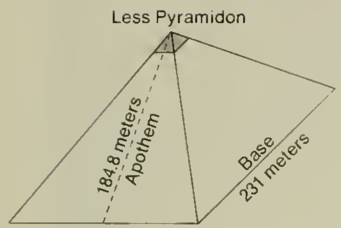
In his book *Le Problème des pyramides,* Lauer writes: "We must recognize that all this pretty hypothesis rests on inexact data. The cubit of .462 meters derived by Jomard from the base and the apothem of the Pyramid appears to be as hypothetical as that of Piazzi Smyth."

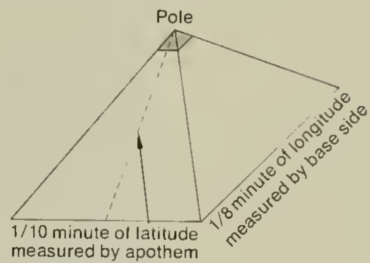
Ironically, the Director of the Department of Egyptian Antiquities, M. Etienne Drioton, who wrote the preface to Lauer's book, complained that it is because of their opposition to such theories as Jomard's that Egyptologists are being treated like "naif, blind, refractory dabblers in science whose quiet routines have been disturbed!"

That Jomard's cubit of .4618 or .462 meter is incorporated 500 times in the base of the Great Pyramid and 400 times in the apothem is no longer a matter of debate. Thanks to Cole it is a simple matter of multiplication. Even the confusing report of the Roman historian Pliny that the base of the Pyramid measured 833 1/3 feet and its apothem 666 2/3 feet becomes easily resolvable. The incongruity is rational when it is realized that Pliny's foot was simply 9/10 of a geographic foot. In other words, 833 1/3 of Pliny's feet turn out to be 750 geographic feet, or 500 geographic cubits.

The 500 cubits base is equal to 230.3625 meters (almost exactly Cole's figure) if measured by a geographic cubit computed at the equator, and 230.925 (almost exactly Jomard's figure) if measured by a cubit computed at the parallel of the Great Pyramid. The difference in cubits—which amounts to a fraction of a millimeter—makes no difference whatsoever to the relative values of the other units. For the sake of clarity the accompanying chart uses a cubit of .462 and a foot of .308.

Ancient Units of Measure Contained in the Great Pyramid in Round Numbers or Exact Fractions





The units of measure, from the short foot of .300 meter, through the various cubits, brasses, megalithic yards, parasangs, and miles, all fit perfectly in either round numbers or exact fractions into the base and apothem of the Great Pyramid because they are *all* fractions of a correct geographical degree of latitude or longitude at the equator. The Great Pyramid is thus a true standard of measure and a scale model of the northern hemisphere.

Apothem	Base
616 Egyptian feet of .300 meter	770 Egyptian feet
600 Greek or geographic feet of .308 meter	750 Greek feet
500 remen of .3696 meter	625 remen
400 geographic cubits of .462 meter	500 geographic cubits
352 royal cubits of .525 meter	440 royal cubits
320 *pyk belady* of .5775 meter	400 *pyk belady*
275 megalithic yards of .84 meter	220 megalithic yards
100 brasses or fathoms of 1.848 meters	125 brasses or fathoms
60 decapodes or rods of 10 feet	75 decapodes
40 rods of 15 feet	50 rods of 15 feet
6 plethra	7.5 plethra
1 stadium of 600 feet (.308)	1 1/4 stadium
1/10 of a mile, or angular minute	1/8 mile or minute
1/600 of a geographic degree	1/480 of a degree

Agatharchides was quite right when he quoted ancient Egyptian sources as saying that the base of the Pyramid was intended to be 1/8 minute of degree at the equator. 500 of Jomard's cubits multiplied by 8 for a minute, by 60 for a degree and 360 for a circumference, equal 86,400,000 cubits.

Relation of the Ancient Egyptian Foot (of .308 meter) and Multiples Thereof to the Circumference of the Earth

In the circumference there are			129,600,000 feet
There are 360	degrees	of	360,000 ft.
3,600	great Egyptian schoene	of	36,000 ft.
21,600	miles	of	6,000 ft.
216,000	stadia	of	600 ft.
1,296,000	plethra	of	100 ft.
2,160,000	schoenia	of	60 ft.
8,640,000	cannes	of	15 ft. (1) cubit
12,960,000	decapodes	of	10 ft.
21,600,000	brasses or ogyie	of	6 ft.
86,400,000	cubits	of	1 1/2 ft.
129,600,000	feet	of	1 ft.
518,400,000	palms	of	1/4 ft.
2,073,600,000	fingers	of	1/16 ft.

Obelisks outside the temple of Amon-Ra at Karnak which was oriented to the solstice. By measuring their shadow at the solstice it was possible to extrapolate the meridian circumference of the planet.

This reveals the source of the Egyptian cubit and foot. There are 86,400 seconds in a day of twenty-four hours, or the time it takes the earth to revolve on its axis. So the distance traveled by the earth at the equator in one second is exacly 1000 of Jomard's cubits.

The builders of the Great Pyramid gave its base a length corresponding to the distance the earth rotates in 1/2 a second. This makes the cubit and the foot doubly earth commensurate: the cubit was equal to 1/1000 of a second of time, the foot to 1/100 second of arc.

How could the ancient observers have established this fact? To compute the polar circumference of the earth the ancients used the sun and the shadows cast by obelisks. To compute the equatorial circumference they observed the passage of stars across fixed points such as obelisks. For the polar circumference they needed merely to measure the distance between two obelisks a few miles apart and the difference in the length of the shadows of the obelisks.

There was no need to measure such a vast distance as separated Alexandria from Syene. The difference in latitude, and hence the fraction of arc separating any two meridian obelisks, can be obtained by the relation of the obelisk's shadow to its height *when measured at the moment of the solstice or equinox.*

To obtain the equatorial circumference, an observer at the base of an obelisk at the thirtieth parallel could signal the appearance on the eastern horizon of a zenith star to an observer at a measured distance in the western desert where the tip of the obelisk would be on the horizon. Noting the interval of time between the signal from the first observer and the moment the star appeared on *his* horizon (and knowing the earth moves through 1,296,000 seconds of arc in 86,400 seconds of time), the observer could figure the equatorial circumference of the earth. At the thirtieth parallel it would vary from the equator by the cosine value of 30° or $\sqrt{3/2}$.

It was thus simply a matter of deciding what *unit of measure* to use in computing these lengths. An observer looking up at the Grand Gallery from a point far enough back to subtend an angle of 2° at the opening, could then note the time it took a star on the celestial equator to cross the opening. He would then possess the necessary data to relate the width of the Grand Gallery to the circumference of the earth.

From the figures it is evident that the ancient astronomers took the earth's daily rotation on its axis as a unit of time and made 1000 cubits the distance traveled by the earth in a second of time.

With a series of obelisks they could physically measure minutes and seconds of meridian arc, along a meridian and extrapolate the distorted distance to the pole.

From many scattered texts Stecchini has deduced that the Egyptians had worked out a simplified method of computing the change in each degree from equator to pole by means of an additive and subtractive series. The geographic cubit was also ideal in that it gave an admirable length for Egypt of 1,800,000 cubits. From Behdet to Syene is 7 1/2 degrees, or 1/48th of the earth's circumference of 86,400,000 cubits.

These cold facts should settle one whole facet of the mystery of the Great Pyramid. Clearly the ancient Egyptians knew the shape of the earth to a degree not confirmed till the eighteenth century when it was established that Newton was correct in his theory that the planet was somewhat flattened at the poles, and they knew the size of the earth to a degree not matched till the middle of the nineteenth century when it was first remeasured with comparable accuracy by the German geodesist Friedrich Wilhelm Bessel. It is equally evident that they could divide a day into 24 hours of 60 minutes and 60 seconds, and produce a unit of measure that was earth commensurate—just as Taylor, Smyth and Jomard had surmised.

So now that Cinderella's foot has been found to fit her lost slipper without pinching or effort, to go on lengthening and shortening the carbuncled feet of her ugly sisters would indeed be like M. Drioton's naif, blind and refractory dabblers in science. On the other hand, a little cooperative effort by experts on ancient Egypt and Sumeria might help bring to light many more fascinating details of the early history of science.

Sexagesimal, Decimal and Quaternary Relations of Ancient Egyptian Units of Measure

60 palms	= 1 canne
60 feet	= 1 short schoenion
60 decapodes	= 1 stadium
60 short schoenia	= 1 Hebraic mile
60 plethra	= 1 Egyptian mile or minute of degree
60 stadia	= 1 grand schoenion
60 Egyptian miles	= 1 degree or moira
60 grand schoenia	= 1 sexagesime
60 sexagesimes	= 1 circumference of the globe
10 Egyptian feet	= 1 decapode
10 Egyptian cubits	= 1 canne or Egyptian pole
10 orgyie or brasses	= 1 short schoenion
10 decapodes	= 1 plethron
10 cannes	= 1 side of land unit of 100 cubits (aroura?)
10 short schoenia	= 1 stadium
10 stadia	= 1 Egyptian mile
10 grand schoenia	= 1 degree of longitude
4 fingers	= 1 palm
4 palms	= 1 foot
4 cubits	= 1 orgyie or brasse
4 cannes	= 1 short schoenion
4 sides of 100 cubits (aroura?)	= 1 stadium

Number of Greek or geographic feet of .308 meters.

In circumference of world	360,000 × 360
In a geographical degree	360,000
In a long schoene	36,000
In a geographical minute (or mile)	6,000
In a stadium	600
In a brasse	6
In a cubit (geographical)	1 1/2

Geodetic Values Incorporated in the Dimensions of the Great Pyramid

	Base	Perimeter	Apothem
Egyptian foot of .300 meter	770	3080	616
Greek or geographic foot of .308 meter	750	3000	600
Greek or geographic cubit of .462 meter	500	2000	400
Royal Egyptian cubit of .525 meter	440	1760	352
Pyk belady cubit of .5775 meter	400	1600	320
Megalithic yards of .84 meter	275	1100	220
Brasse of 6 geographic feet (1.848 meters)	125	500	100
Decapodes of 10 geographic feet	75	300	60
Plethra	7.5	30	6
Stadium of 600 geographic feet	1 1/4	5	1
Miles or minute of degree	1/8	1/2	1/10
Parasangs	1/24	1/6	1/30
Long schoene	1/48	1/12	1/60
Geographical degree	1/480	1/120	1/600

XVII. DECLINE OF ANCIENT KNOWLEDGE

What remains a mystery is how all the advanced science of the ancient Egyptians could have been lost for so many centuries.

In his reconstruction of preclassic geographical data, Stecchini has traced an advanced science of geography based on accurate astronomical tables which were kept up to date all the way down to the beginning of the first millennium B.C. He has established that the later Babylonians still had excellent maps for their area of the world between the thirtieth and thirty-sixth parallels, made in segments of 6° of latitude by 7° 12′ of longitude, which gave them perfect squares because of the diminished length of a degree of longitude between those parallels.

This same system, says Stecchini, was in use as late as the reign of Darius the Great of Persia, whose empire, centered on the arbitrary geodetic point of Persepolis, ran precisely 3 units of 7° 12′ east of the Egyptian meridian and three units of 7° 12′ west of the Indian border.

But errors were already creeping into the geography because of a lack of direct observation of celestial phenomena and because of the reliance by geographers on ancient astronomical data that were no longer up to date.

As an explanation for this regression of geographic science, especially during the Hellenistic period, and thereafter almost to modern times, Stecchini suggests that when Alexander the Great destroyed Persepolis in the fourth century B.C. he may have exterminated the Egyptian geographers imported by the Persians to do their figuring, and that when he dismantled the center of Egyptian science at Heliopolis in order to build his own capital at Alexandria, he may have compounded the damage.* The destructions of Persepolis and Heliopolis were considered by Alexander

* Heliopolis, the On of the Bible, was considered the greatest university in the world. It had existed since much earlier times under the domination of the priests, of whom there were said to be 13,000 in the time of Rameses III, 1225 B.C. More than 200 years earlier, Moses was instructed at Heliopolis "in all the wisdom of the Egyptians," which included physics, arithmetic, geometry, astronomy, medicine, chemistry, geology, meteorology and music.

Romantic nineteenth-century depiction of Moses being found in the bullrushes.

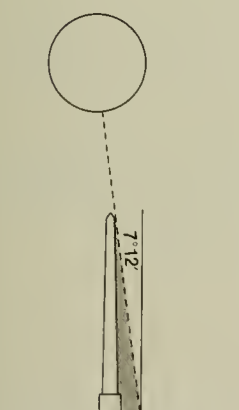
essential in order to destroy the geographic, and therefore the political, basis of the older empires.

Stecchini's evidence shows that far from being the great innovators of geographical knowledge, the Alexandrine geographers of the next half millennium, such as Eratosthenes, Hipparchus and Ptolemy were mainly handling and mishandling traditional data of an advanced science that preceded them, and which they only understood in part.

Current scholarship keeps repeating that the circumference of the earth was first measured by Eratosthenes, the Greek who was put in charge of the library of Alexandria, but it is clear that Eratosthenes merely cited old Egyptian information about the circumference of the earth without really understanding it.

Eratosthenes claimed to have found that a degree of latitude was 700 stadia. This, says Stecchini, was nothing but the traditional Egyptian datum of 14 *atur* to 50 stadia.

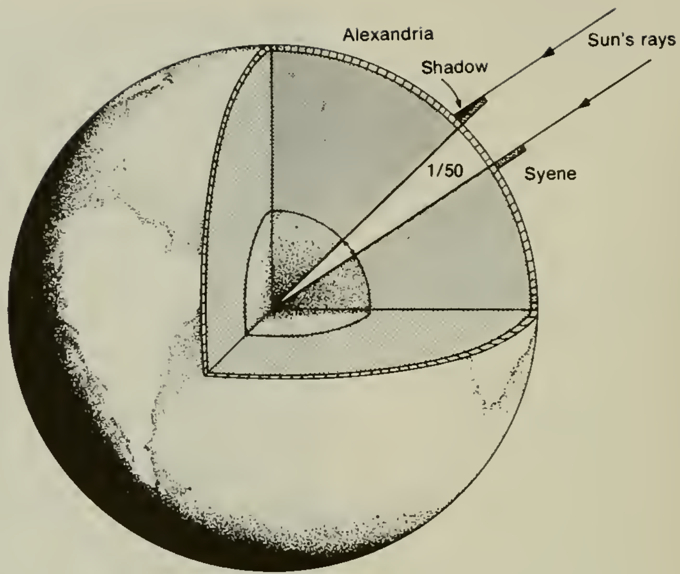
Eratosthenes also claimed to have found by observation that when the sun does not cast a shadow at the southern limit of Egypt, it casts a shadow of 7° 12′ at Alexandria.



Gnomon at Alexandria at summer solstice.

Eratosthenes is said to have measured the circumference of the earth by noting the angle of the sun's rays at Alexandria at the summer solstice, the day he knew the sun would be directly overhead at Syene on the tropic of Cancer.

Finding a shadow angle of 7° 12′ at Alexandria, he deduced the distance from Alexandria to Syene to be 7° 12′ of the 360° circumference of the globe. As 360/7° 12′ = 50, Eratosthenes multiplied the 5000 stadia he believed to separate Alexandria from Syene by 50 and got a figure of 250,000 stadia for the circumference of the earth. Because his various errors canceled out, he was credited with a scientific answer.



In reality Eratosthenes had read the old Egyptian data (then more than 2000 years old) to the effect that the tropic was at latitude 23° 51′ and that the sun did not cast any shadow at Elephantine. What he did not know, and could not measure, was that by his time the tropic had shifted to 23° 45′. Nor did Eratosthenes understand the necessity of adjusting his figures according to the apparent semi diameter of the sun; he believed Alexandria to be 7° 12′ north of 23° 51′; he even claimed that Alexandria was on the same meridian as Elephantine, whereas they are apart by about 3°, or 200 miles of longitude.

Furthermore, Eratosthenes used the "great cubit" of Babylon (532.702 millimeters) to obtain his stadium, instead of the more ancient royal cubit of the Egyptians of 525 millimeters, unaware that the first step taken by the Assyrians when they conquered Egypt in the seventh century B.C. was to substitute their own Mesopotamian cubit for the Egyptian one in order to manifest their own dominion.

On the basis of his research into ancient geography, Stecchini is now convinced that there existed on this planet a people with an advanced mathematical and astronomical science several millennia before classic Greece.

XVIII. WHO BUILT THE PYRAMID? WHEN? AND HOW?

It would be satisfactory to be able to describe the method by which the Great Pyramid was put together, by whom, and when.

But the builders, whoever they may have been, left no description of their method. No one has even found a *later* Egyptian report of how the first pyramids were built. It is only on the basis of shrewd guessing that Egyptologists estimate the stepped pyramid of Saqqara to be the oldest of the Egyptian pyramids and attribute its construction to the legendary architect Imhotep in the reign of King Zoser of the Third Dynasty.

The stepped pyramid of Medûm, which was the first stepped structure to be converted to a true pyramid, is attributed to Cheops' father Sneferu on similarly sketchy evidence; the same goes for the bent pyramid of Dashur.

Lacking solid history, the Arabs (and the Jews) of the Middle East proliferated legend. The most ancient tradition about the Great Pyramid is that it was erected to memorialize a tremendous cataclysm in the planetary system which affected the globe with fire and flooding.

Arab authors recount that the pyramids were built before the deluge by a king who had a vision that the world would be turned upside down, and that the stars would fall from the sky. According to these Arab sources, the king placed in the pyramids accounts of all he had learnt from the wisest men of the times, including the secrets of astronomy, complete with tables of the stars, geometry, and physics, treatises on precious stones, and certain machines, including celestial spheres and terrestrial globes. They also speak of "malleable glass."

The earliest Jewish reports—other than the vague reference in the Bible to "pillars of stone"—is in Josephus, who says the Sethites were inventors of a wisdom which dealt with celestial bodies and their order in the heavens, and that to preserve their wisdom for all mankind they built two monuments—one brick, the other stone—the stone one being still extănt in Egypt in Josephus' time, during the first century after Christ.

The Arab legends maintain that the Great Pyramid not only contained representations of the position of the stars and their cycles, but also a history and chronicle of the times past and future.

As to *who* built the Great Pyramid, Arab historians such as Ibrahim ben Ebn Wasuff Shah say that the Giza pyramids were built by an antediluvian king called Surid or Saurid, who saw in a dream a huge planet falling to earth at the time when "the Heart of the Lion would reach the first minute of the head of Cancer."

Abu Zeyd el Balkhy quotes an ancient inscription to the effect that the Great Pyramid was built at a time when the Lyre was in the Constellation of Cancer, which has been interpreted as meaning "twice 36 thousand solar years before the Hegira," or about 73,000 years ago.

The famous traveler ibn-Batuta, writing 730 years after the Hegira, says that Hermes Trismegistos (the Hebrew Enoch), "having ascertained from the appearance of the stars that the deluge would take place, built the pyramids to contain books of science and knowledge and other matters worth preserving from oblivion and ruin."

According to Basil Steward, a theosophist, author of *The Mystery of the Great Pyramid,* there is no more reason to believe that because the Pyramid stands in Egypt it was built by Egyptians than that the modern Egyptians built the Aswan Dam. Steward says that when all the evidence—archeological and traditional—is coordinated and examined collectively, it leads to but one conclusion: ". . . The seeds of Egypt's greatness were sown by a few colonists who entered the country peaceably and organized the carrying out of great constructional works."

Sir George Cornewall Lewis, in *An Historical Survey of the Astronomy of the Ancients,* complained of the arbitrary dating used by Egyptologists which he compared to "the manipulation of the balance-sheet of an insolvent company by a dexterous accountant (who, by transfers of capital to income, by suppression or transposition of items, and by the alteration of bad into good debts, can convert a deficiecy into a surplus)." Lewis pointed out that Baron Bunsen and Dr. Lepsius, both eminent Egyptologists, separated the dates of the figure Sesostris by no less than 3793 years, and asked: "What would we think if a new school of writers on the history of France, entitling themselves Francologists, were to arise in which one of the leading critics were to deny that Louis XIV lived in the seventeenth century, and were to identify him with Hercules, or Romulus . . . or Charlemagne."

The only major historian of ancient Egypt was Manetho, a priest, who wrote a history of Egypt for Ptolemy II, but it was lost. Only scraps of it, translated by authors who lived about six hundred years after his death, have survived. His list of dynasties, checked and modified, forms the framework on which the history of Egypt has been reconstructed. But very little detail is known concerning the political history of the first two dynasties, other than the nearly twenty names of Pharaohs listed by Manetho.

Most Egyptologists consider the First Dynasty to have started with Menes about 2900 B.C., and the Fourth, consisting of Sneferu, Cheops, Didoufri, Kephren, and Mykerinos, to have lasted about 120 years from 2680 to 2560 B.C., as the Old Kingdom.

There followed a first intermediate period, a Middle Kingdom from 2052 to 1785 B.C., a second intermediate period, and a New Kingdom from 1580 to 1085 B.C. Post Empire Dynasties XXI to XXVI follow down to 525 B.C.

According to Steward the colonists were probably a band of Asiatic or Euphratean travelers with a very advanced scientific and mathematical knowledge, who entered Egypt and organized the erection of the Great Pyramid, on completion of which they left the country, taking their knowledge with them.

As Steward puts it, the plans for the Great Pyramid were in existence a long time before the actual construction commenced, and were the design of a single individual "who belonged to the Adamic White civilization endowed with moral, scientific and cultural attainments far in advance of all other contemporary civilizations."

Petrie substantiates this theory to the extent that he believes: "the exquisite workmanship often found in the early period (of Egyptian architecture) did not so much depend upon a large school of widespread ability, as on a few men far above their fellows." Referring to the phenomenal accuracy of the work embodied in the Great Pyramid, Petrie says, "It was limited to the skill of one man."

Recent Soviet authors postulate that the Egyptians may have come from Indonesia when their civilization was devastated some ten to twelve thousand years ago as a result of some cosmic catastrophe such as the falling of an asteroid.

According to Peter Kolosimo in *Terra Senza Tempo,* published in Milan in 1969, the Russians have recently brought to light some fascinating secrets of Egyptian archeology.

The Russians are said to have found astrònomical maps of surprising correctness, with the position of the stars as they were many thousands of years ago. The Russians are also reported to have dug up several objects, many not yet identified, including crystal lenses, perfectly spherical, of great precision, possibly used as telescopes. Kolosimo says similar lenses have been found in Iraq and central Australia, but that they can only be ground today with a special abrasive made of oxide of cerium which can only be produced electrically.*

As to the actual dates of construction of the Great Pyramid, apart from the statement that it was built 300 years before the Flood, the legends add little. Egyptologists who worked out that the Fourth Dynasty must have reigned between 2720 and 2560 B.C. believe the Great Pyramid was commenced in 2644; others believe that its construction was begun in 2200 and that 30 to 56 years were required to

* Several attempts to check these data with Soviet academicians have so far been without result.

complete it. Still others place the building of the Pyramid a thousand years earlier.

As for the method employed by the builders, the record is equally bleak. I. E. S. Edwards of the Egyptian Department of the British Museum, who spent a lifetime going over the available evidence, points out in his scholarly treatise on the pyramids written in the 1930s that little or no light is thrown on the subject by extant Egyptian records, either written or pictorial.

The result is a congeries of conflicting theories not only about when but about how the Great Pyramid was built.

Nevertheless Egyptologists are in general agreement that the first step required on the Giza plateau was to clear the sand and gravel down to bedrock, then produce a leveled base by removing protuberances and filling in depressions.

R. L. Engelbach, a pupil of Petrie, and for many years Keeper of the Cairo Museum, believes that to obtain a true level the Egyptians surrounded the four sides of the area with low banks of mud from the Nile which they filled with water and through which they cut a network of trenches. The degree of their success is attested by Cole's survey, which found the base rock of the thirteen acre perimeter to be less than 1 inch out of level.

Into the base rock a row of fine rectangular, white limestone slabs were carefully fitted as a pavement on which to lay the first row of casing stones.

When it came to drawing the first straight side, Borchardt and Lauer agree, the correct orientation must have been obtained by means of repeated observations of the rising and setting of circumpolar stars, of which the most likely was alpha Draconis.

The next step would have been to fix the large limestone corner blocks into the rock base so as to form the square corners for the laying of the first rows of casing stones.

Archeologists have had little trouble establishing that most of the limestone blocks for the construction of the Pyramid must have been obtained from the deep Mokattam quarries a few miles across the Nile on the Arabian side of the river, though many of the blocks may have been obtained directly from the Giza hills.

On some of the blocks the names of the quarry gangs were daubed in red ochre, such as "Boat Gang" or "Vigorous Gang."

The nearest source for the 70-ton granite monoliths used to protect the King's Chamber is the Aswan quarry, near Syene about 500 miles up the Nile; from there they were presumably floated downstream on a series of reed barges.

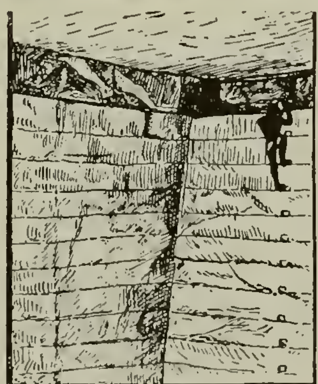
W. Emery has shown that as early as the First Dynasty

To Egyptologists Imhotep (above) was a national hero in the reign of King Zoser (below). Imhotep as designer of the stepped pyramid of Saqqara was considered not ony the world's greatest architect but a sage, magician, high priest, medical doctor, diplomat, economist, and poet.

The limestone blocks with which the Pyramid is built appear to have been mostly quarried on the spot, or across the Nile in the Mokattam hills about 20 miles away, or from the Turah and Maura quarries opposite Memphis. The 22 acres of casing stones are from the same quarries.

The granite blocks for the Pyramid are believed to have come from Aswan, near the First Cataract, where they were quarried from the face of the rock about a mile from the right bank of the Nile.

Hillsides were hollowed out to provide uniform limestone blocks for the outer casing of the Pyramid.



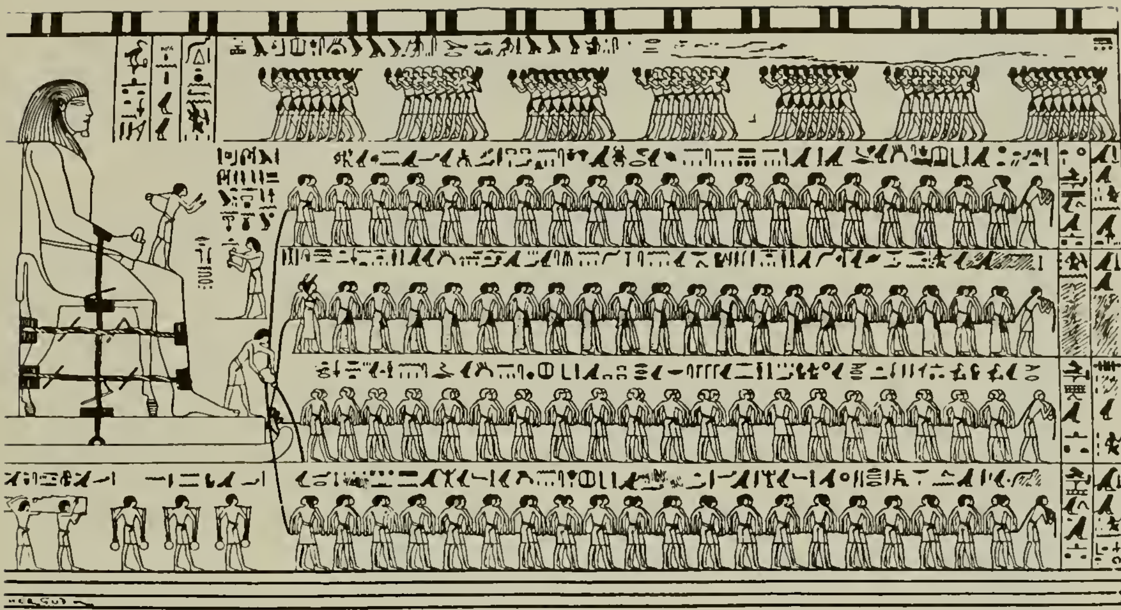
Limestone was quarried in layers from the top down.

The Aswan granite quarries were 500 miles south of the Great Pyramid.
Egyptologists conjecture that in order to cut the stone blocks, the ancient Egyptians must have had some method of tempering bronze unknown in modern times. To cut and finish hieroglyphs and other ornaments would require a tool with an extremely hard-tempered edge.
Few iron tools have been found, probably because of the rapid oxidation of iron in Egypt, where the soil is especially nitrous.

the Egyptians possessed excellent copper tools, including saws and chisels, with which to cut any kind of limestone, and that their technique of working and polishing granite was developed to a truly remarkable art. As an abrasive material in their sawing operations they are believed to have used moistened quartz sand.

To quarry the rock from the hillside, the Egyptians developed a variety of systems, traces of which can still be found on the Mokattam range. Tunnels were dug several hundred feet into the rock, shelves were cut out between the roof and the block to be detached, then a line was chipped away vertically with a wooden mallet and a copper chisel, which must have been highly tempered by some method unknown today. Wedges were inserted which were moistened till they expanded to crack the rock. Sometimes fires were built along the grooved lines, and water poured on the heated stone to obtain a clear fracture.

The only historical description of the manner in which the limestone blocks were taken to the Pyramid is by Herodotus, who claims that he was informed in Egypt that it took twenty years to build the Pyramid and that levies numbering a hundred thousand men were employed for periods of three months to transport stone from the quarries. Herodotus says that to transport the rough blocks from the edge of the Nile up to the top of the Giza plateau, a great causeway was built, which required ten years to complete. The causeway was said to be 3000 feet long and 60 feet wide, of polished stone, over which sleds could pull the heavy stones.



Several score Egyptians transporting a colossal statue with men harnessed in double rank. Note the timekeeper standing on the statue's knee, and a man pouring liquid on runners to decrease friction.

Commander F. M. Barber, an American naval attaché who was stationed in Egypt at the end of the last century and wrote an informed booklet entitled *Mechanical Triumphs of the Ancient Egyptians,* figured that if the causeway had to rise to a height of 120 feet above the Nile, it would have had an incline of 1 foot in 25, which he considered a very easy grade for a greased stoneway.

Barber estimated that it would take a force of 900 men harnessed in double rank on four draft ropes to drag a 60-ton monolith up such an incline. On the causeway the men would cover a space 225 feet long by 16 feet wide, which Barber considered a sufficiently compact and manageable force.

Barber says that such a force would have no trouble dragging the stone, especially if they were drilled to pull together; he concludes that for this reason men and not animals are pictured hauling wrought stones: men could be drilled to march in absolute cadence to a song or time-keeping instrument. A "one-two-three, surge," says Barber, produces a momentary force represented by nearly the weight of the whole mass of men, or several times their ordinary pulling force. Also, vacancies in the ranks caused by sickness could be filled without materially affecting the drill of the remainder. Cattle could never be so well organized.

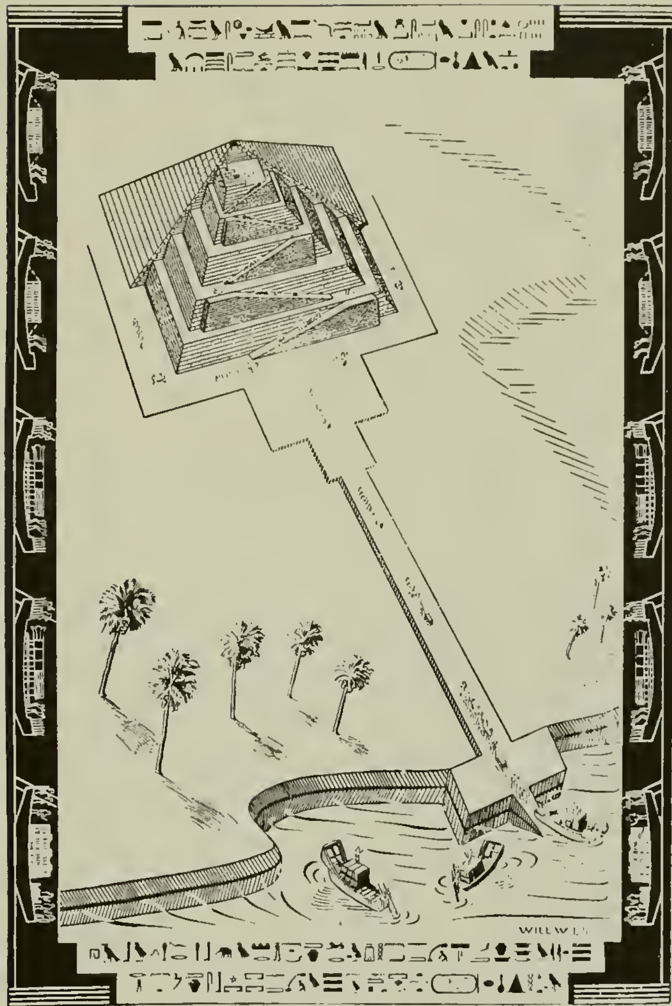
Pictures show Egyptians hauling stone in the manner described by Barber and include a special artisan pouring some sort of grease on the sled runners to reduce friction.

Other Egyptologists have suggested that owing to the great quantity of supplies necessary for building Cheops' pyramid, it was likely that several ramps led from the valley up to the Giza plateau, but very few remains of such possible causeways can now be observed because of modern excavations and the widespread tourist layout.

According to the French scholar E. Amélineau, considerable remains of an inclined plane leading to the pyramid of Kephren still existed at the end of the eighteenth century; and remains of a causeway leading to the pyramid of Mykerinos are still visible today.

The Egyptian archeologist Selim Hassan says that at the edge of the Giza plateau there is a considerable surface composed of large limestone blocks which run in a northeasterly direction and descend to a little less than half the height of the plateau. He believes they may have been part of a construction ramp which was demolished when the Great Pyramid was completed.

Causeway to the pyramid of Kephren.



W. W. Lucker's reconstruction of a pyramid and its causeway to the Nile.

Ahmed Fakhry, another Egyptian archeologist, says that remains of a southern supply ramp composed of rubble mixed with mud still exists a short distance from the south side of the main causeway.

As to how the Great Pyramid was actually constructed, there are differing opinions among Egyptologists. Herodotus reported that the upper portion of the Pyramid was finished first, then the middle, and finally the part nearest the ground. This has been interpreted as meaning that the finished outer casing stones were placed in position against the nucleus starting from the top, presumably by means of a ramp that was removed as the builders worked downward; this would have required four ramps, one against each face.

Herodotus maintains the casing blocks were lifted from the ground, step by step, on pieces of wood, with a machine

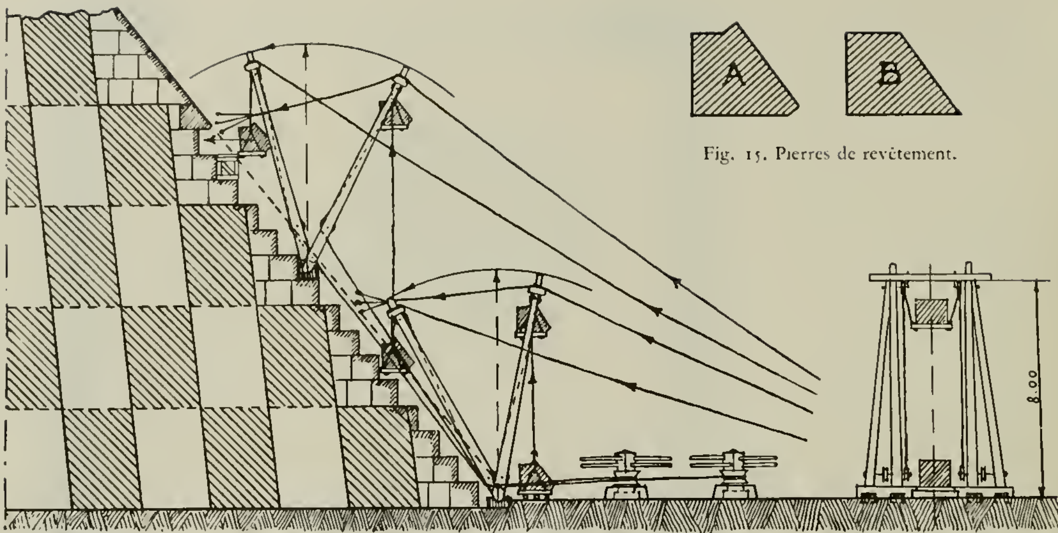


Fig. 15. Pierres de revêtement.

Machine for raising casing stones, as described by Herodotus and reconstructed by H. Straub-Roessler.
A and B are Lauer's indication of how casing stones may have been fitted.

which he does not adequately describe. Cotsworth figures that if the stones had had to be rocked to the top as reported by Herodotus, it would have taken about a month to get each of the final ones up to the summit.

Barber maintains that steel cranes or derricks would have been required to swing such great stones as are found ir, the Pyramid, and that for lack of such equipment the Egyptians would have had to construct a ramp in order to raise the heavy stones to the required level. Remains of such ramps have been found at the pyramid of Amenemhet at Lisht and also at Medûm. Aerial photographs indicate substantial remains of ramps under the sand at Dashur.

Petrie thinks the casing stones were placed in position at the same time as the core, starting from the bottom and going up course by course. He estimates that about 500 blocks were brought over from the quarries each day and laid in place. As the lower courses contain as many as 50,000 blocks, it would have taken over three months to lay each of these courses.

Petrie says the transporting was done during the three months of inundation, when a vast labor force was available and when advantage could be taken of the flood waters to float the blocks from the quarries downstream and across five miles of swollen Nile. Petrie suggests that even if no more than eight men could work together on an average block of 40 cubic feet weighing about 2 1/2 tons, they could have transported ten such blocks to the Pyramid in three months, taking two weeks to bring the blocks down the causeway from the quarry, a day or two with good wind to ferry the blocks down the Nile, and six weeks to raise them to the required position on the Pyramid. By November the men would be at liberty to return to their usual occupations when the land was again accessible.

Petrie estimated the Great Pyramid to contain about 2,300,000 stones weighing 2 1/2 tons apiece and averaging $50 \times 50 \times 28$ inches. If eight men could bring ten stones in three months, 100,000 men could bring 125,000 stones each season, or the required total in the twenty years reported by Herodotus.

Edwards says there can be little doubt that in addition to the 100,000 men levied for the purpose of transporting the blocks to the Pyramid, many others were engaged in building the Pyramid. These men, says Edwards, consisted of skilled masons and an attendant body of laborers, continually employed throughout the year preparing and laying the blocks and erecting or dismantling the ramps. Presumably these workers could have been housed in the buildings found

Aerial photograph showing ramp under the sand leading to the pyramid of Dashur.

Romanticized modern drawing of barges being rowed down the Nile toward the Giza pyramids.

by Petrie west of Kephren's pyramid, where about 4000 at a time could have lived in barracks.

Petrie figures that 40,000 skilled workers living permanently on the spot could easily cut and finish the 120,000 blocks needed each year; a party of four men would have a whole month to handle each block.

Petrie believes the masons finished and laid the casing and some of the core masonry, course by course, on the ground, before raising them. He found horizontal lines carved on the casing stones and on the core stones showing just how they were to be fitted. He believes that skilled masons planned all the work throughout the year and that at flood time gangs of unskilled workmen raised the finished stones to their indicated positions.

Petrie says the casing stones were dressed by very fine picking or adzing and were moved into position from the *inside,* whereas the core was filled in afterward.

Maragioglio and Rinaldi, two Italian scholars who recently made extensive measurements of the pyramids of Giza which they incorporated into four carefully illustrated quarto volumes entitled *L'Architettura delle Piramidi Menefite,* agree that the casing and the nucleus were built up at the same time; they think the casing blocks were slid into place by means of a thin layer of very liquid mortar that served as a lubricant as well as a filler and binder; they also think the casing blocks were levered into position from the back and sides so as not to show marks or chips on the front.

Ballard believes it would have been impossible to place the finished blocks without damaging their fine edges; he thinks the roughly scabbed blocks were put in place and finished off with the aid of templates.

In support of Petrie, I. E. S. Edwards points out that because the lowest course of casing stones lies on the smooth pavement of Turah limestone which projects a couple of feet beyond the Pyramid base, it would have been impossible to lay the casing stones from the *outer* side without damaging the fringe of the pavement which was to remain exposed; nor could they have been dressed *after* being put in position without damaging the pavement.

The fact that some of the limestone slabs of the foundation pavement are seen to be laid *beneath* the nucleus blocks also indicates the nucleus was filled in after the casing blocks had been placed in position.

Petrie believes the casing blocks were placed side by side on the ground and worked so that the back, sides and bottom would fit perfectly when put in place. The only thing left to do on the spot would have been the leveling of the upper faces.

According to the architect Rex Engelbach and the engineer Somers Clarke, authors of *Ancient Egyptian Masonry,* in order to render the sides of the casing blocks perfectly equal they were placed side by side in the yard and a saw was passed between them. However, Maragioglio and Rinaldi could find no trace of saw marks on the vertical sides of any of the remaining blocks.

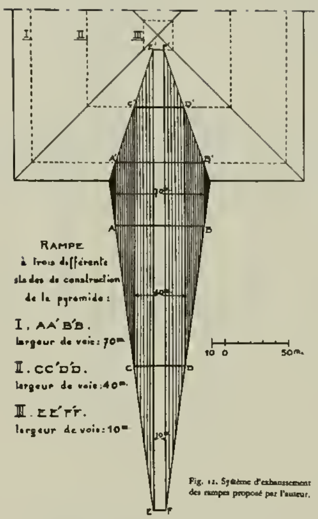
Petrie claimed to have found traces of red ochre on some of the stone faces which had not been perfectly dressed. From this he deduced that the dressing was done by degrees —as a dentist shapes a tooth—the control being made with facing plates covered with ochre.

In any case, the arrangement of casing blocks must have been worked out in detail well in advance of placement so as to assure a variance in the width and height of the backing stones from level to level, so as to prevent the vertical joints from coinciding.

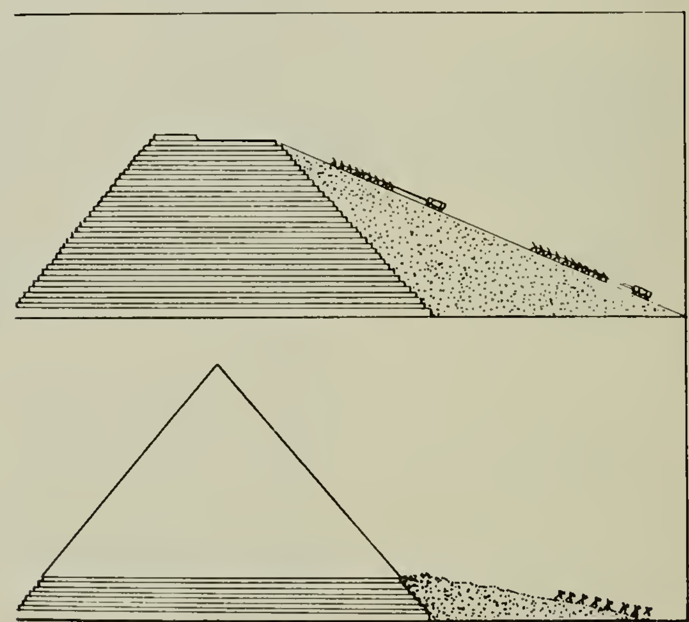
All the stones presently visible in the Pyramid are backing stones specially cut to dovetail and fit behind the outer casing. They are well dressed and squared, but made with fossilized limestone instead of the pure white.

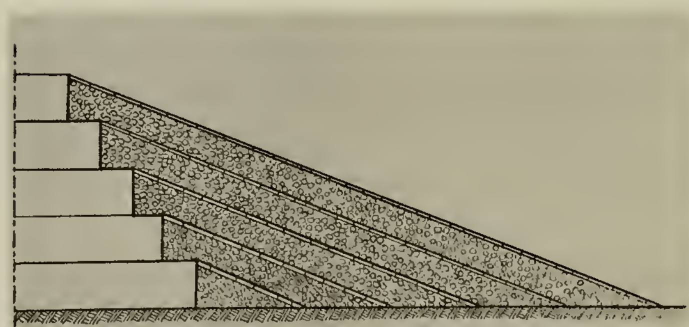
Behind them the nucleus consists of less well-dressed and roughly faced blocks of greatly varying sizes, for easier construction, and to insure that break joints did not coincide in either sense. They are held together by a mortar composed of sand, lime and crushed red pottery, which gives it a slightly pinkish color.

Maragioglio and Rinaldi attribute the concavity of the sides of the visible backing blocks to a means of preventing the facing courses from sliding, especially in the middle, by wedging the backing stones together at the center. On the north side the concavity has been measured as .94 meter. Maragioglio and Rinaldi believe the casing faces may also have been slightly concave, if only for esthetic reasons, as the optic aberration would thus be corrected, the Pyramid edges would appear sharper, the faces flatter; also,



Lauer's idea of how the ramp would grow wider and narrower.





Various methods of building ramps.

any errors in dressing the faces could be more easily distinguished.

Slight variations in the angle of the outer faces of casing fragments found in the rubble at the Pyramid's base may be explained by such a surface concavity.

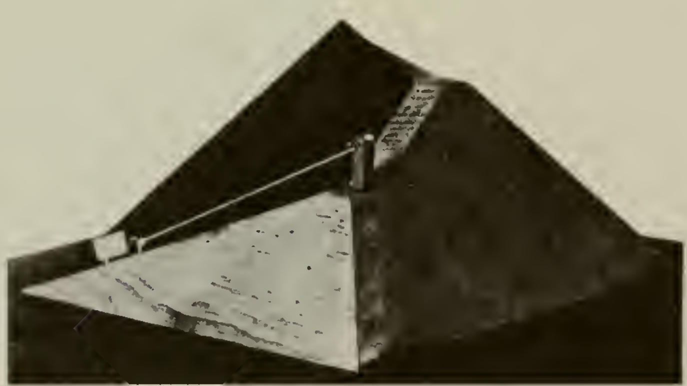
To raise each course of casing stones and nucleus all the way up the Pyramid, Petrie believes a ramp was constructed against one face, and he estimates that its volume would have had to be at least equivalent to that of the Pyramid itself.

Barber points out that to carry an inclined plane to the top of the Pyramid at a grade of one in ten, it would have been necessary to start the ramp 6000 feet away in the Nile valley at a point over 1600 feet before the commencement of Herodotus' causeway. Furthermore, says Barber, there would always have been four times as much work to do on the inclined plane as on the Pyramid.

In order to carry the ramp to the top of the Pyramid, Barber estimates that some 75,000,000 cubic feet of Nile bricks would have been necessary, or four times the number of cubic feet of stone still required to finish the Pyramid. With each additional course of masonry the ramp would grow higher and longer, but it would also grow narrower as the Pyramid narrowed at the top. According to Pliny such ramps were composed of niter and salt which could later be dissolved with water, but the idea seems fanciful as it would have required an ocean.

In *Natural History* of November, 1970, Olaf Tellefsen, an engineer, suggests that the Great Pyramid could have been erected with only a few thousand men using a simple piece of machinery consisting of a sturdy wooden arm balanced with counterweights on a fulcrum fixed to wooden skids—much like the machine drawn by the German engineer L. Croon.

This, says Tellefsen, would have done away with the need



for huge ramps postulated by Egyptologists on the basis of archaeological remains. According to Tellefsen, there was not enough manpower in ancient Egypt to build such ramps beyond the halfway mark of the Pyramid. Egyptologists countered, a little acidly, that from that point on the ramps narrowed rapidly, and that there appeared to be little evidence for Tellefsen's contention.

Cotsworth believes the Egyptians used a more ingenious system for raising the stones by taking advantage of the building itself as a ramp, dragging the stones up the Pyramid's own spiraling outer wall. This would enable the builders to fill in the core as they went up and finish the casing as they came down. Cotsworth says he watched a modern Egyptian peasant build a pigeon house by just this method.

The system has the added advantage that if the south wall of the Pyramid were completed first, the rest of the work could have been carried out in its shade rather than in the broiling sun.

But with or without the broiling sun, if one takes into account the problems of quarrying, roughing out, transporting over two million core stones, and finishing some 115,000 enormous casing stones to a precision of 1/100 inch, then raising, manipulating and mortaring them into their correct

place in a unified polished structure, one must agree with Antoniadi that the mind boggles at the enormity of the effort.

According to Barber's well-trained naval mind, it must have required the organizing capacity of a genius to plan all the work, to lay it out, to provide for emergencies and accidents, to see that the men in the quarries, on the boats and sleds, and in the masons' and smithies' shops were all continuously and usefully employed, that the means of transportation was ample, that the commissariat did not fail, that the water supply was ample and conveniently disposed, and that the sick reliefs were on hand.

Barber points out that public works were essential to keep this population employed and fed during the floods. August Mencken presumes that no less than 150,000 women and children also had to be housed, fed, and policed in nearby settlements. Judging from the texts and the paintings dealing with the subject of forced labor, Barber figures a large portion of the duty of the standing army of 400,000 men must have been that of guards.

Cotsworth says that in the rainless climate of Egypt no housing was needed for the natives who were accustomed to surviving on grain and water, and that the desert provides better sanitation than was available in Victorian England.

The waste chips of the masons were thrown over the

In 1950 the Museum of Science in Boston built a model to the scale of 1:120 showing how they believed the pyramids of Giza to have been constructed with slanting side ramps, three up and one down.

Dows Durham, curator of Egyptian art at the Museum of Fine Arts in Boston, responsible for the technical details, disagreed with the theory of long ramps because every time the building rose a few feet the ramp would become unusable until it was raised and extended.

Durham conceived the side ramps as being about 10 feet wide, or sufficient to handle a sledge with a double row of men to drag the stones over wet timbers for reducing friction. However, turning the corners would not have been easy.

cliffs of the Giza hill on both the north and the south sides, where they formed banks stretching out a hundred yards, occupying a space almost half the bulk of the Pyramid. The slopes formed an angle of rest of about 40°, showing the different qualities of refuse thrown away on different days, varying from large chips to mere sweepings.

In pits which had recently been made in part of the heap close to the edge of the cliff, Petrie noted layers of desert flint and sand showing when a piece of desert ground had been cleared to get more space for working. Among the rubbish he found pieces of workmen's water jars and food vessels, chips of wood and charcoal, and even a piece of ancient string.*

The only report on the daily cost of building the Pyramid is given by Herodotus, who says that an interpreter told him the daily sum spent on radishes, onions and garlic for the workmen was inscribed in Egyptian characters on the base of the Pyramid. But the report sounds apocryphal, as does the one passed on by Herodotus to the effect that Cheops became so broke during the operation that he prostituted his daughter by placing her in a chamber and charging each visitor the equivalent of a finished limestone block for her favors.

Kingsland figured that to position an estimated 2,300,000 blocks in a period of 20 years, or 7300 workdays, would have meant placing 315 stones each day, or 26 stones an hour working 12 hours a day.

Mencken, who has such disdain for the mathematical and astronomical knowledge of the ancient Egyptians, considers it remarkable that they were able to solve some of their problems of construction unless they had "more knowledge, better instruments, and far more ingenuity than is generally believed."

Kingsland wonders what means of illumination the Egyptians used while digging down to the subterranean pit and what method they used for getting air to the diggers. He finds it difficult to resist the conclusion that the Egyptians must have had tools and appliances of which we are totally ignorant, and must have employed methods which today would be termed occult.

Some of their solutions may have been no more arcane than Lockyer's suggestion that with one movable mirror and several fixed ones, sunlight could have been reflected to any part of the interior of the Pyramid.

Though legend attributes to the priests of Heliopolis the

* It would be helpful if more fragments could be excavated and carbon-tested.

knack of being able to cause tempests and levitate rocks that a thousand men could not move, most Egyptologists argue strenuously against the possibility of sophisticated instruments such as laser beams for cutting surfaces, or ground-effect or antigravity machines for raising weights, insisting that the job was accomplished with nothing but primitive appliances and unlimited manpower. Nevertheless the conscientiously academic Edwards fudges the issue by saying: "Cheops, who may have been a megalomaniac, could never, during a reign of about twenty-three years, have erected a building of the size and durability of the Great Pyramid if technical advances had not enabled his masons to handle stones of very considerable weight and dimensions."

Petrie is more specific and gives substance to the hypothesis of unknown methods, pointing out that in the pyramid of Kephren there is a granite portcullis weighing about 2 tons which is in such a position in a narrow passage that only 6 or 8 men could work on it at once. As it would take a force of 40 to 60 men to manipulate such as a mass, Petrie concludes that the Egyptians must have had some more efficient means which remains unknown to us.

Although the Danish engineer Tons Brunés has demonstrated how a block as large as the beams of the King's Chamber could be comfortably raised by a single man with the dexterous use of balancing and wedges, Petrie is convinced that ancient builders possessed some more efficient means of raising and setting stones than mere rollers, levers, ramps and manual hauling.

But perhaps the most puzzling riddle of the Pyramid, requiring an intellectual game of detection, is the one constituted by the three granite plugs wedged into the end of the Ascending Passage.

XIX. WHY WERE THE PYRAMID PASSAGES PLUGGED? WHEN? AND HOW?

Most Egyptologists conclude that the Pyramid was built as a tomb for some Pharaoh, presumably Cheops. Any mathematical, religious or prophetic theories about the structure they consider to be fanciful, or, at best, coincidental. To Egyptologists the corridors of the Great Pyramid were designed solely as a means of transporting the coffin of the dead Pharaoh to his sarcophagus in the burial chamber, as a means of exiting after the entombment, or as blinds to lead grave robbers away from a hidden chamber.

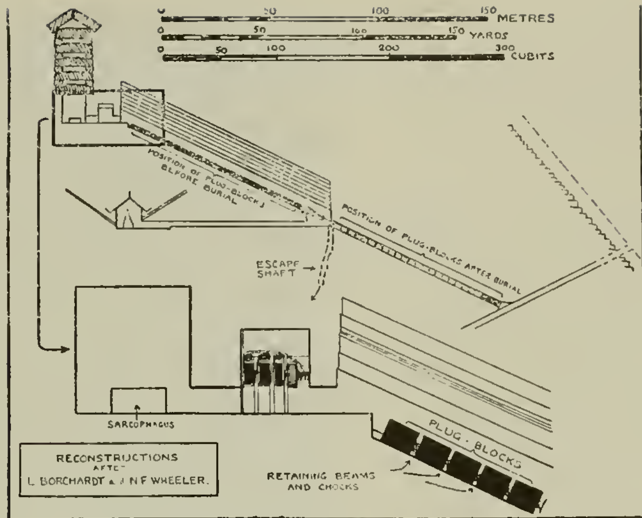
No other reason is offered for piling up so massive a mound of masonry than to protect the dead Pharaoh from the attention of grave robbers. Oddly, this is the single function which neither the Great Pyramid, nor any of the others, managed to fulfill, there being no reliable report of any body having been found in any of the pyramids, only some fragments of bones whose dates are uncertain.

Even the "unplundered" tomb of Cheops' mother, Hetepheres, found in 1925 by the Harvard-Boston Expedition at the bottom of an 85-foot-deep shaft filled with rubble, appeared untouched in 5000 years: yet the sarcophagus was empty and is presumed to have been so placed within the "burial" chamber.

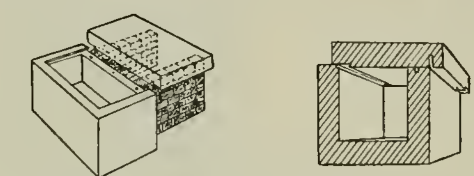
According to the Egyptologists, who include such eminent figures as Petrie and Borchardt, once the body of a Pharaoh had been laid to rest in the Great Pyramid and the burial party had made its exit, the three huge granite blocks, plus several limestone ones, were allowed to slide down the incline between the ramps of the Grand Gallery till they had completely plugged the Ascending Passage.

Whether the tripping mechanism could have been operated by remote control from a safe distance below the plugged entrance, or whether the technicians responsible for the tripping device were immured for life, or whether they managed to make their escape down what is known as the "well" are theories supported in different degrees by different Egyptologists.

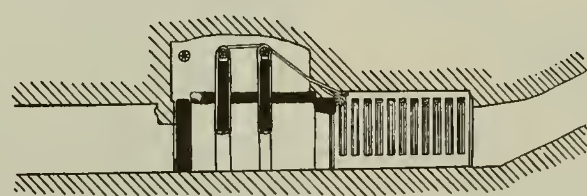
Method of plugging the Ascending Passage as visualized by Cottrell from the ideas of Borchardt and Wheeler.



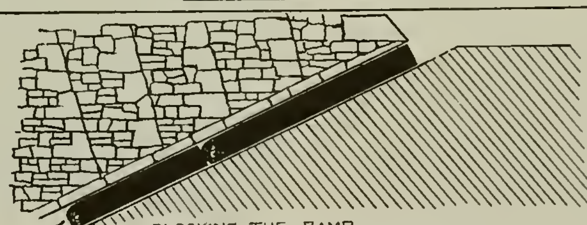
Ideas of various Egyptologists of the methods of plugging passages, lowering portcullises and sealing sarcophagi.



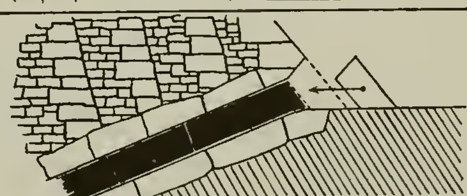
SLIDING THE LID ON THE SARCOPHAGUS.
(After U. Hölscher. Chephren, 1912, Abb. 51, page 63).



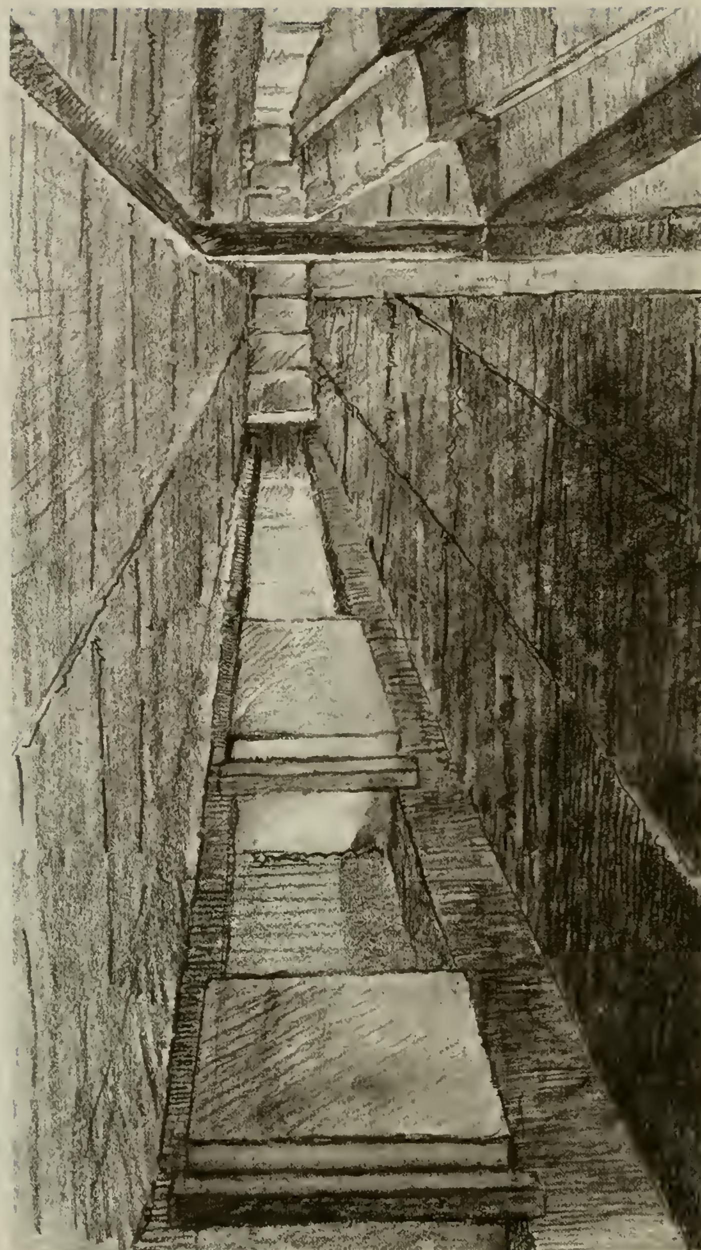
LOWERING THE PORTCULLIS SLABS.
(After L. Borchardt & H. Ricke. Beiträge zur Ägyptischen Bauforschung 1932. Tafel 12).



BLOCKING THE RAMP.
(Adapted from J. E. Gautier & G. Jéquier. Fouilles de Licht, 1902. Figs 2 & 3)



SEALING THE ENTRANCE.
(Adapted from L. Borchardt. Ne-user-re', 1907, Abb. 81, page 101).
L.V.G. 1945

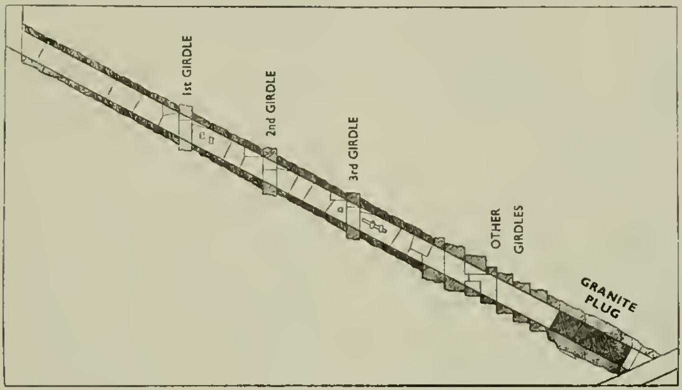


Modern illustration of the granite plugs in the Grand Gallery.

To account for the three granite plugs and the peculiar arrangement of the Pyramid's passages and chambers, Borchardt put forward the theory that the builders started with one plan, but kept changing it as they went along.

Borchardt believes the "original" intention was to bury the dead Pharaoh in the pit carved out of natural rock at the bottom of the Descending Passage, but that this plan was changed. For some unspecified reason, says Borchardt, it was decided to bury the king higher in the body of the Pyramid, which was already several courses high. The pit was therefore left unfinished. An Ascending Passage was carved up through the already laid courses of masonry, and continued as a new passage up to the level of the Queen's Chamber.

While making a careful study of the walls of the Ascending Passage, Borchardt observed that the stones at the lower end were laid approximately parallel with the ground, whereas nearly all those at the upper end were parallel to the gradient of the corridor. From this he deduced that the Pyramid must have already reached a level corresponding to halfway up the as yet nonexistent Ascending Passage before it was decided to use an upper chamber; at that point the Ascending Passage was dug up through the existing level courses; thereafter it was built with blocks parallel to its slope.



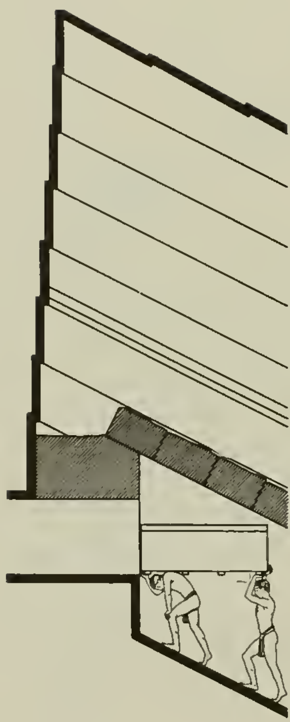
Arrangement of girdle stones 10 cubits apart, to tie the Ascending Passage to body of Pyramid, as drawn by Adam Rutherford, director of the Institute of Pyramidology in Great Britain.

Borchardt's theory is supported by Leonard Cottrell, author of a popular book on the pyramids, *Mountains of Pharaoh,* who suggests that when the builders switched plan they got as far as the Queen's Chamber complete with its air channels before they again changed their minds.

Cottrell says a third scheme brought with it the decision to heighten the Ascending Passage into "the magnificently corbeled Grand Gallery," extending it another 160 feet so as to build yet a third chamber, the King's, as the final resting place for the Pharaoh's body.

According to Cottrell, the change came about as a sort of afterthought, while the great mass of builders was already in the midst of constructing a building whose base and slopes appeared to have been worked out with such extraordinary precision.

Why the Grand Gallery should have been raised to 28 feet, when less than half that height would have been ample for the bearers and for the storage of the plugs, was not explained by Cottrell.



Borchardt's fanciful idea of pallbearers reaching the Great Step at the top of the Grand Gallery, with plug stones supported on a platform above them.

Borchardt and Cottrell's theory was disputed by Maragioglio and Rinaldi, who point out that the bottom of the Ascending Passage was *intentionally* cut through the lower courses simply as a means of anchoring it to the body of the Pyramid. The Italians say the lower part of the Passage was not dug out of normal masonry or with normal methods, but in masonry especially erected to anchor the end of the Passage, many of the blocks being exceptionally large, laid flat, vertical and edgewise, and of a different quality from the rest of the nucleus, with joints very thin and finely finished; whereas in other areas where the regular nucleus masonry is visible, the joints are wide and coarse.

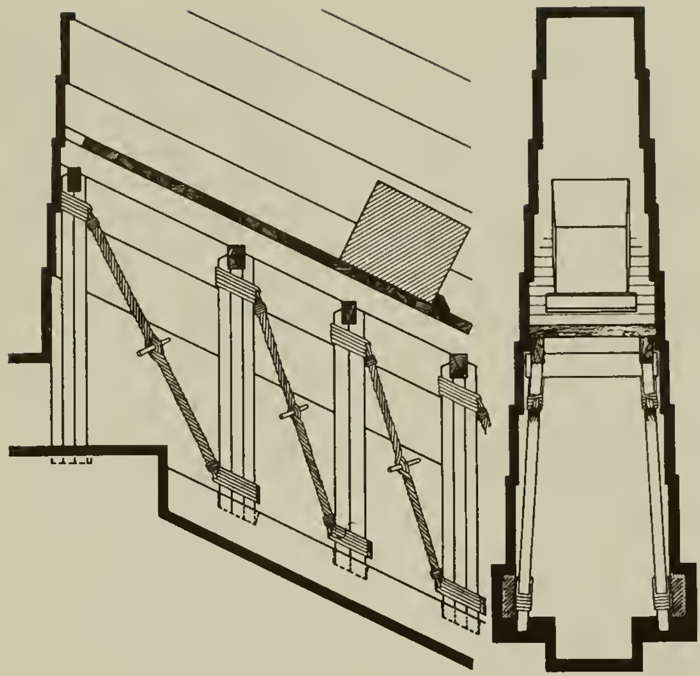
The object, say Maragioglio and Rinaldi, was to create a bulwark at the juncture of the Ascending and Descending Passages so that the ceiling and floor of the Ascending Passage would not thrust down on the empty space of the Descending Passage. The Italians point out that several monolithic girdle stones are employed at 10-cubit intervals all the way up the Ascending Passage to reinforce its bond with the nucleus of the Pyramid, and prevent its slipping, but that no such girdle stones appear in the Descending Passage, where they are not needed because the whole passage rests against the solid rock of the Giza hill.

Borchardt produced a further refinement to his theory, which not only found few supporters, even among his fellow Egyptologists, but tended to discredit his whole approach to the problem: namely, that the granite and limestone plugs which filled the Ascending Passage could not have been stored on the Grand Gallery floor between the ramps, because they would have provided an "undignified obstacle" for the funeral train to clamber over. As the plugs were too large to be brought in or out of either the Queen's Chamber or the King's, Borchardt theorized that the blocks were raised onto a wooden platform which was fitted into the grooves which appear halfway up the walls of the Gallery.

This would have allowed the funeral cortege to move beneath them; though how this would have been any less undignified than having to crawl up the low and narrow Ascending Passage is not explained, nor is it explained how the heavy blocks were brought down from the level of the wooden planking to the level of the pavement on which they were to slide.

That Borchardt's hypothesis is unreasonable, say Maragioglio and Rinaldi, is evident from the fact that few archeologists have paid much attention to it.

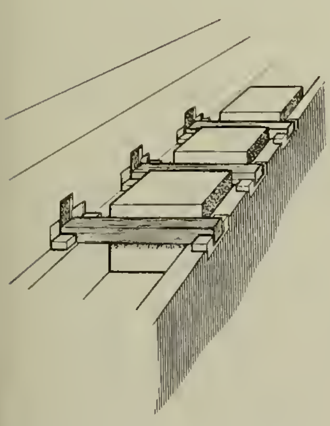
As for the method of triggering the plugs down the Ascending Passage, Cottrell believes the notches in the



Trestle believed by Borchardt to have raised plug stones to a level half the height of the Grand Gallery.

ramp of the Grand Gallery were cut to hold cross beams of wood or limestone to keep each of the massive plugs from prematurely sliding. According to Cottrell, once the funeral cortege had passed, operators standing on the ramps could have released each plug, starting with the bottom one, and allowed them to slide into the Ascending Passage, on the theory that had they all been released simultaneously the momentum and the total weight might have caused damage at the lower end.

The theory raises the question as to what became of the wooden or limestone crosspieces. Had they been made of wood they might conceivably have pulverized and completely disintegrated in the thousands of intervening years. They might also have been carried down the well by the escaping operators, though this would have been something of an ordeal, if indeed possible. The material might also have long since been disposed of by grave robbers. Still, the question is puzzling. Also, why go to all the trouble of plugging the Ascending Passage, only to leave the well shaft as a perfectly simple way for thieves to climb back up to the Grand Gallery? The lower end of the well shaft could have been cleverly concealed; but its whole length could hardly have been plugged or made impassable with fill *after* it had been used as a means of escape.



Goyon's idea of how granite and limestone plugs were held in place by crossbeams fitted into the ramps.

Part or all of the *Descending* Passage could have been plugged and the Pyramid sealed. This would have been the simplest way conclusively to close up *all* the chambers in the Pyramid, making it an almost superhuman job to chisel out 350 feet of solid limestone.

Petrie disputes the notion that the long Descending Passage could have been filled with blocks; and Maragioglio and Rinaldi suggest that traces of the dismantling of such plugs would have been left on the walls of the Descending Passage, which is not the case, with the exception of a few feet beyond the entrance.

The most sophisticated refutation of the theory holds that the Descending Passage may have been purposely left empty and the pit unfinished as a blind to lead any robber who entered by the trap door to believe that no king had been buried in the Pyramid!

As for the well shaft, Maragioglio and Rinaldi have a completely different theory about its function. They do not think it was ever designed as an escape route; they think it was built in from the early stages as a service shaft and to bring air to the lower end of the Descending Passage.

The Italians say the need which led to the building of such a shaft may have arisen shortly after the beginning of the Ascending Passage, most likely as a means of ventilating the lower shaft. They believe the diggers at the bottom of the Descending Passage had difficulty breathing. Plausible at first sight, the theory is open to two objections: as the building went up course by course, above the level of the rock base, there would have been all the air in the world; whereas digging the well shaft *below* rock level, the diggers would have been as cramped and airless digging the well shaft as digging the Descending Passage, at least until the two met at the bottom—by which time the well would no longer have served its ventilating purpose, the digging having been completed.

Such an air vent might conceivably have been useful to bring air to the pit, had the pit been used for any continuing purpose, such as observing the stars.

The Italians also believe that long before any funeral party entered the Grand Gallery, the entire well shaft was filled from the top with debris and loose material. The bottom entrance was then carefully camouflaged, and a stone was mortared into the upper end in the west ramp of the Grand Gallery to seal and hide the shaft from the top. They cite the fact that from classic times till the nineteenth century no one appears to have spotted the bottom entrance to the well shaft.

Maragioglio and Rinaldi agree with Petrie that the Pyramid was violated by thieves or grave robbers soon after it was finished, during the civil wars, which they date between 2270 and 2100 B.C. At this point the theory of the Italians becomes radical. They maintain it was these early despoilers of the Pyramid and not Al Mamun who cut a hole around the granite plugs at the end of the Ascending Passage. These thieves then worked their way up the Ascending Passage, broke through the lowered portcullis, and entered the "crypt." According to the Italians it was these or successive thieves who found the well shaft by noting a difference in the stones at the bottom of the ramp in the Grand Gallery, which they forced in order to clear out the well shaft in search of treasure. The Italians maintain that the marks in the west ramp around the missing stone appear to have been made with a chisel struck from above. They say it would also have been extremely difficult to remove the stone from below in the very restricted passage which leads to the head of the well shaft.

To explain the way the Ascending Passage was plugged, the Italians maintain the tripping mechanism could have been operated by remote control. They point out that it has recently been discovered that in the bent pyramid of Sneferu, the blocks of granite which plug the Descending Passage could *only* have been moved by gravity and not directly levered by workmen, because there *is* no escape route.

The Italians believe the plugs in the Great Pyramid were slid on liquid mortar and that its forced accumulation accounts for the 10 centimeters of empty space between the first and the second granite plug; though they offer no explanation as to what may have become of the mortar, which could hardly have volatilized in the meantime, unless it was some sort of oil and not mortar.

It is also hard to imagine how the antique grave robbers could have immediately found the exact spot halfway down the Descending Passage from which to dig up past the granite plugs if there is any truth in the story of the plug being covered by a prismatic block.

Maragioglio and Rinaldi suggest there was no such block; paradoxically they give credence to the story that Al Mamun's workers heard a heavy block fall—simply because Al Mamun's passage takes a sudden turn to the east in order to break into the Descending Passage.

Another theory which attempts to account for what could have taken place in the plugging of the Pyramid was produced in 1963 by August Mencken, the engineer from Baltimore who has so little regard for the scientific knowledge of the ancient Egyptians. According to Mencken's somewhat farfetched reconstruction of events, when the Great Pyramid had been built up above the ridge of the roof of the King's Chamber, and work was still going on in the Grand Gallery and in the Antechamber, the structure was suddenly shaken by a severe earthquake. It was then, says Mencken, that the ceiling beams of the King's Chamber were cracked, the fissures opened, and, "to the terror of the builders, the triggering device which held the plugs on the floor of the Grand Gallery was sprung and the blocks slid down the Ascending Passage, blocking all exit from the Pyramid."

According to Mencken, the men inside were trapped, but their plight was not desperate. "As soon as the fright and confusion caused by the earthquake had subsided, the men on the outside discovered what had happened to the men on the inside and opened communication with them through the air ducts leading out from the King's Chamber. By the same ducts the trapped men were supplied with food and water."

Mencken figures that to have chipped out the three granite plugs in the restricted space of the Ascending Passage was out of the question, and that to have tunneled around them would have caused irreparable damage to the passageways. Rather than chip out the granite blocks, the Egyptians, says Mencken, decided to dig the well up from the bottom of the Descending Passage all the way to the end of the Grand Gallery.

The trapped men, says Mencken, were informed of what was being done, "and by the time the tunnel reached the opening in the Gallery they had removed the ramp stone." According to this theory an inspection crew was sent to ascertain the damage and examine the King's Chamber ceiling; for this purpose the small tunnel, later known as Davison's, was dug straight through the lowest of the cushioning chambers.

The plugging of the Ascending Passage, says Mencken, put an abrupt stop to all other interior work and made it impossible for the King's Chamber to be used for a burial, either real or token. "So everything above the plug blocks was abandoned and thus ended the first and only attempt of the ancient Egyptians to build elevated chambers."

In criticism of Mencken's theory it may be asked why, if the building had been constructed to just beyond the peak of the King's Chamber, would it not have been easier to remove several blocks from the upper tiers in order to reach the trapped men rather than go through the trouble of boring hundreds of feet up the whole length of the well? Also, if the builders had no further use for the interior of the building, why go to the effort of finishing off the Pyramid and casing it with 22 acres of finely polished limestone?

An entirely different solution to the problem is provided by David Davidson, the structural engineer from Leeds. According to Davidson, the depth and width of the granite plugs which seal the lower end of the Ascending Passage clearly indicate that the plugs must have been built into the passage *at the time the Pyramid masonry had reached the height of the plugs, or 17 courses.*

Davidson, who spent several months in Egypt studying the Pyramid closely, says the half-inch clearance at the sides of the top of the Ascending Passage would *not* be sufficient to insure the granite plugs being slid from the Grand Gallery without jamming.

This raises the question as to why the builders would have bothered to even build the Ascending Passage if they intended to plug it up immediately with three large granite plugs.

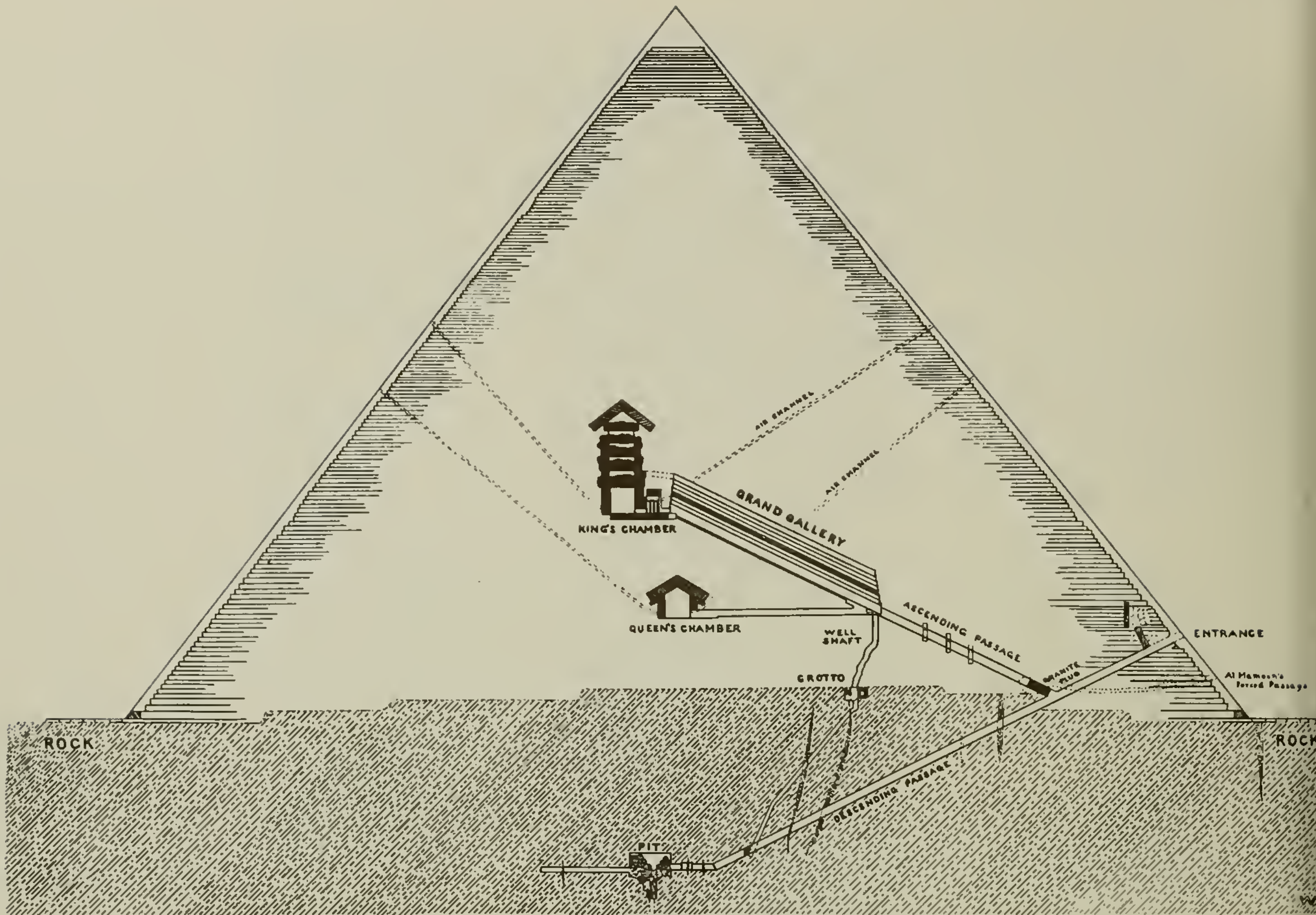
Davidson answers that the inside of the Pyramid was not designed for contemporary use, but was intended to be discovered by people of a much later civilization, rather like our modern time capsules, and that the discoverers would have to break their way in through the series of limestone plugs, much as Al Mamun is reputed to have done.

This raises the question of the presence of the well shaft, which could have led any intrepid explorer straight to the Grand Gallery, bypassing the Ascending Passage. Davidson answers that the well was an afterthought, not planned in the beginning as an escape route after a burial, if for no other reason than because the Pyramid was never intended as a tomb.

Davidson has an ingenious reconstruction of what may have occurred. He maintains that some time not long after the completion of the Pyramid, an earthquake or several disasters severely shook the building. After the disaster the priests or guardians of the Pyramid noted certain subsidence effects on the external surface of the structure, and they decided they must investigate the interior to see if the King's Chamber had collapsed or been badly damaged.

Davidson says this must have happened within a few generations of the completion of the construction, and before precise details and measurements of the internal construction had been lost.

The keepers, says Davidson, entered the Descending Passage and instead of trying to carve their way up through a score or more of limestone plugs in the Ascending Passage, as was later to be done by Al Mamun, they went nearly to the bottom of the Descending Passage and then began to bore a hole upward toward the beginning of the Grand Gallery.



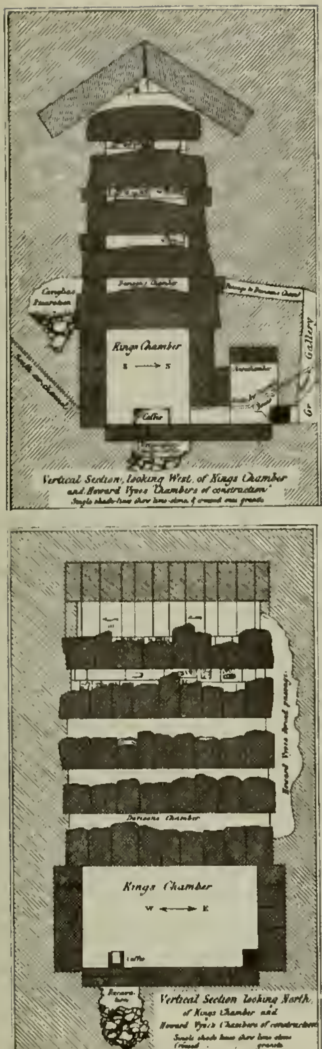
Davidson's rendition of the Great Pyramid passages, showing three large fissures in the natural rock.

Their reason for starting so far down, says Davidson, instead of taking a shorter route past the plugged Ascending Passage, was to cut their way through, and carefully observe, two large fissures that had appeared in the bedrock. A third fissure, present at the time of construction, had already been shored up by the builders.

The problem of the priests, says Davidson, was to determine if the fissuring was severe enough to cause further subsidence.

Digging in a gradual upward slope, says Davidson, the keepers worked their way through both fissures, finding them in not as bad condition as they had expected. At the level of the Grotto the keepers made a staging area for tools, for rest, and for the bypassing of workers and material.

From the Grotto they continued their shaft up toward the commencement of the Grand Gallery. Having somehow made an accurate survey of exactly where they were, they



Davidson's rendering of the way the chambers in the Pyramid are aligned just east of the main east-west axis.

then bored straight up and came out beneath the lowest ramp stone on the west side of the Gallery. To Davidson it is clear from the fractured appearance of the ramp around the well entrance that the stone was forced upward and outward.

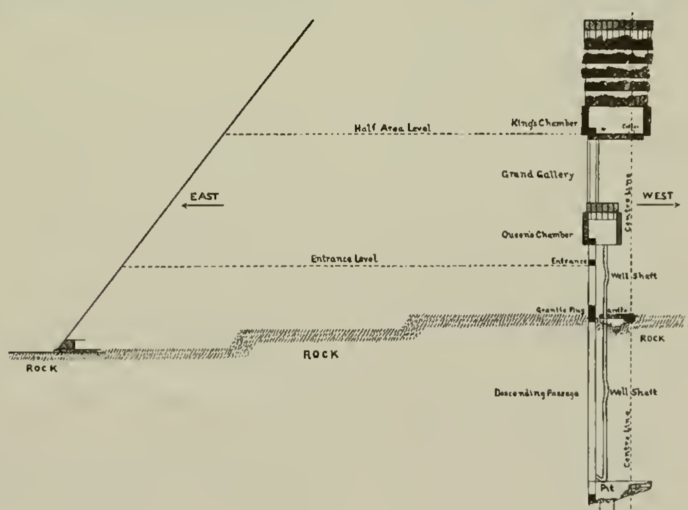
To accomplish such a feat of accurate digging would have meant knowing the precise internal arrangement and measurements of the Pyramid. Anyone boring blindly could have missed the few feet of Grand Gallery and been obliged to bore several hundred more feet through the limestone courses before coming out into daylight. This goes a long way toward discounting the possibility of the well shaft having been dug by either thieves or explorers.

Once they had reached the Grand Gallery, says Davidson, the keepers dismantled the lower section of the Gallery floor for a dozen or so feet and uncovered the passage to the Queen's Chamber. This they inspected carefully, but found little or no sign of failure.

Proceeding to the King's Chamber, the keepers found indications of possible instability due to the movement. Inside the chamber they found the ceiling beams uniformly cracked along the south ends.

According to Davidson, it was then that the keepers smeared the fractures and open joints with cement and plaster. Petrie was later to report that he had found cement daubed on with fingers for about 5 feet on each side of the joints.

When Petrie carefully examined the King's Chamber he discovered that it had been badly shaken, probably by an earthquake, which caused the whole room to expand



Cracks in granite beams at the south end of the King's Chamber.

an inch or so. Every single beam had been wrenched more or less loose from the south end, and cracked through; the whole ceiling, weighing some 4000 tons, was held up solely by "sticking and thrusting." As Petrie summed up the situation, the downfall of the King's Chamber "is a mere question of time and earthquakes." What has saved it so far was not being bonded to the main structure.

Davidson says the five construction chambers were especially designed to take a considerable impact. Instead of resting the uppermost beams on a hard granite wall, the builders rested them on limestone, which could more easily crush and flow in case of subsidence, taking the strain off the lower rows of rafters and keeping the walls of the King's Chamber intact. Davidson says that a more rigid design, uniform from the lowest to the highest chamber, would have been disastrous.

To permit this buffer effect being fully developed, the rafters of the chambers were not tied into the east and west walls. Instead, two immense limestone walls, wholly outside of, and independent of all the granite floors and supporting blocks, were built on the east and west sides. As Petrie put it: "Between these great walls all the chambers stand, unbonded and capable of yielding freely to settlement."

To gain access to these important construction chambers above the King's Chamber, the keepers, says Davidson, next drove an opening into the east wall of the Gallery, starting at its upper, or south, end.

In support of the theory that this hole was bored by keepers who were precisely acquainted with the layout of the Pyramid (rather than by later explorers or thieves), Davidson points out that the hole is bored in exactly the right place, and takes off at the precise angle and direction to reach the lowest of the upper chambers.

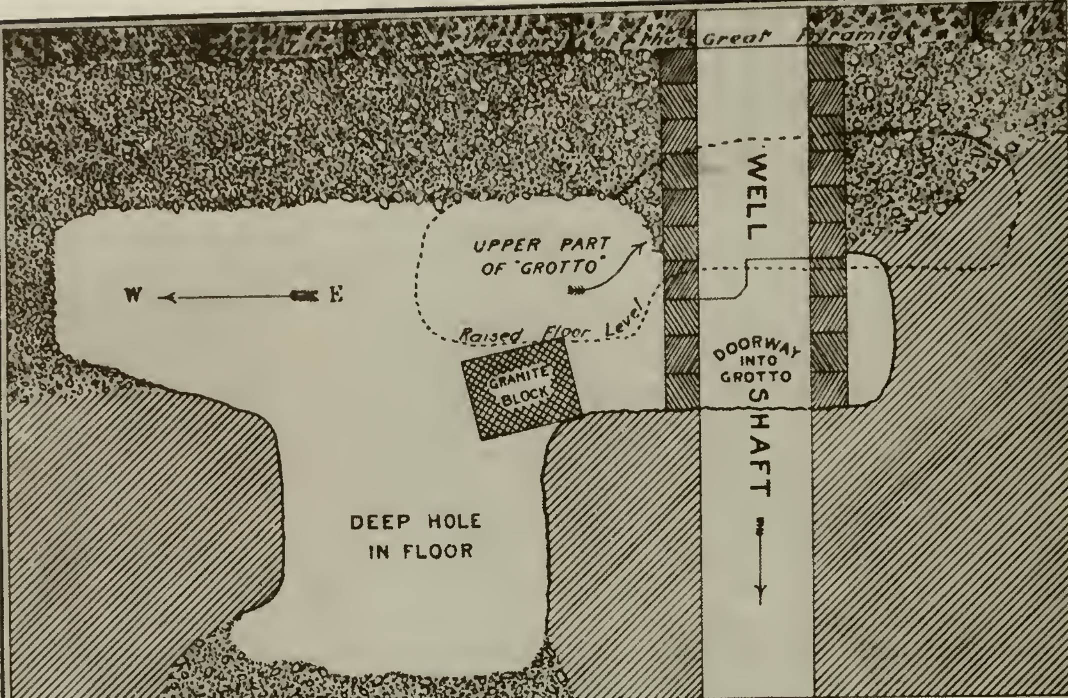
Once inside the first chambe; (later to become known as Davidson's), the Pyramid keepers, says Davidson, found that the indications of instability were not so serious as they had feared. The great granite beams were indeed cracked, but the damage did not seem to be enough to cause any further crumbling or subsidence, nor warrant their boring any higher into the overlaying chambers. Instead, the keepers again daubed the cracks with plaster so as to be able to return at a later date and observe if any further movement had taken place.

According to Davidson, the keepers then climbed back down the well, the bottom end of which they camouflaged, and left by the swivel-stone entrance on the north face.

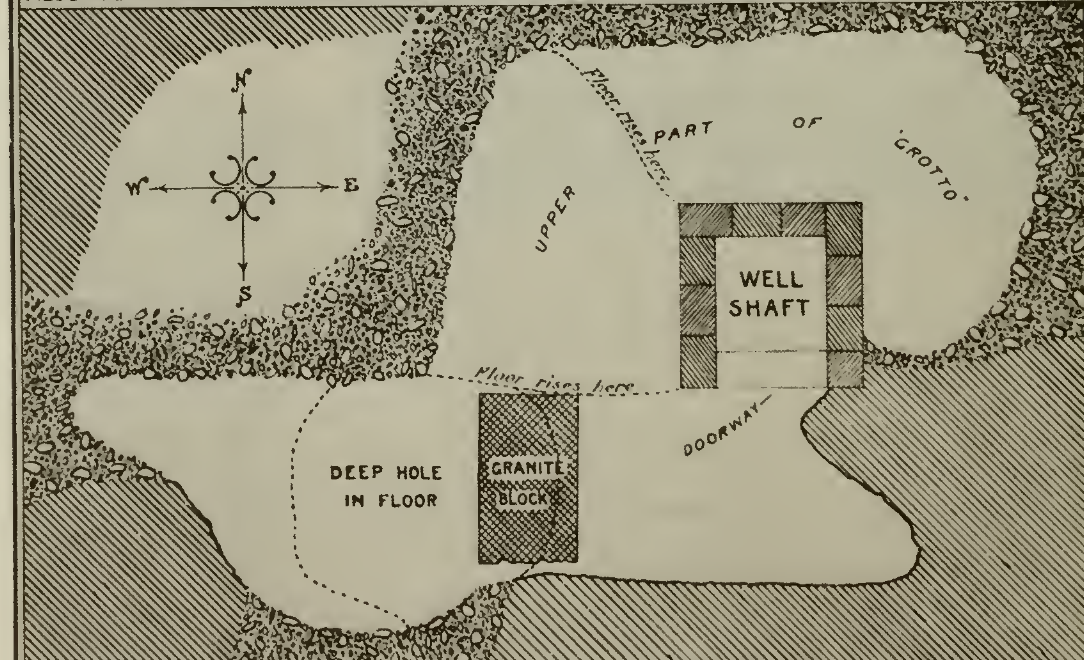
There is nothing inherently illogical about this version of events. It would have been no easy job to tunnel upward through the solid rock and the various courses of masonry—altogether hundreds of tons of material would have had to be chipped away and taken out of the Pyramid up the Descending Passage—but it would not have been impossible.

It would also have been a problem to get light and air to the men doing the chiseling, and it would have been tricky to raise a platform or system of suspension while chiseling upward; also it would have been a nuisance to have the fragments fall constantly in the face of the chiselers and those below them; but all of this would not have been impossible.

What militates against this theory is the observation of Maragioglio and Rinaldi that the walls of the well shaft upward from the Grotto are built and lined with regular blocks of limestone, apparently as a feature of the original structure.



VERTICAL SECTION *(From East to West, looking North)* OF THE "GROTTO"
SHOWING THE WELL-SHAFT BUILT THROUGH WITH TEN COURSES OF LIMESTONE BLOCKS;
ALSO THE MYSTERIOUS DRILL-HOLED GRANITE BLOCK WEDGED AT THE EDGE OF THE DEEP HOLE IN THE FLOOR.



GROUND PLAN OF THE "GROTTO" IN THE **GREAT PYRAMID OF GIZEH**
SHOWING THE POSITION OF THE WELL SHAFT, THE GRANITE BLOCK, AND THE DEEP HOLE IN THE FLOOR.
SINGLE SHADED LINES INDICATE NATURAL ROCK.

Grotto showing walls of the well shaft built out of masonry from the level of the Grotto to the first course of masonry of the Pyramid.

Conceivably these walls could have been lined by the keepers, operating from the Grotto, perhaps to insure a stable surface in this final section of the shaft.

Clear indications that it was *not* designed from the beginning were found by Petrie in the fact that the shaft is irregular and tortuous through the rest of the masonry, and that blocks with sharp corners were left in an irregularly curved shaft.

A French professor of architecture, J. Bruchet, who went to the spot to verify and measure, and who published an illustrated book on the subject in Aix-en-Provence in 1966, agrees with Davidson that the granite plugs could not have been slid down the Ascending Passage; he believes they were put in place at the moment of construction, when the Pyramid was still a truncated body. To have slid them down, with so little clearance, says Bruchet, would have required walls as smooth as glass, whereas he found the walls of the corridor roughly finished.

But Bruchet disagrees with Davidson that the well shaft could have been dug from the bottom up, giving as his reason the fact that the bottom of the well shaft goes slightly below the level of the Descending Passage. Bruchet believes that this would not be so if the shaft had been started from below.

For the well shaft to have been dug from above, the operation could only have been completed *before* the Ascending Passage was plugged, or *after* the opening of "Al

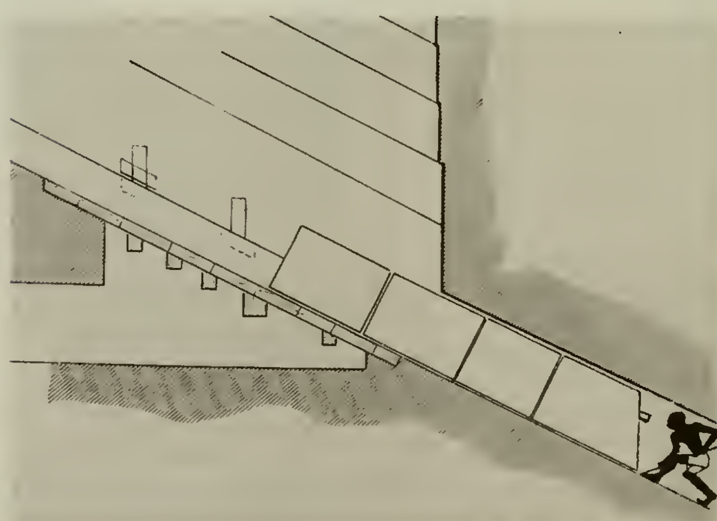
Mamun's hole." In a closed upper Pyramid there would have been no place to store the carloads of rubble from the digging of the well shaft: the King's and Queen's chambers would not have been sufficient, and storage in the sloping Grand Gallery would have required crosspieces and sacks.

Bruchet points out that the well shaft could not have been dug *after* Al Mamun, because the lower end of the Descending Passage was filled by him with the refuse of broken limestone plugs, which were not cleared out till 1817 by Caviglia. Also, says Bruchet, there are no graffiti to indicate the presence of visitors in the lower passage after the date of the Hegira.

Another Frenchman, Georges Goyon, who collected reproductions of all the graffiti on the Pyramid, which he put into a book dedicated to King Farouk, also does not accept the idea that the service shaft was used as an escape way. He too believes the Pyramid was violated a short time after it was built, and that "Al Mamun's hole" was made at this early period. He even goes so far as to suggest that the first violators entered by the tunnel now attributed to Al Mamun, and that Al Mamun's violation was made *after* the ablation of the Pyramid casing, which is in strict contradiction with the historical record.

Maragioglio and Rinaldi find some of Goyon's theories tenable, but are awaiting the publication of a booklet by Goyon in which he promises to add further material on the subject.

In a recent article in *Revue Archéologique,* entirely devoted to the mechanism of the closing of the Great Pyramid, Goyon suggests that one or two men alone could have manipulated the whole train of blocks down the Ascending



Goyon's view of how a single man could have eased a train of granite plugs down the Ascending Passage with the help of unguents and wooden wedges.

Passage by simply sliding them on clay mixed with cows' milk for greater viscosity, controlling the downward motion by means of wooden wedges on either side of the first block.

Goyon says there are indications on the lowest granite block of two slots 7 centimeters wide intended for wedges.

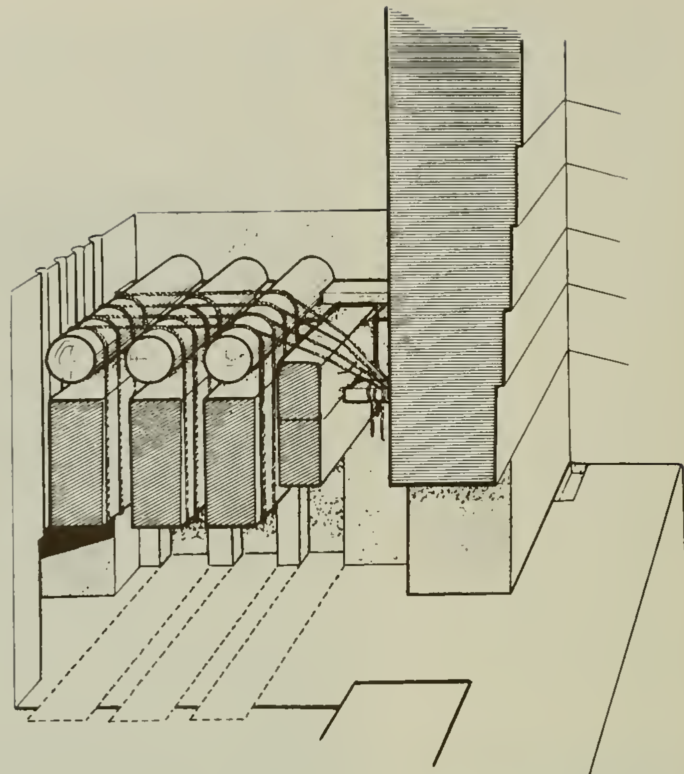
Goyon's arrows indicate slots in the granite plug for the insertion of wedges to control its downward movement.

Goyon disputes the point made much of by Davidson that the purely stylized portcullis outside the King's Chamber indicates it was never used to seal an actual tomb.

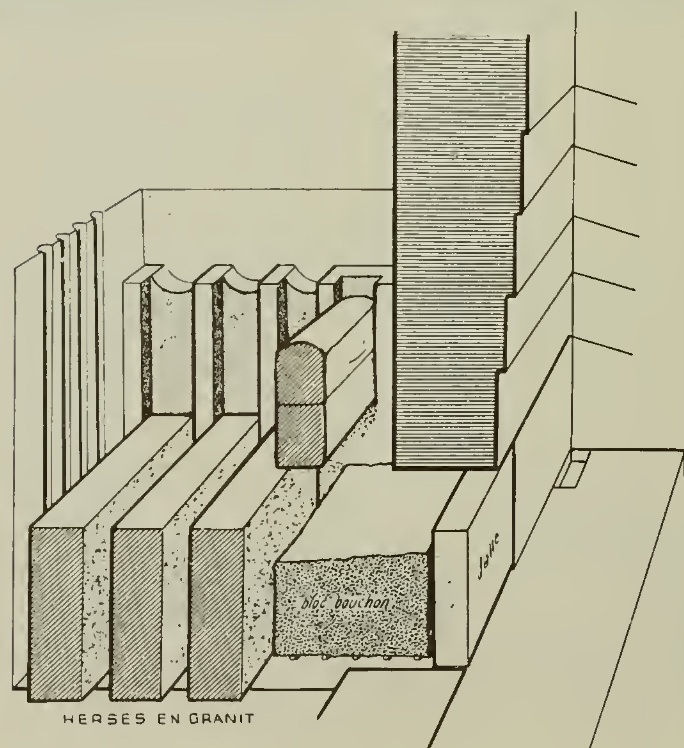
Goyon believes that the granite slabs—long since removed by grave robbers—could have been lowered in the appropriate side slots by ropes run on wooden rollers, and that the four vertical slots carved in the face of the portcullis were intended to allow free play for the ropes.

In the final analysis, the theory which stands up best, and is not in conflict with Davidson's findings, is that of the astronomers Proctor and Antoniadi, which is supported by Kingsland and John and Morton Edgar, that the truncated Pyramid served as a stellar observatory by means of which the ancient Egyptian priests were able to make accurate maps and tables of the visible stars from which to create their entire science of astronomy, geography and geodesy. Once they had obtained what they needed for their astronomical and astrological predictions (and for the secrets of surveying and map making), they may have decided to wall up their instrument so that no one else could know how their lore was obtained.

Borchardt's idea of how ropes around wooden rollers could have been used to lower the granite slabs of the portcullis.



Goyon's rendition of granite blocks plugging passage to the King's Chamber.



It would then have made sense to place the granite and limestone plugs in the Ascending Passage while the top of the Grand Gallery was still open to the level of the King's Chamber. To satisfy this theory, the well shaft could have been carved upward, as suggested by Davidson, or it could have been built in earlier to serve the builders for a variety of reasons, including to serve as a means of coming and going to the pit while the Descending Passage was blocked by a reflecting pool. In any case, the shaft could have been comfortably filled from the top before the builders finished off the building to its apex to serve as a sundial and almanac.

Donald Kingsbury, a professor of mathematics at McGill University, suggests that the well could have been used for observing the passage of stars at the zenith above the Pyramid. There are two vertical sections of the well which could have served this purpose admirably and at different moments in the construction. There is a short vertical passage dug into the plateau which is served by the Grotto and linked to the Descending Passage so that signals could have been freely passed between polar and zenith observers. Another vertical section leads from the bottom of the Grand Gallery and could have been used for zenith observation in conjunction with the Ascending Passage looking south and reflecting north. Kingsbury points out that with two such wells a short distance apart the circumference of the earth could have been computed by observing the passage of a zenith star.

Duncan Macnaughton in *A Scheme of Egyptian Chronology* subscribes to the slightly different theory that ancient scientists used the truncated Pyramid as an observatory, but that a later generation finished it off as a tomb for some Pharaoh.

The custom of burying distinguished citizens in national monuments that were not originally designed for that purpose is common to the world, as in Westminster Abbey, the Invalides, the Pantheon, and Maes-Howe.

Then there is the idea that the sarcophagus was never an actual tomb, but "an open tomb" symbolic of the resurrection, and of a reawakening of the dormant spirit of the great initiates.

XX. TEMPLE OF SECRET INITIATION

Several authors have expressed the opinion that there is a close connection between the Great Pyramid and what are known as the Egyptian mysteries, that is to say, the secret knowledge possessed by a hierarchy of initiates which was communicated to those who could prove their worthiness by passing a long period of probationary training and severe trials, the sort of system that was perpetuated or debased by such societies as the Templars, the Rosicrucians, and the Masons.

In due course the initiates are said to have been shown the great laws and principles of the cosmos and of man's relation thereto, which could not be explained to the more or less ignorant, "who could not rise above the level of a crude realism which takes things to be what they *seem.*"

The Egyptian temple order is described by modern Free Masons as a gradual process of initiation and admission, in which the Great Pyramid was probably used for the initiation of the highest degree, or the three highest degrees in the order.

Throughout the graduated admission, which is said by Masonic writers to have lasted twenty-two years, the prospective initiate was taught the various sciences, of which geometry and numbers were among the most important. "In this context," says Tons Brunés, author of *The Secrets of Ancient Geometry,* "it is not surprising that they should have worked this knowledge into the structure of the initiation temple."

Knowledge of the astronomical cycles and their application also formed part of the ancient initiatory teaching. In those days, says William Kingsland, astronomy was not the mere science of the mechanism of the heavens, but was intimately connected with astrology, "a profoundly esoteric science connected with the great cycles of man's evolution, understood only by the Adepts."

Kingsland adds that if the Great Pyramid was built by initiates for initiates, "What could be more likely than that some of the deeper forces of nature were used in its construction, and that these would—did we but know of them—solve the problems of construction which still remain an enigma to us."

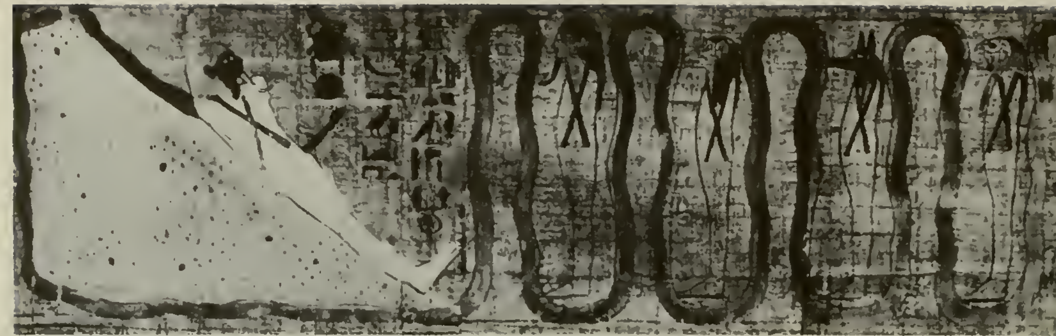
The theosophist H. P. Blavatsky in *The Secret Doctrine* says the Pyramid not only indicated the courses of the

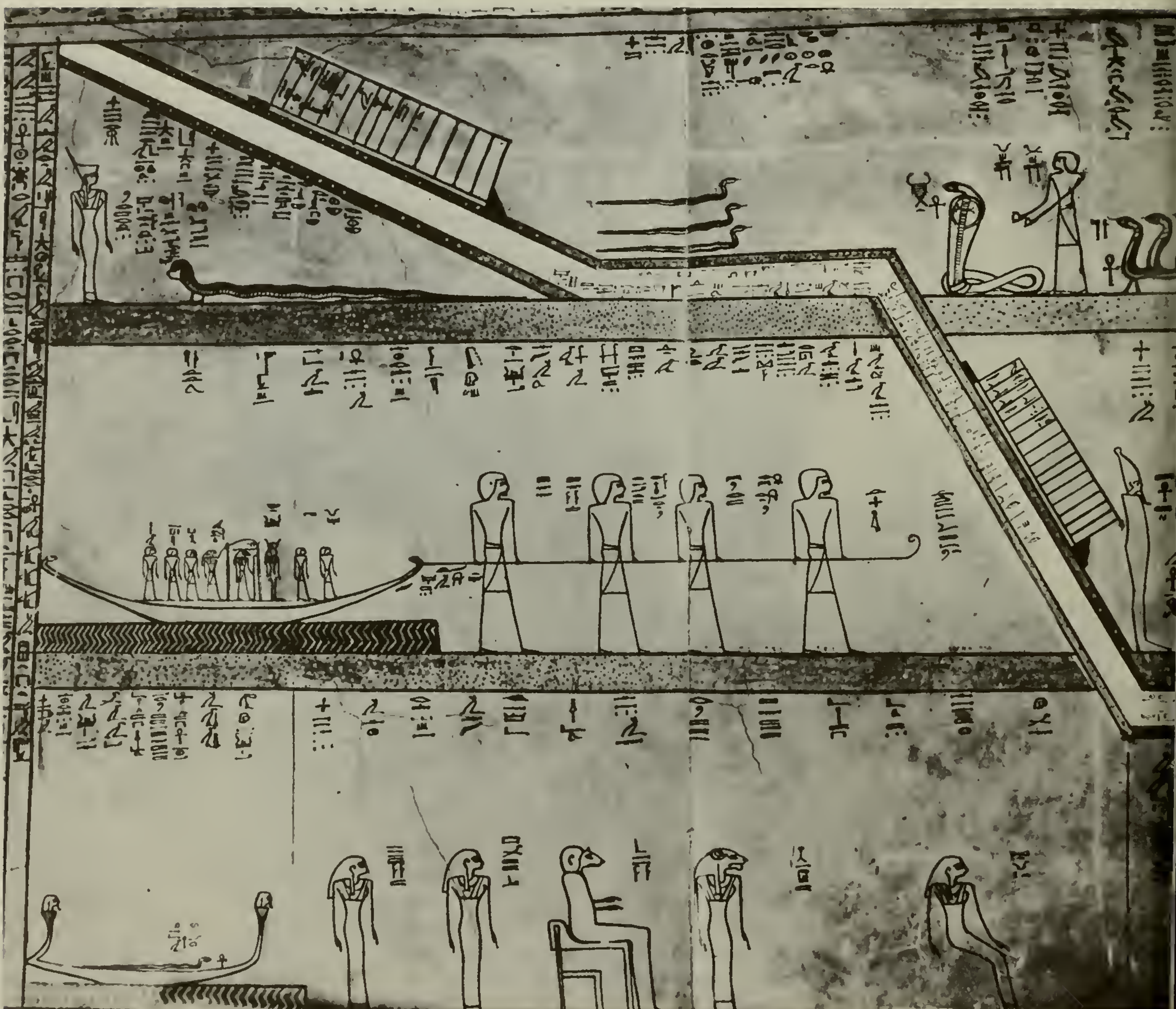
According to Manly P. Hall, the illumined of antiquity passed through the mystic passageways and chambers of the Great Pyramid, entering its portal as men and coming forth as gods.

"The candidate," says Hall, "was laid in the great stone coffin, and for three days his spirit—freed from its mortal coil—wandered at the gateways of eternity. His *Ka*, as a bird, flew through the spiritual spheres of space. He discovered that all the universe was life, all the universe was progress, all the universe was eternal growth. Realizing that his body was a house which he could slip out of and return to without death, he achieved actual immortality. At the end of three days he returned to himself again, and having thus personally and actually experienced the great mystery, he was indeed an Initiate—one who beheld and one to whom religion had fulfilled her duty bringing him to the light of God."

stars in heaven but was "the everlasting record and the indestructible symbol of the Mysteries and Initiations on Earth." In *Isis Unveiled* Madame Blavatsky elaborated, saying that whereas externally the Pyramid "symbolized the creative principle of Nature, and illustrated also the principles of geometry, mathematics, astronomy and astrology," within the building itself was the site of the mysteries of initiation—"a temple of initiation where men rose towards the Gods and the Gods descended towards men." To Blavatsky the coffer was "a baptismal font upon emerging from which the neophyte was born again and became an adept."

Brunés says that during the ceremony of initiation, the candidate was placed by the temple leader in a deathlike trance symbolizing death itself. On awakening from this condition, "having wandered in the world of the gods," he was regarded as having been reborn.





Blavatsky describes the ancient rite: "The initiated adept, who had successfully passed through all the trials, was attached, not nailed, but simply tied on a couch in the form of Tau . . . and plunged into a deep sleep (the 'Sleep of Siloam'). He was allowed to remain in this state for three days and three nights, during which time his Spiritual Ego was said to confabulate with the 'gods,' descend into Hades, Amenti, or Patala (according to the country) and do works of charity to the invisible beings, whether souls of men or Elemental Spirits; his body remaining all the time in a temple crypt or subterranean cave. In Egypt it was placed in the Sarcophagus in the King's Chamber of the Pyramid of Cheops, and carried during the night of the approaching third day to the entrance of a gallery where at a certain hour the beams of the rising Sun struck full on the face of the entranced candidate, who awoke to be initiated by Osiris, the Thoth and God of Wisdom."

For such a rite to have been possible, either the Pyramid must still have been truncated, or it contains secret passages at present undiscovered.

Most of the ancient philosophers and great religious teachers, including Moses and St. Paul, acknowledged or are acknowledged to have derived their wisdom from the Egyptian initiates. Individuals who admitted or hinted they were initiates include Sophocles, Solon, Plato, Cicero, Heraclitus, Pindar and Pythagoras.

Some of the ceremonies of what are sometimes referred to as the lesser mysteries have survived in a more or less degraded and merely formal manner in the ritual of Masonry and of the Christian churches. Kingsland believes the secret of the Pyramid is even known to present-day initiates, but is probably "one of those matters which they do not see fit to disclose to the world at large."

According to Norman Frederick de Clifford, author of *Egypt, the Cradle of Ancient Masonry,* ancient Masonry had its origin long centuries before the dawn of authentic history; he claims the ancient brotherhood "possessed a far greater knowledge of mechanical arts and sciences than is known to architects of the present day."

Several authors, including W. Marshal Adams, believe the Pyramid represented in monumental form the doctrine which *The Book of the Dead* sets forth in script, containing in an allegorical and symbolic manner the secret wisdom of the initiates, or the laws which govern and direct the universe, enabling the initiate to know "how he came into being in the beginning."

The Book of the Dead is the title generally given to a collection of Egyptian inscriptions and papyri found in tombs

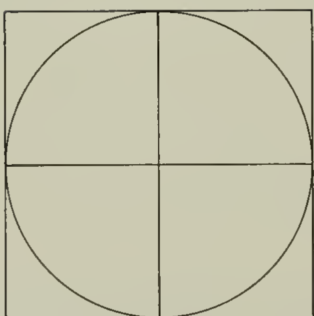
These illustrations from Albert Champdor's *The Book of the Dead* show a mummy with phallus erect sliding into the Seventh Region of the Lower World, described as being "filled with serpent's coils and the four sons of Horus who protect the viscera of the dead." This Twenty-first Dynasty drawing has lost the precise φ proportions of the earlier renditions of the same subject shown in earlier illustrations.

or in mummy wrappings. Sir E. A. Wallis Budge translated it as *The Book of the Mistress of the Hidden Temple*. One late text found with a mummy was on a papyrus roll 20 meters long divided into 165 chapters: It is now in the Turin Museum.

The ancient Egyptians attributed *The Book of the Dead* to Thoth, Lord of Wisdom, and recorder of the deeds of men, which were produced when the soul came to judgment.

Egyptologists in general label it a collection of funerary and ritual texts of different periods in different forms, used by ancient Egyptian priests in their burial ceremonies. But Henri Furville in his *La Science Secrète* claims that the texts of *The Book of the Dead* are incomprehensible to those who never made a careful study of them from the point of view of psychic science. The obscure texts, says Furville, "shine in the light of initiation, and the practices which seem extraordinary and even absurd to the profane, are, on the contrary, the result of the most profound science."

The problem of translating hermetic language from hieroglyphs is highlighted by Giorgio de Santillana when he points out that in the Erman-Grapow Egyptian dictionaries there are thirty-seven terms for "heaven." As a result, says Santillana, the elaborate instructions in *The Book of the Dead* referring to the soul's celestial voyage translate into "mystical" talk, and must be treated as holy mumbo-jumbo. Modern translators, says Santillana, believe so firmly in their own invention, according to which the underworld has to be looked for in the interior of our globe—instead of in the sky—that even 370 specific astronomical terms would not cause them to stumble. He gives as an example the goddess Hathor being described as "lady of every joy," when the literal translation is "the lady of every heart circuit." The determinative sign for "heart," explains Santillana, often figures as the plumb line coming from the astronomical or surveying device, the *merkhet*. "Evidently," says Santillana, "the heart is something very specific, as it were, the center of gravity."



J. Ralston Skinner in *The Source of Measure* was convinced that the Pyramid was not a tomb, but a temple of initiation. He went further and linked the Pyramid to the Jewish cabala, a system of allegorical symbolism among the initiated which sets forth the secret teachings of the Bible, concealing the great cosmic principles of man's origin.

According to Skinner the key to the cabala was said to be the geometrical relation of the area of the circle inscribed in the square, or the sphere in the cube. This gave rise to the relation of the diameter to the circumference of a circle, with the numerical value of the relation expressed in integrals, such as 22/7.

The relation of diameter to circumference, says Skinner, was considered a supreme one, connected with the god names Elohim and Jehovah, the first being the circumference, the second the diameter, which were numerical expressions of these relations.

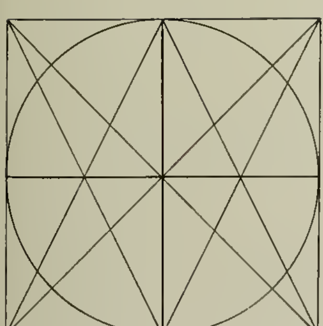
Tons Brunés, who dedicated his *The Secrets of Ancient Geometry* to the Fraternity of Free Masons, shows that the Great Pyramid, like most of the great temples of antiquity, was designed on the basis of an advanced but hermetic geometry known only to initiates, only fragments of which percolated to the classic and Alexandrine Greeks. According to Brunés, the secret of this ancient geometry was so well guarded that the whole of it was not revealed until the publication of his book in 1969.

Brunés shows how the ancient Egyptians used the basic design of a circle inscribed in a square to divide both circle and square geometrically into equal parts from 2 to 10, and all their possible multiples, without recourse to measuring or arithmetical calculations, with the aid of nothing but a straightedge and a compass—common emblems, along with the Pyramid, of the Masonic orders of yesterday and today.

In Brunés' reconstruction of the secret geometry, the cross emerges as the first geometric addition to the circle and square, and is the key not only to the solution of geometric problems but to the development of numerals and the alphabet.

By including the diagonals, every number both Latin and Arabic and all the letters of several alphabets may be obtained.

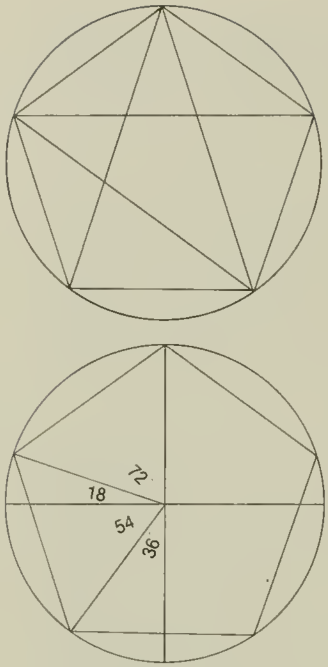
According to Brunés, both mathematics and the alphabet sprang from geometry, not the reverse. He says that nowadays we use numbers as the primary factor in our calculations, and geometry only as a subsidiary, whereas he believes the Egyptians reversed the order. He uses a detailed analysis of the Rhind Mathematical Papyrus to demonstrate that the ancient Egyptian system of counting was directly governed by geometric factors and that their ideas and theories were bound in geometric rules.



Brunés found that the circle was indeed considered sacred by the Egyptians, as were the square and the cross and the triangle, all of which are intimately incorporated into the Great Pyramid with its square base and triangular faces designed to represent the "sacred" circle.

Brunés demonstrates how the circle inscribed in a square and quartered by a cross enabled the ancient Egyptian geometer to inscribe in a circle the basic figures of pentagon, hexagon, octagon and decagon.

Of these the pentagon with its five-pointed star is perhaps



$\text{Sin } 18 = \tfrac{1}{2}\varphi$
$\text{Sec } 36 = 2/\varphi$
$\text{Sin } 54 = \varphi/2$
$\text{Sec } 72 = 2\varphi$

The circle in a square with a cross and diagonals, plus a pentagon or decagon, enabled ancient mathematicians to measure lengths of $\sqrt{2}$, $\sqrt{3}$, $\sqrt{5}$, as well as multiples and fractions thereof without arithmetical computation.

the most important: it automatically produces the Golden Section and the φ proportion in the simplest geometric manner.

Each line of the five-pointed star—the symbolic sign of recognition of the initiated Pythagorean, whose hermetic meaning it meant death to reveal—cuts the other in the proportion of major to minor: the Golden Section.

Furthermore, the side of a pentagon inscribed in a circle whose circumference is equal to the perimeter of the Pyramid will be equal to the apothem, or slant height, of the Pyramid, which will be the value of φ.

A pentagon divides a circle in 72° segments. With the main cross, the pentagon radii form angles of 18°, 36°, 54° and 72°.

Though Greece has been looked upon as the birthplace of mathematics—largely because of surviving written material on the subject of mathematics and geometry—Brunés points out that Pythagoras, the founder of Greek mathematics, spent 22 years in Egypt as a priest of the temple, and only returned to Greece after Cyrus the Great, king of Persia, burnt the temples at Memphis and Thebes in 527 B.C. and dragged him off as a prisoner to Babylon.

Back in Greece, Pythagoras taught mathematics on the basis of what he had learnt in Egypt; but after his death his followers were persecuted and had to take refuge abroad. Some eighty years later, Plato left Athens after the execution of Socrates and joined the Pythagorean societies. He traveled to Egypt, where he too was initiated into the lower degrees of learning in the temple, which were slowly recovering from being disbanded by the Babylonian-Persian conquerors.

Plato collected documents and writings connected with Pythagoras. In the end he produced the concept that the cosmos was represented by the five regular solids that can be inscribed in a sphere.

Brunés maintains that Plato incorporated into the body of his writings, and especially in the *Timaeus,* the secret teachings of the Egyptians, which he had sworn not to divulge directly, but which he handled in a hermetic language for which Brunés provides a solution.

Brunés says that Moses, who was also an Egyptian priest, had knowledge of the ancient geometry, which he passed hermetically in his instructions for building the Tabernacle, data which eventually reached Jerusalem and were incorporated into holy teaching.

The French archeologist and mathematician Charles Funk-Hellet, in his *La Bible et la Grande Pyramide d'Egypte,* agrees that the cubit of the Bible can only be the Egyptian royal cubit, which he makes a hair, or 1/2 millimeter, shorter than Stecchini's. According to Funk-Hellet the cubit was incorporated into the Temple at Jerusalem as $\pi/6$, or 523.6 millimeters, instead of Stecchini's 524.1.

Funk-Hellet points out that Solomon had Hiram Abiff build a temple whose columns were 18 cubits high and 12 cubits around. In other words, one cubit equaled the twelfth part of the circumference of the arc of 30°, or $\pi/6$.

By subtracting the circumference from the height, they obtained 6 cubits in a straight line, which was equal to half the circumference, or the exact value of π; so that a thousand years before Christ the Hebrews knew that a cubit was a mathematical entity dependent on the circumference, and were able to resolve π to four points of decimal.

Using *one unit* of measure as the radius of a circle, the ancients found the trigonometric value of 30° to be $\pi/6$, which was the value of the royal cubit, or .5236 of the unit used.

$$\frac{3.1416}{6} = .5236$$

SERIES P

I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII	XVIII
1	5	6	11	17	28	45	73	118	191	309	500	809	1309	2118	3427	5545	8972
2	10	12	22	34	56	90	146	236	382	618	1000	1618	2618	4236	6854	11090	17944
3	15	18	33	51	84	135	219	354	573	927	1500	2427	3927	6354	10281	16635	26916
4	20	24	44	68	112	180	292	472	764	1236	2000	3236	5236	8472	13708	22180	35888
5	25	30	55	85	140	225	365	590	955	1545	2500	4045	6545	10590	17135	27725	44860
6	30	36	66	102	168	270	438	708	1146	1854	3000	4854	7854	12708	20562	33270	53832
7	35	42	77	119	196	315	511	826	1337	2163	3500	5663	9163	14826	23989	38815	62804
8	40	48	88	136	224	360	584	944	1528	2472	4000	6472	10472	16944	27416	44360	71776
9	45	54	99	153	252	405	657	1062	1719	2781	4500	7281	11781	19062	30843	49905	80748
10	50	60	110	170	280	450	730	1180	1910	3090	5000	8090	13090	21180	34270	55450	89720
11	55	66	121	187	308	495	803	1298	2101	3399	5500	8899	14399	23298	37697	60995	98692
12	60	72	132	204	336	540	876	1416	2292	3708	6000	9708	15708	25416	41124	66540	107664
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
24	120	144	264	408	672	1080	1752	2832	4584	7416	12000	19416	31416	50832	82248	133080	215328

Funk-Hellet found another additive series made by adding 5 to 1, and so on; 1, 5, 6, 11, 17, 28. . . . He developed the series in 18 columns and 36 lines horizontally, with some extraordinary results, including values for π, φ, and the royal cubit; this led him to conjecture that the royal cubit might have had a theoretical value before it had a practical one.

The first line gives the numbers 11, 17 and 28, which are divisions of both the royal cubit and the Chaldean cubit; furthermore, 11 × 17 × 28 equals 5236, which is Funk-Hellet's figure for the royal cubit in millimeters, or $\pi/6$.

The fourteenth column of the series gives the φ^2 value of 2.618, the royal cubit value of 5236, and the π value of 3.1416.

The second row produces the φ, or Fibonacci-type, series of $1/\varphi$, 1, φ, φ^2 with 618, 1000, 1618 and 2618.

The seventh column gives the divisions of a 360-degree circle in halves, quarters, eighths, etc.

Funk-Hellet maintains that as early as the fourth millennium B.C. the Chaldeans had a mathematical series which gave the exact values of the cubit, the meter and π. What's more, he insists that the present *meter,* as developed by the French in the nineteenth century, was already a hermetic measure known in antiquity, and was linked trigonometrically with the cubit.

To Funk-Hellet the Great Pyramid is a geodetic gnomon, or pillar, incorporating values for both the meter and the cubit. He says the finger, palm and cubit are built into the apothem. In the King's Chamber, he says, the double square of the floor is 5.236 meters by 10.472 meters—which varies from Petrie's and Davidson's measurements by a few millimeters.

Funk-Hellet says the basic meter unit from which the cubit was derived had to be kept a deep secret, presumably so that all the calculations, including the means for obtaining the exact length of the year, would remain the sole property of the officiating priests.

Schwaller de Lubicz in *Le Temple de l'Homme* corroborated the evidence that the Egyptians knew the meter, pointing out that on the whole length of a surrounding wall of the Third Dynasty (3000 to 2000 B.C.), "one finds three lines painted at the time, of which the distance between two lines is exactly one meter," adding that this is not an isolated case, "but one of thousands." In ancient constructions of Troy, Heinrich Schliemann found a unit of measure which was exactly half a meter, or 50 centimeters.

Funk-Hellet says the meter and the cubit depended from each other and were both defined by geodetic measurements. He suggests the way the meter was derived by the ancients was by watching from a measured height the moment a light disappeared on the horizon.

At the beginning of the nineteenth century, Sir John Herschel tried to calculate the radius of the earth with two observers placed 10 feet above the sea who ceased to see each other at 12,873 meters. This gave Herschel an earth radius of 6797 kilometers instead of the correct 6378, or an error of 419 kilometers.

Funk-Hellet believes the ancient Egyptians did better. He points out that the full apothem of the Pyramid including the pyramidion is 10,000 fingers long, or 187 meters. He then computes that if 1870 meters is taken as an arc of 30°, the resulting radius will be 3570 meters. Modern experiments indicate that a light disappears on the horizon at 3570 meters when the eye of the observer is exactly 1 meter above the ground.

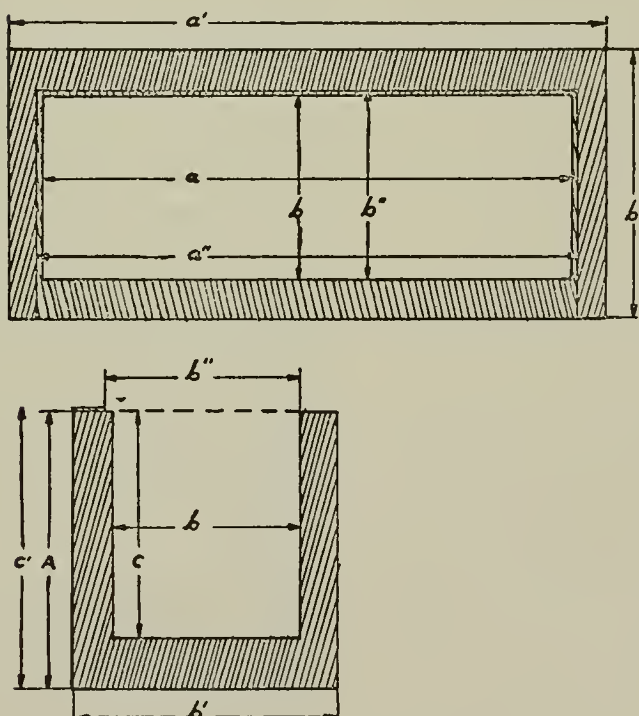
José Alvarez Lopez of Argentina, in his work *Fisica y*

Creacionismo, says that a cubit of 523 millimeters—about half a millimeter shorter than Funk-Hellet's and 1 millimeter shorter than Stecchini's—is exactly half of what he calls an *absolute meter*, which he says occurs as a natural unit in the solar system.

According to Alvarez Lopez the planets of our system orbit in harmonic distances from the sun which are multiples of a single unit of length—his *absolute meter*—in an arrangement which is naturally decimal.

Alvarez Lopez says that beginning with Mars, the planets are disposed in the order of the colors in the solar spectrum —with Mars as red, Jupiter yellow, Saturn yellowish-green, Uranus green, Neptune blue, and Pluto violet. According to Alvarez Lopez the Pyramid may once have been painted with the colors of the spectrum starting with red for Mars, just below the gilded pyramidion representative of the sun, and diminishing through yellow and blue to violet at the base, symbolizing the construction of the solar system both geometrically and with color.

The only evidence that the Pyramid may have once been painted, apart from the legends of the Arab storytellers, are some fragments of casing stone found in the early nineteenth century which were covered with what appeared to be red paint. Subjected to careful chemical and spectrographic



Alvarez Lopez's rendition of the dimensions of the coffer used by the Egyptians for basic astronomical ratios.

analysis at the Sorbonne, it was determined that the casing stones had once been covered with a layer of paint with a red ochre base, and that the paint could not have been caused by any chemical recomposition of the stone itself.

The Great Pyramid, says Alvarez Lopez, represents a decimal schema of the solar system. He figures the height of the Pyramid to be a millionth part of the distance to the sun, measured from the limit of the earth's atmosphere, and its base to be the ten-thousandth part of the surface of the earth.

The dimensions of the granite coffer in the King's Chamber, as worked out by the Argentine professor, are arranged to form a perfect "astronomical atlas": he says the inner measure gives an *absolute cubic meter,* but that the coffer was not designed as a cube so that its various inner and outer measures could also represent the various astronomical constants of the solar system.

He says there was just one way to build a coffer so that it would include not only the distance from the earth to the sun (a basic astronomical unit), but the weight of the earth, the weight of the earth and the moon, the weight of the sun in relation to the earth, the weight of the sun in relation to the earth and the moon, the weight of the earth in relation to the moon, the value of the absolute cubic meter, and the polar radius (one-half the diameter from pole to pole) of the earth in terms of an absolute meter.

Alvarez Lopez considers the original discovery of these figures to have been perhaps the hardest job yet mastered by man, and says this explains the care and trouble taken by the builders of the Pyramid to secrete the information in the heart of the building. Were the coffer not so badly chipped and worn, says Alvarez Lopez, it might give us more exact astronomical figures than we now possess.

All these astronomical constants, says the professor, depend on a precise knowledge of the solar parallax; he is amazed that the builders of the Pyramid could have known the parallax and the earth's polar radius so exactly without the help of telescopes and cameras. It will be interesting, he says, to compare our new figure for the sun's parallax with that of the granite coffer, as determined by the near passage of the small planet Eros, which occurs every 37 years and is due in 1975.

Stecchini is more *terre-a-terre.* He can show that the half meter found by Schliemann is really a Babylonian cubit of .49907 meter and that the meter of Funk-Hellet and de Lubicz is in fact three feet of .3329 meter, both derived from the geographic foot and cubit.

When I reminded Stecchini that Petrie had found the coffer in the King's Chamber to be designed in even numbers of fifths of a cubic cubit, Stecchini resolved the millennial riddle of the coffer by showing that it contains exactly 40 *artaba,* or 40 cubes whose sides are one geographic foot, and that its outside volume is twice this amount, or 80 cubes of one geographic foot.

Would it not be worthwhile, nonetheless, for academic institutions, so admirably equipped with computers and talent, carefully to analyze such conceits as those of Alvarez Lopez and Funk-Hellet and either refute them or support them with reliable data? Some of their ideas may turn out to be no wilder than those for which Jomard, Taylor, Smyth and maybe even Davidson were unjustly lampooned.

Napoleon's French Institute in Cairo.

XXI. MORE SECRET PASSAGES AND CHAMBERS

Many Egyptologists and explorers were convinced—and many still are—that the Pyramid conceals one or more secret and yet undiscovered chambers. It is also believed that the Pyramid is connected by subterranean passageways to other pyramids, to the Sphinx, and to long-demolished reception halls, small temples and other enclosures.

The engineer of the Australian railways, Robert Ballard, believed the Giza pyramids may also have been built above a vast series of catacombs, with chambers and galleries, like the pyramids of Lake Moeris, which are said to have vast subterranean residences for its priests and keepers.

Ballard suggests that much of the limestone for the structure of the pyramids of Giza may have been quarried from such catacombs. He suggests that a good diamond drill with two or three hundred feet of rods be used to make tests on the Giza plateau. Ballard believes that when this subterranean city is discovered, it will be found that it had access passages for the priests and the surveyors linking it to every pyramid.

While the pyramids appeared to the outside world to have been sealed up as mausoleums for the dead, says Ballard, the sealing may simply have rendered more mysterious and private the recesses and abodes of the priests who entered from below, and who were possibly enabled to ascend by private passages to their very summits.

When Perring and Howard-Vyse were exploring the bent pyramid at Dashur in 1839, they noticed an extraordinary phenomenon. The workmen clearing the passages were suffering from intense heat and lack of oxygen when suddenly a strong cold wind began to whistle through the passages. It blew so fiercely for two days that the men had trouble keeping their lamps lit. Mysteriously it stopped and no one has yet figured out the mystery.

Ahmed Fakhry, working in the same pyramid in the 1950s, heard weird noises which led him to conclude that there must be undiscovered passages within or under the bent pyramid.

Edgerton Sykes, an archeologist and author, who is perhaps the best living authority on ancient Atlantis, also

Herodotus speaks of a palace complex of 3500 chambers half above and half below ground at Moeris. The Egyptians called it "the temple at the entrance to the lake." Herodotus called it a "labyrinth," and considered that it outranked the pyramids as a wonder.

believes there is a whole maze of corridors and passages dug into the Giza hill. Sykes quotes an ancient Arab source to the effect that the designers of the Pyramid made "several doors, built over underground vaults of stone, each with a secret stone door revolving upon a hinge."

Peter Kolosimo believes there are more tombs and caves beneath Saqqara, Abydos, and Heluan, of very ancient dynasties, and reports the legends of hidden doors "that could be opened by a mysterious force" such as a supersonic wave length, or specially resonant voice.

According to the Baron de Cologne, as quoted by Robert Charroux in *Le Livre des Secrets Trahis* (Paris, Laffont, 1965), there is an underground kingdom under the Egyptian desert similar to the "Agartha" of Tibet.

Commander Barber, the American attaché who gave such attention to the construction of the Pyramid, wrote that "when one considers the inexplicable and yet exact arrangement of the various chambers and galleries, and that there is room for 3700 more such chambers, provided we could find them, we can almost be tempted to believe that we have not yet discovered all the chambers or even the true chamber of Cheops."

Piazzi Smyth was equally convinced that there was an undiscovered chamber in the Great Pyramid "which will prove to be the very muniment room of the whole monument."

Bent pyramid at Dashur. Arrow points to a secondary entrance to pyramid high on the north side.

When a multitude of chips of black diorite rock were discovered on the Pyramid hill, Smyth surmised that the undiscovered chamber might be lined with black diorite.

Thomas Holland, a Thirty-third Degree Free Mason, believed that if the granite leaf were removed from the portcullis it would disclose the way to "magnificent passages and chambers hitherto undiscovered."

Louis P. McCarty, in a privately printed booklet, *The Great Pyramid of Jeezeh,* published in San Francisco in 1907, says he believes the Pyramid contains at least three more chambers located between the King's Chamber and the apex, and at least one with double the capacity of the King's Chamber. McCarty believes the next largest chamber will be found at the 75th course, and the largest at the 100th course, and that the largest should be of an equal capacity to the three below it. He believes there is a fifth and final chamber on the 120th course of masonry, and that this one should be just half the capacity of the King's Chamber. McCarty also subscribes to the theory that there is a passage somewhere beneath the northeast corner of the Pyramid which leads to the Sphinx.

Funk-Hellet suspects there might have been a room on top of the present platform, now destroyed.

William Kingsland, in his two-volume work on the Pyramid, suggested generating radio waves of 5 meters length in the King's Chamber, and by noting the strength of reception at measured intervals all round the outside of the Pyramid, determine if some hidden chamber might exist.

In the late 1960s Dr. Luis Alvarez, the 1968 Nobel Prize winner for physics, developed a machine for recording the passage of cosmic rays through the pyramid of Kephren, by means of which he hoped to discover any secret chambers or passages within its body.

The operation, which required a team of scientists, turned into an expensive venture in which twelve United States and United Arab Republic agencies became involved, including the U.S. Atomic Energy Commission, the U.A.R. Department of Antiquities, the Smithsonian Institution and the Faculty of Science of the Ein Shams University in Cairo.

Alvarez's project was based on the fact that cosmic rays, which bombard the planet day and night, lose part of their energy as they pass through an object, in proportion to the density and thickness of the object.

By placing a "spark chamber" in the subterranean vault of the pyramid the scientists planned to monitor the number of cosmic rays which made their way through the pyramid walls. Those rays which passed through a void in the body of the pyramid would reach the chamber more frequently than those traversing solid rock, and the variance would indicate the presence of a secret chamber or passage in the pyramid.

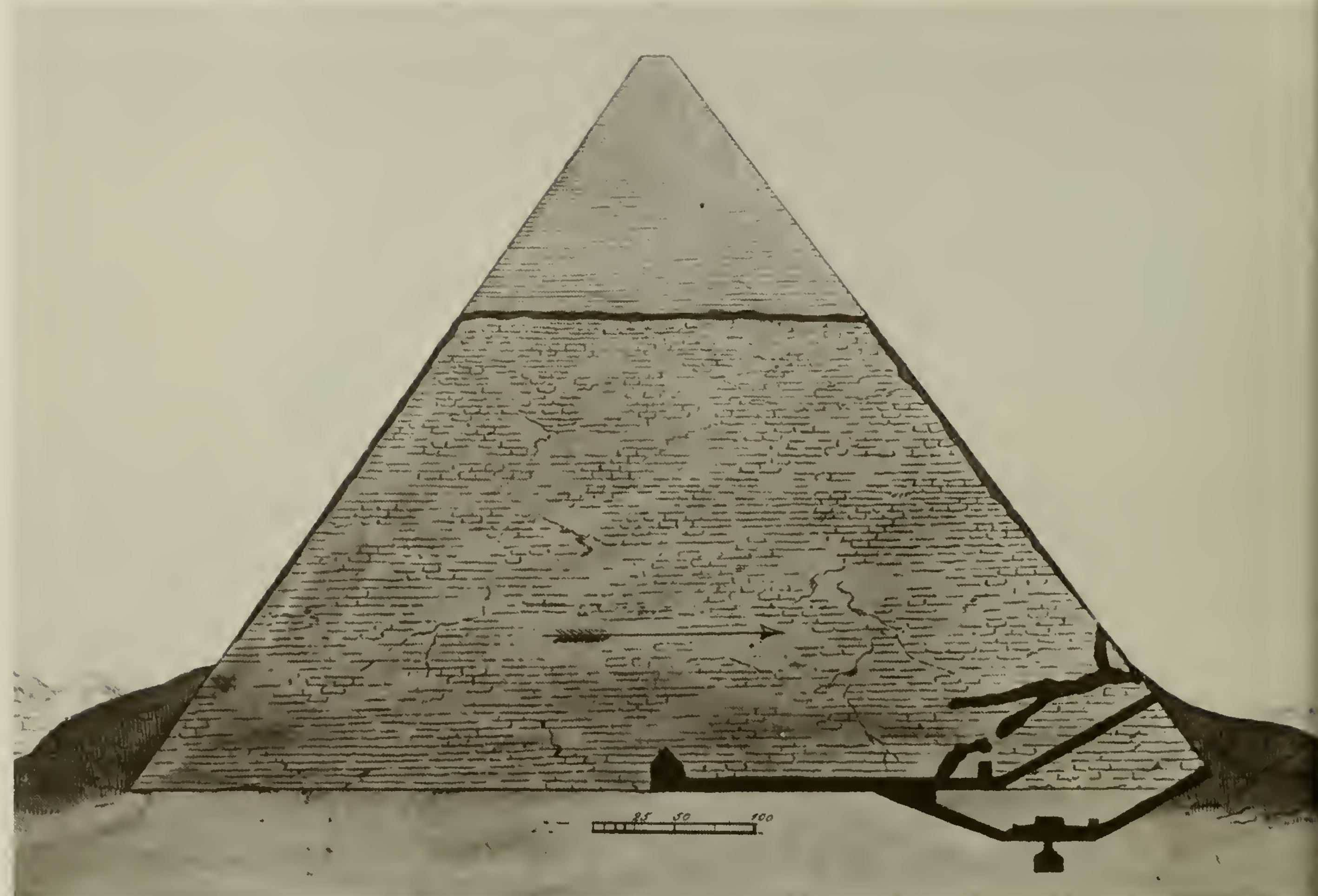
The path of each ray is recorded electronically and stored on a magnetic tape. The tapes are then fed into a computer to calculate and memorize the point at which each recorded ray penetrated the surface of the pyramid.

To pinpoint the location of any cavities which showed up, the scientists planned to shift the "spark chamber" and obtain a sort of stereo picture.

Were any hidden chamber located, it would then be possible to dig directly to it without risking great damage to the rest of the pyramid. The operation would consist of drilling a small hole upward in the indicated direction of any cavity that appeared on their "X-ray plate." Modern optical tools would allow archeologists to look into the chamber through a long hole, perhaps 100 feet long and only 3/4 inch in diameter.

Dr. Alvarez chose the pyramid of Kephren because he considered it unlikely that Kephren, as the son of Cheops, would have had such an imposing pyramid erected without incorporating some secret system of passages and chambers such as have been discovered in the Great Pyramid.

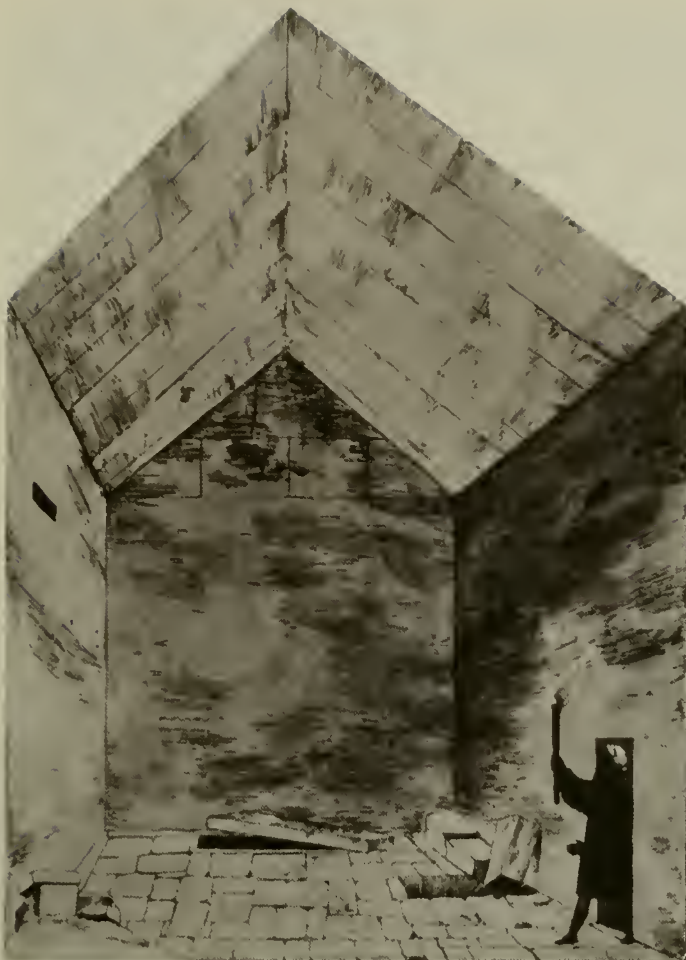
Alvarez assumed that Cheops' architects must have had a choice of clever ideas for secreting chambers, some of which had to be left out of his pyramid, but could have been applied to Kephren's. "My hunch," says Alvarez, "was that younger architects working on Cheops' pyramid would have had their ideas rejected. Later, in Chephren's time, they could have persuaded Chephren to use them, or some other improved plans."



On this tenuous assumption Alvarez hoped to find a secret chamber in Kephren, and perhaps even the sarcophagus of the dead Pharaoh: an Egyptologist's dream.

Alvarez also chose Kephren's pyramid because its central chamber was more convenient for setting up his complex electronic equipment. The subterranean vault discovered in 1818 by the Italian explorer Giovanni Belzoni had recently been cleared of rubble, and other chambers and passages in the pyramid had been lit with electricity by cable from the nearby Mena House.

By September of 1968 two million cosmic-ray trajectories had been measured: these were considered ample for finding any hidden vault within the field of view of the upward-looking equipment. When the tapes were run through the local computer in Cairo for the first analysis, the results looked wonderful. They clearly



In 1818 the Italian adventurer Giovanni Belzoni tried to find an entrance to the second pyramid of Kephren.
He found what appeared to be the original entrance close to the ground plugged by three granite blocks. The passage was cleared all the way down to a funerary chamber containing only a granite sarcophagus. On the west wall of the chamber an inscription in Arabic indicated the chamber had been penetrated some time after the Hegira.

Portrait of Giovanni Belzoni used as a frontispiece for a book edited by his wife commenting on his exploits in Egypt.

showed up the corners and the faces of the pyramid as outlined by the passing cosmic rays, recorded in the central chamber. The equipment appeared to be functioning excellently. But there were some mysterious developments.

As Dr. Lauren Yazolino, Alvarez's assistant, returned to the United States to analyze the tapes on the most up-to-date computer at Berkeley, a correspondent from the London *Times* visited Cairo to check on the results locally. At Ein Shams University, John Tunstall found an up-to-date 1130 IBM computer surrounded by hundreds of tins of recordings.

"It defies all known laws of physics," Tunstall quoted Dr. Amr Goneid, who had been left in charge of the pyramid project since the return to America of Dr. Yazolino.

According to Tunstall's report, each time Dr. Goneid ran the tapes through the computer a different pattern would appear, and the salient points which should have

been repeated on each tape were absent. "This is scientifically impossible," Tunstall quoted Goneid, explaining that earlier recordings which had raised the hopes of a great discovery were now found to be a jumbled mass of meaningless symbols with no guiding pattern whatever.

Tunstall asked Goneid: "Has all this scientific know-how been rendered useless by some force beyond man's comprehension?" To which Goneid is reported to have answered: "Either the geometry of the pyramid is in substantial error, which would affect our readings, or there is a mystery which is beyond explanation—call it what you will, occultism, the curse of the pharaohs, sorcery, or magic; there is some force that defies the laws of science at work in the pyramid."

At Berkeley, Alvarez refuted Tunstall's account, insisting that the equipment was functioning admirably. In the 35° cone scanned by the spark chamber there was no sign of any hidden passageway or chamber. This was the area believed by the scientists to be the most likely to contain them, though there was still hope of finding something in the remaining sections.

As soon as further funds were available the team of scientists planned to resume their scanning of Kephren. Dr. Yazolino added that if sufficient funds were available they might even move their equipment to the Queen's Chamber in Cheops to see if they could find any unknown passages or chambers in the Great Pyramid.

Yazolino explained that the only trouble they had encountered had been poor readings when the spark chamber ran out of neon and produced some mysterious dark spots which looked like a possible chamber till they were carefully analyzed and found to be caused by the gap between two spark chambers.

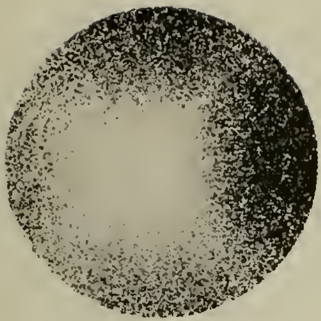
Alvarez stressed his confidence in Dr. Goneid as a very able physicist, saying that he thought so much of him he had invited him to spend a year at his lab at Berkeley. "If I thought for a moment that he had said any of the nonsense attributed to him, you can be sure I wouldn't want him as a member of my research group."

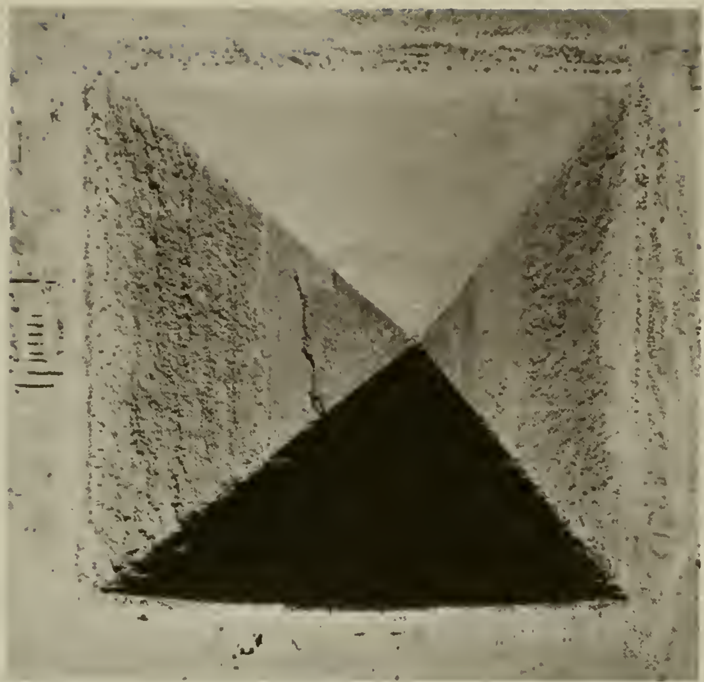
Yet there remains something mysterious about the pyramid which needs to be explained.

When a Frenchman, M. Bovis, visited the Great Pyramid he noticed that some garbage cans in the King's Chamber contained dead cats and other small animals that had apparently wandered into the Pyramid and died.

There was something odd about these corpses: there was no smell or decay to them. Curious as to the cause

Diorite statue of Kephren dating from the Sixth Dynasty found by Marietta Bey in the so-called Temple of the Sphinx, now in the Cairo Museum.





of this phenomenon, Bovis examined the animals and found them dehydrated and mummified, despite the humidity in the chamber.

Bovis wondered if the mere shape of the Pyramid could have been responsible for this natural process of embalming: so he made a wooden model of Cheops with a base three feet long, and oriented it due north. Inside the model, a third of the way up, he placed a freshly dead cat. After a few days it mummified. Bovis then placed other organic materials in the model, especially matter that normally decays very quickly, such as calf's brains, and when these failed to putrefy, he concluded there must be something about the shape of the Pyramid which prevents decay and causes dehydration.

A Czechoslovakian radio engineer named Karel Drbal read Bovis's reports and made some further experiments with pyramid models, concluding that there is "a definite relation between the shape of the space inside the pyramid, and the physical, chemical and biological processes going on inside that space."

The same phenomenon has been noted in Italy and Yugoslavia where milk packaged in pyramidal cartons keeps fresh indefinitely without refrigeration. A French firm has also patented a pyramidal container for yogurt.

Drbal wondered if the shape might be responsible for an accumulation of electromagnetic waves or cosmic rays, or of some unknown energy. Placing a used razor blade within a six-inch-high cardboard model of Cheops' pyramid, oriented to true north, Drbal found that the edges of the blade automatically recovered their sharpness after use, that he could shave with one Gilette blue blade as many as 200 times. He concluded that the environment inside the pyramid somehow made the crystals in the blade return to their original form. Drbal was issued patent no. 91304 by the Czechoslovak patent office and began manufacturing "Cheops Pyramid Razorblade Sharpeners" out of cardboard. Today they are being made of styrofoam.

An engineer and former professor of radio, L. Turenne, maintains that all sorts of different forms—being combinations of different frequencies—act as different types of resonators for energy in the cosmos. This has led to speculation that the Pyramid might be some sort of gigantic lens which is able to focus an unknown energy simply by means of its shape.

Even the coffer in the King's Chamber has been considered such a device by Worth Smith, who points out that the cubic capacity of the coffer is *exactly* the same as that of the biblical Arc of the Covenant.

According to Maurice Denis-Papin, descendant of the famous inventor, the Arc of the Covenant was a sort of electric capacitor capable of producing an electrical charge of 500 to 700 volts. The Arc is said to have been made of acacia wood, lined inside and out with gold: that is to say, two conductors separated by an insulator. On either side were garlands which may have served as condensors. Denis-Papin says the Arc was placed in a dry spot where the magnetic field reached a normal 500 to 600 volts per vertical meter.

Insulated from the ground, the Arc is said to have given off fiery rays, acting like a Leyden jar. According to Denis-Papin the capacitor was discharged to earth by means of the garlands. To move the Arc, two golden rods were slid through rings attached to the exterior.

The similarity of such an "energy accumulator" to the orgone box developed by Wilhelm Reich, which was such a puzzle to Albert Einstein, is also striking.

Sir W. Siemens, the British inventor, related that one day while he was standing on the summit of Cheops' pyramid an Arab guide called his attention to the fact that whenever he raised his hand with his fingers outspread an acute ringing noise was heard.

Raising just his index, Siemens felt a distinct prickling in it. When he tried to drink from a wine bottle he had brought along he noted a slight electric shock. So

Siemens moistened a newspaper and wrapped it around the bottle to convert it into a Leyden jar. It became increasingly charged with electricity simply by being held above his head.

When sparks began to issue from the wine bottle, Siemens's Arab guides became distrustful and accused him of practicing witchcraft. One of the guides tried to seize Siemens's companion, but Siemens lowered the bottle towards him and gave the Arab such a jolt that he was knocked senseless to the ground. Recovering, the guide scrambled to his feet and took off down the Pyramid, crying loudly.

Such weird but soberly recounted tales about the Pyramid are tame compared to the wilder conceits that have been propounded by pseudoscientific, science-fiction and sensational authors. According to one science-fiction theory, the Pyramid was used as a huge protecting baffle for ancient scientists who had found a way to tap the energy of the Van Allen belts by letting it flow on an ionized path through the atmosphere to the peak of the Pyramid, possibly on a laser beam. The authors of this science fiction recount how an error was committed in the length of time the energy was allowed to flow, causing an avalanche of power which knocked the planet off its axis.

Another popular idea is that the truncated Pyramid served not merely as an observatory but as a landing pad for extraterrestrial space ships. The polished sides of the Pyramid would have made such a platform inaccessible to the hoi polloi, so that godlike visiting astronauts could have confabulated in security with the high priests who had access to the platform from interior passages. Herodotus lends romance to the idea that ziggurats and pyramids were steppingstones for the gods from heaven and that the King's Chamber—which Petrie found to be built quite separately from the surrounding Pyramid—could have served as a reception room on the truncated platform.

Herodotus describes a reconstructed ziggurat which he visited in Babylon. "On the topmost tower there is a spacious temple, and inside the temple stands a great bed covered with fine bed-clothes, with a golden table by its side. There is no statue of any kind set up in the place, nor is the chamber occupied at night by any but a single native woman who—say the Chaldean priests—is chosen by the deity out of all the women of the land. The priests also declare—but I for one do not credit it—that the god comes down in person into this chamber, and sleeps upon the couch."

In the light of recent scientific discoveries, one more theory must be added to this world of fable: that the Great Pyramid was built not only as an astronomical observatory but as an astrological one in order to make accurate large-scale horoscopes for the reigning monarch.

XXII. ASTROLOGICAL OBSERVATORY

Though many of the doctrines of astrology appear to be preposterous, modern science is beginning to indicate that in its original form astrology may have been based on some reasonable theories.

Proctor points out that the ancient Egyptians viewed the king as the representative of all the people in their relations with the forces of the cosmos, and the world of spiritual powers.

On the theory that what was good for the king was good for the country, Proctor suggested that the Egyptians made no move in either domestic or foreign policy without the recommendation of their astrologer priests, whose opinions were based on the movement of heavenly bodies as scanned from a pyramidal observatory.

Once the king was dead, Proctor believes, his body may have been buried within the pyramid and the platform finished off to a point.

The idea that the shifting of heavenly bodies bears some relation to man's fate is so ingrained that people are still called martial, jovial, saturnine or lunatic; the days of the week are still named for sun, moon and planets; and our religious festivals are still based on the astrological system of ancient Egypt, with Christmas tied to the winter solstice and Easter to the spring equinox.

In his *The Scientific Basis of Astrology,* published in 1969, Michel Gauquelin describes some of the effects of the motions of the sun and moon upon terrestrial phenomena. Apart from such obvious effects as the seasons, the growth of vegetation and the tides, he deals with the less apparent but equally powerful effects of the eleven-year cycle of sunspots on our flora, fauna and inhabitants.

Sunspots, which appear like dark flowers on the surface of the sun, spring up, develop and disappear. As they do so, the sun spews up fantastic incandescent clouds of gas, and whips up huge magnetic whirlwinds.

Rotating on its axis in a twenty-seven-day cycle, the sun periodically aims these spots and eruptions directly at the earth. The result is an increased projection of waves and particles towards the earth. In the words of Gauguelin, "we terrestrians can regard ourselves as living in the interior of the sun."

The position of the earth in its orbit also affects the sunspots: when Venus and Earth are on the same side of the sun, their effect on the sunspots is combined. The sun's vagaries induce earthquakes and even alter the duration of the day; the earth's magnetic fields are disturbed; there are radio interferences and other such mysterious phenomena. At the same time the earth is subject to bombardment by galactic particles such as Alvarez's cosmic rays, which also have their effect.

Sunspot activity has been related to such different phenomena as the number of icebergs in the North Atlantic, the level of water in lakes, the concentric rings in the growth of trees and the number of rabbit skins taken by the Hudson's Bay Company. Even the quality of wines in Burgundy is affected, excellent vintages corresponding to periods of maximum solar activity.

Sunspots have been proved to affect the smallest cells, and the world of microbes is disturbed to the point that waves of epidemics can be generated. Gauguelin quotes a Doctor Fauré to the effect that the frequency of diphtheria cases in Central Europe and of smallpox victims in Chicago follow the eleven-year cycle of sunspots, as did the recurrent great plagues of typhus and cholera in Europe.

Indirectly, most of the phenomena of weather, such as barometric pressure and the rate of winds, depend on the eruptions of sunspots. Gauquelin wonders if there may not be more subtle effects on the air we breathe, on our physical and mental states, and even on the way we think.

Recent experiments indicate that subjects breathing air charged with positive ions are likely to feel discomfort, headaches and giddiness; whereas when the atmosphere is full of negative ions the same subjects feel cheerful, relaxed and in top form.

The concentration of positive and negative ions in the air we breathe depends in the final analysis on solar activity. The ionosphere is filled with positive and negative ions. Particles which induce a very high ionization in the upper atmosphere are directed toward the earth by the sun. Unfortunately, negative ions have a tendency to attach themselves to clouds, whereas positive ions tend to accumulate on the ground.

Such data tie in with the theories of Wilhelm Reich about the healthful effects of what he calls "orgone energy" and the toxic effects of its counterpart "deadly orgone," which was reputed to turn rocks brown, make strong men giddy and bring on women's menses out of season.

Current research and experiments behind the Iron Curtain as reported by Ostrander and Schroeder in their *Psychic Discoveries Behind the Iron Curtain** have added even more fantastic details to the use of astrology as a science.

These authors describe a Czechoslovak Ministry of Health center, complete with modern computers, run by gynecologists and psychiatrists. It is called Astra Research Center for Planned Parenthood and uses astrological data, or the position of sun, moon and planets in relation to the birth of an individual, in order to assure a safe and reliable means of birth control without pills, contraception or operations. The same system is being used to help seemingly sterile women become fertile, help women who have had nothing but miscarriages deliver full-term babies, and even allow them to choose whether they will have a boy or a girl child.

In a book called *Predetermining the Sex of a Child,* Eugen Jonas, a Czech medical doctor who developed the Astra clinic, maintains that women's cycles are affected not only by the phases of the moon, but that each individual at birth is affected by the basic pattern of sun, moon and planets. From this basic pattern Dr. Jonas claims to be able to figure out the exact days in a woman's entire lifetime when she can conceive, as well as the ones which are the best or worst for a forthcoming child. The woman may then take advantage of such days, or avoid them.

Jonas found that dead, deformed and retarded children were produced when women conceived during certain oppositions of the sun, moon and major planets.

The system is now being tested in Hungary as well as Czechoslovakia, where Dr. Kurt Rechnitz, former director of the Budapest Obstetric Clinic prescribed astrological birth control for one hundred twenty women. None was reported pregnant.

It has been too short a period to establish the validity of such data, but the endeavor could prove more rewarding than voyaging to the moon. It would certainly be simpler for a lady in New York to step into the booth of an astrological computer in Grand Central Station in order to arrange her calendar of engagements for the year. And it might do wonders for an overpopulated planet.

Jonas' good-humored complaint is that most gynecologists know as little about astronomy as astronomers know about obstetrics, and that both believe

* Prentice-Hall, Englewood Cliffs, New Jersey, 1970.

astrology to be superstitious nonsense. If the disciplines were combined, the results, says Jonas, might be great for mankind. Had the designers of the Great Pyramid been able to monitor the sunspots with a screen across the Grand Gallery, as suggested by Proctor, and had they been aware of such phenomena as has been described by Dr. Jonas, they may well have been able to use the Great Pyramid as a means of providing accurate astrological data on which to formulate the charts for individual behavior, if not for the thronging masses, at least for the pharaohs, priests or nobles.

In his book on the Great Pyramid William Kingsland declares flatly that the ancient Egyptians used "their profound knowledge of what we call the outer facts of astronomy" to connect them astrologically with the principles of man's relation to the cosmos, and that this formed part of the concealed knowledge contained in the mysteries.

Kingsland notes that from the very remotest antiquity the Egyptians believed firmly in an afterlife and were not afraid to think cosmically in terms of millions of years. He quotes an introductory hymn to *Ra* in *The Book of the Dead* as saying: "millions of years have gone over the world; I cannot tell the number of those through which thou hast passed. . . ."

To Kingsland *The Book of the Dead,* though it appears to be a ritual for funerary rites of a deceased king or high official, was actually a description of the trials, temptations and difficulties which the adept had to meet and overcome as he progressed from knowledge to knowledge and from power to power, as he penetrated the superphysical regions from plane to plane. The ultimate goal of initiation, says Kingsland, was "the full realization of the essential *divine nature of man,* the recovery by the individual of the full knowledge and powers of his divine spiritual nature, of that which was his source and origin, but to the *consciousness* of which he is *now* dead through the 'Fall of Man' into matter and physical life."

The old Greeks, says Kingsland, learning from the Egyptians, embodied these trials and difficulties of the great initiates into the legends of their heroes and demigods.

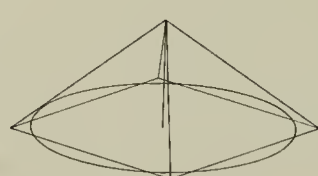
Manly P. Hall, a lifelong researcher into the mysteries of ancient initiation, says the Great Pyramid was dedicated to the god Hermes, the personification of Universal Wisdom; it was not only a temple of initiation but a repository for the secret truths which he calls the foundation of all the arts and sciences. The time will come, says Hall, when the secret wisdom shall again be the dominating religious and philosophical urge of the world: "Out of the cold ashes of lifeless creeds, shall rise phoenix-like the ancient Mysteries . . . . The unfolding of man's spiritual nature is as much an exact science as astronomy, medicine and jurisprudence."

Whatever mystical, occult or science-fiction tales may be associated with the Great Pyramid, it is still an extraordinary piece of masonry, and its designers must have been extraordinary beings. Who they were and when they built their Pyramid remains a mystery. So the quest continues.

But certain facts must be confronted, and the textbooks amended to conform with them. Eratosthenes was obviously not the first to measure the circumference of the earth. Hipparchus was not the inventor of trigonometry. Pythagoras did not originate his famous theorem. Mercator did not invent his projection—though he did visit the Great Pyramid and leave his graffito to prove it.

Whoever built the Great Pyramid knew the dimensions of this planet as they were not to be known again till the seventeenth century of our era. They could measure the day, the year and the Great Year of the Precession. They knew how to compute latitude and longitude very accurately by means of obelisks and the transit of stars. They knew the varying lengths of a degree of latitude and longitude at different locations on the planet and could make excellent maps, projecting them with a minimum of distortion. They worked out a sophisticated system of measures based on the earth's rotation on its axis which produced the admirably earth-commensurate foot and cubit which they incorporated in the Pyramid.

In mathematics they were advanced enough to have discovered the Fibonacci series, and the function of π and φ. What more they knew remains to be seen. But as more is discovered it may open the door to a whole new civilization of the past, and a much longer history of man than has heretofore been credited.



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APPENDIX

NOTES ON THE RELATION OF ANCIENT MEASURES TO THE GREAT PYRAMID

by LIVIO CATULLO STECCHINI

The following pages constitute an abstract from a lifelong research into the history of measures. I became interested in this subject toward the end of my secondary education, when I was trying to put to some use my eight years of Latin and Greek grammar. It was then that I became an acolyte of Angelo Segré, whom I knew as a fellow law professor with my father at the University of Catania. Segré was a scholar of Roman law, but, coming from a family of distinguished scientists and mathematicians, had specialized in the study of ancient measures.

Upon completing my secondary education, I ended my study with Segré to register as a student at the University of Freiburg, Germany. Since at that age one believes that a thinking person must have a philosophical foundation, I chose Freiburg because it was the university where Husserl taught, whose philosophy appealed to me because of its mathematical rigor. But at Freiburg at the moment the focus of attention was the philosopher Heidegger, who had just announced to the world the discovery of something called existentialism. I did not share the excitement of my fellow students for the new dispensation (although I liked the lectures on existentialist mathematics by Oskar Becker), but there were a couple of things that I learned from Heidegger. One was that the idea of the progress of human civilization, on which practically all historians operate, is a theological doctrine developed by the Church Fathers. The other, more specific, was that scholars of Greek culture have murdered the texts of early Greek philosophers, on the assumption that since they were early philosophers they must have had infantile conceptions. In the area of my vocational studies, I identified myself with a group of professors, led by Fritz Pringsheim, who had dedicated themselves to one topic, the contract of sale in ancient times. Since seminar work consisted in interpreting contracts from several areas of the eastern Mediterranean, I focused my attention on the clauses relating to measures, which these contracts contain in abundance. My teachers were tolerant of my passion; for instance, Otto Lenel in his *privatissimum,* dedicated to the development of postclassical Roman law, allowed me to read a paper on the length of the miles in the Syro-Roman Law Book.

After the Freiburg group was disbanded by Hitler, I returned to Italy, where I received a doctorate in the field of Roman law. On that basis I became assistant to the chair of history of Roman law at the University of Rome and a member of the Institute of Roman and Oriental Law of that University. During my Roman years, I learned the most from Edoardo Volterra, later holder of the chair of Oriental law at the University of Rome; he was sympathetic to my interests, since he was the son of the famous mathematician Vito Volterra.

When World War II brought me to the United States, since my interests were historical rather than legal, I registered as a candidate for a doctorate in ancient history at Harvard University. There I discovered that those who come to ancient history from literature have a completely different view of the ancient world from the practical, realistic, and utilitarian view which prevails in legal studies: in substance they see the ancient world as the realm of poetic fantasy. My Harvard teachers used to admonish me to understand "the spirit of the ancients," but the only image that their perorations could stir in my mind was the image of the ancients in a constant state of alcoholic stupor. As to my special field of research, my teachers thought that my notion that the Greeks were concerned with precision in measurement was intellectually preposterous and historically impossible.

The terms of the controversy were clarified for me by Werner Jaeger, who tried to support me by suggesting that I write under him a thesis on the concept of *akribeia,* "precision," in Greek thought. In outlining the proposed thesis, Jaeger explained that with Isocrates there was developed in Greece a new conception of humanism opposed to *akribeia.* Jaeger was impliying that my critics were followers of Isocratean humanism. Because of youthful stubbornness, I declined the flattering offer of Jaeger, being convinced that what counts is to put precision into practice, rather than to talk about it. I tried to prove my point by submitting a thesis on "The Origin of Money in Greece." It was accepted as containing much that was valuable, but I received the advice that before publishing it I should cut down on "all those numbers."

After this, I thought that I could still achieve a result by expanding my documentation. From the study of Greek monetary weights and the operation of Greek mints, I passed to the topic of the dimensions of Greek temples. The study of Greek temples much later led me to the study of ancient geography and geodesy. But I was gradually forced to accept the fact that scholars of ancient history do not read numbers, neither in ancient texts nor in research papers. I noticed a number of times, when I submitted a paper for judgment to a specialist of a particular area, that he would quickly turn a page if he saw numbers on it. In many different guises I was told that "numbers do not constitute evidence in ancient studies." Finally, I learned that I had no choice but to pursue my interests in splendid isolation.

About ten years ago I exchanged manuscripts with Hertha von Dechend, who was then beginning to write her book *Hamlet's Mill.* As an expert of ancient cosmology, she raised a strong objection to the fact that I would discuss length, volume, and weight for hundreds of typewritten pages, without ever mentioning time, whereas the ancients were dominated by the preoccupation with cosmic time, with the movement of the vault of heaven. I answered that she was right, but that I had not yet found in the texts anything that would establish a connection between time and other measures. Giorgio de Santillana, who was writing *Hamlet's Mill* together with Dechend, teased me in a friendly way by saying that I had become so stuck in the mire of economic documents that I could not lift myself out of it; I replied in the same half-serious tone that I was willing to lift my eyes to heaven only on condition of being sure that my feet remained firmly planted on the ground.

Although I recognize that astronomical measurements are extremely important, I have always been wary of dealing with them, because studies of ancient astronomy have become cluttered with metaphysical and theological doctrines. My opposition to the view that the ancients lived in a world of fantasies or even of outright hallucinations (as it is specifically claimed by scholars of ancient astronomy) is such that, after years of dealing with all sorts of measurements, I still feel most at ease with agrarian measures in cuneiform tablets, rates of money exchange in Greek inscriptions, or the volume of jars in papyri from Egypt. Yet the techniques of land surveying used in Meso-

potamia are a key to the understanding of how the ancients mapped the sky.

Because of my horror of metaphysical or pseudo-metaphysical intrusions, I had several times picked up and then dropped the problem of the dimensions of the Great Pyramid of Giza. It was only after Peter Tompkins took upon himself the task of organizing the literature in the field, separating sense from nonsense, that I gained the courage to deal with the problem to the point of some conclusion. In the course of discussing with me the geometry of the Great Pyramid, Tompkins explained how the Great Pyramid with its galleries could have been used to measure the movements of the vault of heaven. In describing the possible procedures, he pointed out how a second of time in the motion of the vault of heaven corresponds to a definite length on earth. For me this was a Galilean revolution in that it permitted me to see ancient astronomy in terms of observational techniques based on measurements, rather than systems based on the theological persuasions or the psychological projections of the modern investigators. Once I was able to link time together with length, volume, and weight, a number of scattered researches suddenly became related to each other. Up to that moment I had had the uncanny feeling that somewhere there was a piece missing, and I knew that a missing piece, even a little one, is vital when one deals with measurements.

Since Tompkins has asked me to write a summary of my findings that relate to the problem of the Great Pyramid, I have tried to comply with his request.

I. EGYPTIAN GEODETIC SYSTEM

1. The present Arabic name of Egypt is *al Miṣri,* which is the equivalent of the biblical *Miṣraîm.* This name is derived from the Semitic root which in Akkadian gives the verb *aṣaru,* "to cut, to delimit, to delineate," and hence "to draw a picture, a plan," and the noun *eṣertu,* "drawing plan, representation," applied in particular to the specifications for the construction of a building. In Semitic language an "m" before the root of a verb forms what we would call a past participle: Egypt is the country built according to a geometric plan.

The Egyptians expressed this idea by calling their land *To-Mera,* "the land of the *mr.*" The word *mr* is used to refer to the pyramids, but more specifically it refers to the meridian triangle of a pyramid, whose hypotenuse is the apothem. The *mr* essentially is a right triangle with an angle of 36° and another angle which of necessity is 54°.

Since the Egyptians did not have trigonometric tables, they used this triangle to obtain the value of trigonometric functions. They conceived of this triangle as the basic building block of the cosmos. They used this triangle or modifications of it by a few degrees in geometric constructions, in the planning of buildings, in surveying, and in geography.

In the last century the Egyptologist Karl H. Brugsch noticed that the hieroglyphic sign for *mr* when used in the name *To-Mera* is accompanied by a determinative in the form of a fret or Greek key. In hieroglyphic writing a determinative is an extra sign which helps in understanding the meaning of a word by indicating the class of concepts to which the word belongs. Brugsch observed that this fret is "a peculiarly shaped geometric figure which in principle could represent the entire land *Mera* and must have a meaning pertaining to a specific peculiarity of Egypt." But, although he was much more sympathetic to science than Egyptologists usually are, he did not pursue this line of reasoning. He resisted accepting the notion that the Egyptians conceived of their country as having an exact geometric shape.

The Egyptians were proud that their country had some unique geographic features which could be expressed in rigorous geometric terms and had a shape which related to the order of the cosmos as they saw it. They believed that when the gods created the cosmos they began by building Egypt and, having created it perfect, modeled the rest around it.

2. Everybody knows that Egypt is a most peculiar, almost unique, country. Since it seldom rains there, the entire life of humans, animals, and plants depends on the water of the Nile. It is also known that the Egyptians linked the regular flood of the Nile with the movement of the sun and other heavenly bodies, such as the star Sirius. But the Egyptians put great stress also on the geographic peculiarities of the course of the Nile.

The Nile originates at the equator from lakes so immense that their water could be identified with the primeval water of the ocean. From the equator it moves north following substantially the meridian of its source at Lake Albert. It follows this line up to latitude 30°, one-third of the distance from the equator to the pole.

The key geographic position in Egyptian geography was the southern tip of the island today called al-Warraq, at the northern limit of the city of Cairo, where the Nile begins to divide into branches to form the estuary which the Greeks called Delta, after the triangular shape of the fourth letter of their alphabet. The apex of the Delta, the tip of the island al-Warraq, is cut by meridian 31° 14′ east. This meridian indicates the main line of the course of the Nile from the equator to the apex of the Delta and divides the Delta into two equal parts. It was considered the main axis of Egypt.

But in terms of latitude the apex appeared at first not as perfect as it should have been, since it was at latitude 30° 06′ north and not at the perfect latitude 30° 00′ north, which is the latitude of the Great Pyramid of Giza. But the Egyptians reassured themselves by observing that the southern limit of Egypt is indicated by the First Cataract. The upper edge of this cataract is at the perfect latitude 24° 00′ north, whereas its lower edge is at 24° 06′ north. Hence, they could say that Southern Egypt has an extension of 6° 00′, which may be counted either from 24° 00′ to 30° 00′ north or from 24° 06′ to 30° 06′ north. They adopted as a principle that geographic distances are measured by units of 6 minutes (1/10 degree). They assumed that the interval between the equator and the pole was divided into belts (in pictures they portrayed actual belts with clasps) of 6′; on the basis of this the Greeks introduced into our geography the term *zone*, which in Greek means "belt."

For the benefit of those who understand mathematics, I may add that the Egyptians analyzed curves by dividing the area under a curve into a series of rectangles, which is the basic principle of integral calculus. It seems that in analyzing the curvature of the earth, they used rectangles 6′ wide.

Geographically Egypt is divided into two different parts. Southern (or Upper) Egypt is essentially a canyon cut into the desert plateau by the Nile; it is long and narrow. Northern (or Lower) Egypt is a typical estuary, swampy and wide. In spite of the efforts of the rulers to stress the unity of the country, the two parts continued to be conceived as different even in political and administrative terms. This is the reason why the Hebrew word for Egypt, *Miṣraîm,* has the grammatical form of the dual. The Pharaoh wore two crowns on his head: a red straw hat for Northern Egypt and a white wool cap for Southern Egypt.

Although not much is known about the history of predynastic Egypt, it seems rather well established that in this period the two Egypts were unified for a time, with a capital at Behdet at the extreme north of the curved coastline of the estuary, as far north as one could go in Egypt. Although archeologists have not yet identified the location of Behdet, the data of geography indicate that Behdet, either as a geodetic point or as an actual city, was at 31° 30′ north 31° 14′ east. It was on the main axis of Egypt and of the

Nile, on the meridian of the apex of the Delta, at a distance of 7° 30′ (1/12 of arc of meridian) from the southern boundary of 24° 00′ north and at a distance of 1° 24′ = 1.4° from the apex. The distance from latitude 30° 00′ north is 1° 30′, so that it could be assumed that Southern Egypt relates to Northern Egypt as 4:1. Southern Egypt is 1/15 of arc of meridian and Northern Egypt is 1/60. We shall see that the total length of Egypt from 24° 00′ north to Behdet was calculated as 1,800,000 geographic cubits. Since 400 cubits is a stadium and 600 stadia is a degree, it is a length of 4500 stadia (3600 stadia for Southern Egypt and 900 stadia for Northern Egypt).

This is the way in which the dimensions of Egypt were rationalized in the predynastic period.

3. The dynastic period begins with the final unification of the two Egypts. At this moment Egypt emerged from prehistory, because writing was invented in the form of hieroglyphs. At the same time the geodetic system of Egypt was revised, stressing the importance of the number 7 and linking the geography of Egypt with the geography of the heavens.

The main feature of the map of the sky is that the sun follows a course which is at an angle with the equator. The circle marked by the sun is called the ecliptic and the angle of this circle with the circle of the equator is the angle of the ecliptic (roughly 24°). The ecliptic cuts the plane of the equator at two points and reaches its highest and lowest points in relation to the equator at celestial latitudes which are marked on the surface of the earth by the tropics.

The moon and the planets in their movements around the earth follow substantially the line of the ecliptic, being at times north and at times south of the course of the sun. (The body which deviates most sharply from the ecliptic is Mercury. Mercury can be as much as 7° 00′ north or south of the ecliptic.) For this reason it was conceived that there was marked in the heavens a great "highway" (*hodos* in Greek) in which there moved the sun, the moon, and the planets. This path is 14° wide and is the origin of the concept of the zodiacal band. Since Mercury determines its dimensions and determines them by a perfect figure, in ancient religions this planet was associated with the god of measurement. It was conceived that the sun, the moon, and the planets were engaged in competing with each other running in the racing course of the zodiacal band. Another conception was that there were two walls, running parallel 14° apart, within which there was going on a ball game. The notion of a wall accounted for the fact that the heavenly bodies could not go beyond a given distance from the ecliptic; they appeared to run away from the ecliptic, hit a wall, and bounce back past the ecliptic to hit the wall on the other side. This is the ritual origin of racing competitions (such as the Olympic races, on foot or in chariots) and of ball games. The most vivid expression of the second conception is the famous ball court in the Mayan city of Chichen Itzá; the structure of this ball court can be understood when one realizes that its two parallel side walls are unfolded cylindrical projections of the sky.

The zodiacal band was conceived to be the inhabited part of the sky; the rest of the sky was still and lifeless (*erēmos,* "desert, desolate," in Greek), because nothing moved in it, except for the rotation of the vault of heaven in a solid block. Hence, in order to make a map of the sky for the study of the moving heavenly bodies, it was enough to draw a map that reaches latitude 31° (24° + 7°). Such a map could be drawn in the form of a cylindrical projection without substantial deformation; this cylindrical projection was unfolded to form a rectangle.

On the basis of this conception, stress was put on the fact that Egypt begins at the line of the tropic of Cancer (the upper edge of the First Cataract is at 24° 00′ north) and extends north for 7°, so that Egypt could be considered as the equivalent on earth of the northern half of the zodiacal band. For the sake of mapping the earth from the equator to the northern limit of Egypt, one could use a cylindrical projection. The maximum deformation in such a type of projection could be determined; it was established that a degree of longitude at parallel 31° 06′ north is exactly 6/7 of a degree of longitude at the equator. According to the Clarke Spheroid a degree of equator is 111,321 meters, of which 6/7 is 95,418 meters; according to the same Spheroid a degree of longitude at 31° 06′ is 95,407 meters. To the north of latitude 31° 06′ north there was the expanse of the Mediterranean, the "Great Green" for the Egyptians, which could be compared with the expanse of the empty sky, north of the same celestial latitude.

The angle of the ecliptic has decreased slowly (today it is 23° 27′; it was about at 23° 45′ in the age of Ptolemy), and accordingly the tropic of Cancer has moved south. This movement is due to the gravitational pull of the planets, particularly Jupiter and Venus. Nobody as yet has succeeded in constructing a valid formula for calculating the angle of the ecliptic in ancient times. But, it is a fact that when the second geodetic system of Egypt was established it was assumed that the tropic of Cancer was at 23° 51′ north. Greek scholars living under the rule of the last Egyptian dynasty, the Ptolemies, continued to quote this figure, although it was not correct at their time.

If the tropic is at 23° 51′ north, it would follow that the southern border of Egypt is out of place. But the discrepancy was rationalized by considering the fact that when one follows the movement of the sun along the ecliptic by observing the shadow cast by a pointer, there must be introduced a correction of about 15′. The position of the shadow is not determined by the center of the sun, but by the upper limb of the disk. The apparent diameter of the sun is about half a degree; calculating exactly, it varies between 32′ 30″ and 31′ 28″, according to the seasons, but, considering the corrections that have to be made for the phenomenon of irradiation, the figure of 15′ for the half diameter of the disk of the sun is satisfactory.

If the tropic of Cancer is at 23° 51′ north, the point at which the sun is at the zenith at noon of the day of the summer solstice is at 24° 06′ north, that is, at the latitude of the lower edge of the First Cataract. Hence, the Egyptians conceived that the line of the tropic of Cancer was marked by three parallels: 23° 51′, 24° 00′, and 24° 06′ north.

For this reason the hieroglyphic symbol for Southern Egypt consists essentially of three parallel lines with a vertical line rising at the middle. Since hieroglyphic writing aims at being colorful and pictorially decorative, this symbol was stylized in the shape of a trunk of a tree from which there sprout three parallel tiers of branches. Egyptologists who do not want to recognize the existence of scientific thought in Egypt have stressed the incidental vegetal appearance of this symbol. They have understood that the name for Southern Egypt, which is *To-Shemau*, "the land of the heat, of the sun, of the summer solstice," means "the land of the plant *sh-m-a*." But if there was such a plant associated with Southern Egypt (which as yet has not been identified), it is possibly the same plant which is called *šamšu*, "sunflower" in Akkadian; the word *šamšu* means "sun" in Akkadian (Hebrew: *šemeš*). In a text of the Old Kingdom in which the hieroglyphs are drawn with particular care, in the symbol for *shemau* there is only one tier of branches, but the trunk starts from a little arc, a semicircle, which obviously symbolizes a parallel. But what probably is most revealing is that in most hieroglyphic texts the tiers of branches sprout from the bottom of the trunk and not from its top.

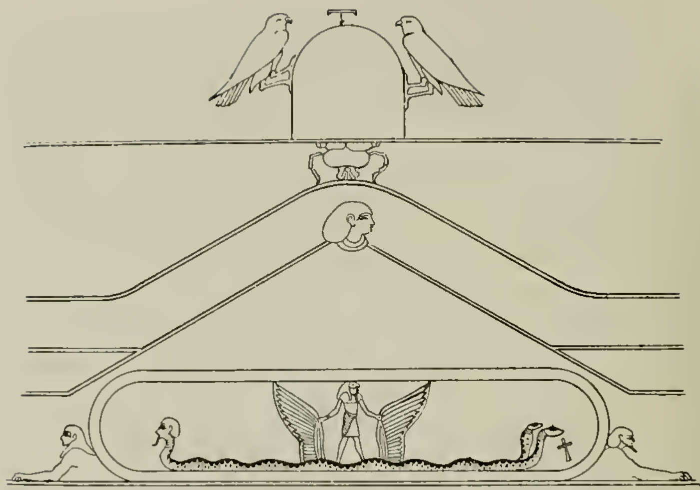
4. Once the latitudes of the southern limit of Egypt were rationalized by identifying the line of the tropic with three parallels (the first of which cuts the lower edge of the First Cataract at 24° 06′, the second cuts the upper

edge of it at the perfect latitude 24° 00′, and the other cuts the Nile at 23° 51′ north, at a place which the Greeks called Parembole, "supplement, addition"), it became possible to rationalize the boundary between Southern Egypt and Northern Egypt. This boundary was understood as marked by three parallels, the first at 30° 06′, the latitude of the apex of the Delta, the second at the perfect latitude 30° 00′, and the third at latitude 29° 51′.

In the administration of Egypt, the area between 29° 51′ and 30° 06′ north was organized as a special district which did not belong either to the list of nomes (provinces) of Southern Egypt nor to that of nomes of Northern Egypt. The hieroglyph for this district is a rectangle which is either empty or filled with water or fish. A distinguished Egyptologist, being at a loss for a better explanation, has read this hieroglyph as "fishpond." He did not realize that a rectangle, either empty or filled with water or fish, is the symbol of the Square of Pegasus. In *Hamlet's Mill,* de Santillana and Dechend have presented illustrations of this symbolism occurring all over the globe (between pages 434 and 435). There are in the sky four stars which are at a distance of about 15° from each other and mark a square with sides that run according to the celestial meridians or parallels; these four stars form the Square of Pegasus. In iconography this square was at times portrayed as filled with water or fish, because it was in the constellation of Pisces. The Square of Pegasus was considered the starting point in the mapping of the sky. The ancients, from the Sumerians to the Romans, in surveying land began by marking a square of a standard dimension and then proceeded to measure out of it in a checkerboard pattern. In cuneiform texts the name *ikū* is given to the basic surveying square, to a unit of land surface, and to the Square of Pegasus. The hieroglyph used to refer to the district extending for 15′ from Memphis-Sokar to the apex of the Delta indicates that this district was considered the basic reference unit from which there started the mapping of Northern and Southern Egypt.

The capital of united Egypt was established at Memphis, at latitude 29° 51′ north. But, since the capital city of necessity had to be on the bank of the Nile, which here runs slightly east of the apex, the geodetic point was set to the west of the city in the funerary area (the city of the dead is always to the west of the city of the living), on the basic meridian 31° 14′ east. This was the point called Sokar, the name of which is preserved by the present village of Saqqara (29° 51′ north, 31° 14′ east). In the religion of the Old Kingdom, Sokar is an important god of orientation

Egyptian papyrus depicting Sokar, the god of orientation. The gadget on top of the *omphalos* is a standard Egyptian measuring ruler (and also the symbol for the sky). The two pigeons facing each other are the standard glyph for the laying out of parallels and meridians.



and of cemeteries. The god and the geodetic point were represented by the stone object which the Greeks called *omphalos,* "navel"; it is a hemisphere (the northern hemisphere) resting on a cylinder (the foundations of the cosmos). Usually on top of Sokar, as on top of any *omphalos,* there are portrayed two birds facing each other; in ancient iconography these two birds, usually doves, are a standard symbol for the stretching of meridians and parallels.

The practice of placing the geodetic center in the city of the dead was followed by King Darius the Great, when he established a new capital for the Persian Empire, Persepolis. Historians have wondered why Darius should have chosen for Persepolis a most inconvenient location; actually the capital of Persepolis was seldom used except for ritualistic purposes. Persepolis is at latitude 30° 00′ north and three units of 7° 12′ east of the main axis of Egypt (31° 14′ east). The reason for choosing units of 7° 12′ is that the Persian Empire was mapped by drawing a series of geodetic squares, east and west of Persepolis, which extend 6° in latitude from 30° 00′ to 36° 00′ north and have a width of 7° 12′ of longitude, since 7° 12′ of longitude is equivalent in actual length to 6° of latitude at the middle point between 30° 00′ and 36° 00′ north. Hence, these geodetic squares are true squares. The geodetic point of Persepolis, 30° 00′ north, 52° 50′ east, is north and west of the wide expanse of the royal buildings and is identified by the tomb of King Darius, around which there were built the tombs of his successors. At the geodetic point 30° 00′ north, 52° 50′ east, there could be erected tombs, but there was not the kind of ground on which there could be stretched a capital city.

The location of Memphis-Sokar had the advantage of being exactly 8° north of the point where meridian 31° 14′ east cuts again the course of the Nile at the Second Cataract. In a new imperialistic spirit, Egypt in a wide sense was understood to end at the Second Cataract.

5. According to the new conception which links Egypt with the sky, if Southern Egypt extends 6° from the tropic, Northern Egypt must extend only 1° to the north of the apex, in order to be in agreement with the order of the cosmos. Hence, the northern limit of Egypt was set at parallel 31° 06′ north.

This was achieved by identifying the northern limit of Egypt with the line that joins the two outer ends of the estuary of the Nile. This line extended 1° 24′ = 1.4° east and west of the axis 31° 14′ east. Hence, there was marked a triangle, which the Greeks called the Delta, with a base line extending from 31° 38′ to 29° 50′ east along parallel 31° 06′ north and a vertex at the long-established point of the apex of the Delta. This isosceles triangle is divided by meridian 31° 14′ into two right triangles of the type *mr*. In calculating the proportions of this triangle, one must keep in mind that at latitude 31° 06′ north, 1.4° of longitude corresponds to 1.2° in actual length, since the degree of longitude is shrunk by 1/7 at this latitude.

The base line of the mathematical triangle of the Delta fell perfectly at the eastern end. Here the corner of the Delta coincides with the well-defined natural boundary point Pelusium, along the shore. On the western side the corner of the Delta did not fall right on the shore, but at the middle of a coastal lagoon; even today the eastern boundary of the Western Desert province of Egypt passes through it.

The old geodetic center of Behdet was not completely ignored, since it could be fitted into the system by considering that it is 1.4° north of the apex of the Delta.

I have stated earlier that it was assumed that at latitude 31° 06′, the degree of longitude is 6/7 of the degree of equator. This calculation permitted the rationalization of the shift of the key positions of Egypt by 6′ to the north of the perfect latitudes 24° 00′ and 30° 00′ north. The shift was related to the polar flattening of the earth, which, according to the septenary order of the cosmos, was assumed to be 1/280. If the earth were a perfect sphere, the degree of longitude which is 6/7 of degree of equator would be at latitude 31° 00′ (cosine 31° 00′ = 0.85717; 6/7 = 0.85714).

Anticipating what I will explain in greater detail later, I must mention here that the dimensions of Egypt were recalculated in terms of a new unit of length, the royal cubit, which is obtained by adding a seventh hand to the usual six which compose a cubit. In terms of this longer cubit, the length of Egypt from 31° 06′ to 24° 00′ north was set at 1,500,000 cubits. The royal cubit summed the septenary spirit of the new geodetic system.

In hieroglyphic writing the name for Northern Egypt is *To-Meḥu*. Most Egyptologists, following the line of reasoning which I have mentioned in relation to Southern Egypt, have understood that *To-Meḥu* means "the land of the papyrus," but the name of the papyrus is *ḥly*, and the symbol for Northern Egypt cannot be compared with a papyrus plant by any stretch of the imagination. The name of Northern Egypt can be explained when we consider that it is similar to the name of the cubit (*maḥe* in Coptic), which comes from a root which means "to fill up." Hence, *To-Meḥu* may mean "the land which fills up the dimensions of Egypt." Northern Egypt corresponds to the seventh hand added to the cubit.

From what we have of early writing attempts from predynastic Egypt, it is absolutely clear that the symbol for Northern Egypt used to be the red straw hat. With the beginning of the dynastic period, the creation of hieroglyphic writing, and the new geodetic system, the symbol of Northern Egypt becomes a plant with three stems springing from one root. In some cases the reference to the triangularity of the Delta is emphasized by putting at the end of each stem a flower with a triangular calyx. In carefully drawn representations the plant springs from a rectangle either empty or filled with the wavy line for water, which is the symbol for the intermediary district, extending from 29° 51′ to 30° 06′ north.

At times the stems in the symbol for Northern Egypt are broken and bent at the top. This may be a reference to the fact that in the new geodetic system the northern limit was lowered from 31° 30′ to 31° 06′ north.

On the two sides of the throne of the Pharaoh there was a design which Egyptologists call "Unity of Egypt." We know it well because it appears in all statues of Pharaohs sitting on the throne; the series of such statues starts with the Fourth Dynasty, but occasional drawings indicate that the design "Unity of Egypt" is older. In the course of centuries the design varied somewhat and the artists who carved the throne stylized it according to different tastes; but on the basis of what I have explained above, one can always recognize that it represents the geodetic system of Egypt.

The center of the design is the hieroglyphic sign for the verb "to unite," which is a windpipe with two lungs.

However, in the design "Unity of Egypt" the windpipe is stretched, so that it looks like a long trunk of a tree, in order to indicate the main axis of Egypt; the lungs are reduced to a diminutive size. On one side of the windpipe there is the symbol for Northern Egypt and on the other side the symbol for Southern Egypt. But what is most significant is that the entire drawing is tied together by a system of ropes and knots, which indicate the geodetic lines and points of Egypt.

The design called "Unity of Egypt" is the standard decoration of the royal throne, because it symbolizes all that the Egyptians held fundamental in their political, ethical, religious, and cosmological conceptions, a cluster of ideas which they summarized by the word *maet,* a word with which I will deal in a following chapter. Nevertheless, this design has received only casual attention. The best way in which I can convey in brief how this design is pregnant with meaning is by referring to Hebrew Cabalistic literature. The Cabala is a Hebrew underground religion or philosophy. The starting point of Cabalistic doctrine is that God in creating the world began by creating the ten numbers and arranged them according to a diagram of points and connecting lines, which proves to be modeled on the design "Unity of Egypt." Actually, what gave me the first insights into the Egyptian geodetic system was the reading of the Italian Renaissance scientists who were influenced by Hebrew Cabalists.

The state of Israel has adopted as its national emblem the Cabalistic symbol of two overlapping triangles. These two triangles should be seen as inscribed in a circle: they represent the poles, the tropics, and the ecliptic, besides having the added meaning of the male and female elements coming together to generate the cosmos. The Founding Fathers adopted as the seal of the United States a pyramid; they wanted to convey the notion that a perfect society had been organized, and in order to convey it they adopted a symbol which, through the tradition transmitted by masonic societies, goes back to the Egyptian idea of *maet.*

6. The geodetic system established at the beginning of the Old Kingdom was modified in part with the advent of the Twelfth Dynasty, the most dynamic of the Egyptian dynasties as far as we know. The advent of this dynasty marks the beginning of what scholars call the Middle Kingdom period. But probably more significant in Egyptian terms was that the advent of this dynasty coincided with the beginning of the age of Aries. It became necessary to revise the system of cosmology, since the sun had moved out of the constellation of Taurus to enter into that of

Aries. The kings of this dynasty identified themselves with the god Amon, symbolized by the ram. The first king of the dynasty called himself Amenemhet, introducing the custom of theophoric names, that is, of personal names composed with the name of a god. The god Amon was made to spring from relative obscurity into the position of the main official divinity of Egypt. It seems that up to that time Amon was a local god of the desert area west of Thebes or that Amon was identified with a local god of that area.

The Twelfth Dynasty moved the capital and the geodetic center of Egypt to a more central position, Thebes. The longitude of the new capital was determined by the point where the eastern axis of Egypt (32° 38′ east) cuts the course of the Nile. The latitude was 2/7 of the distance from the equator to the pole (25° 42′ 51″ north). This latitude was marked by the central room of the temple of Amon, in which the god and the geodetic point most probably was indicated by the same object, the *omphalos,* "navel," which used to represent the god Sokar. What is certain is that when centuries later in the capital of Nubia, Napata, there was built a second temple of Amon in order to link Nubia with Egypt politically, in the center of this temple there was placed such an object.

Egyptologists have tried to torture Egyptian linguistics in order to explain why the Greeks should have given the name Thebes to a city which the Egyptians called Wast. The likely explanation is that the Greeks learned the name of the city from the Phoenicians, who in their own language called it *thibbûn,* "navel." There is textual evidence that in Hebrew, which is practically the same language as Phoenician, the word *thibbûn* is used to refer to a geodetic navel.

The choice of the latitude emphasized the septenary system of Egyptian geography. The ancients divided the space between the pole and the equator into seven zones. This is indicated not only by Greek writers of geography, but also by the ziggurats of Mesopotamia and the earliest pyramids of Egypt, which are step pyramids.

7. It was possibly on the occasion of the transfer of the capital and geodetic center to Thebes, which stresses the importance of the eastern meridian of Egypt (32° 38′ east), that something was done to rationalize the longitude of the First Cataract. The First Cataract happened not to be included in the rectangle of Egypt, being somewhat to the east of meridian 32° 38′, at 32° 53′ east. The lower edge of the cataract, at 24° 06′ north, 32° 53′ east, is 15′ north of the right position and 15′ west of it. It must have been

disturbing that the southern boundary of Egypt should not fit with the system of three meridians passing through the three angles of the Delta triangle. Hence, the area of the First Cataract was extended southward along the course of the Nile up to the point where meridian 32° 38′ east cuts the course of the Nile. This point happens to be at 23° 00′ north. The new point 23° 00′ north, 32° 38′ east was called Sacred Sycamore and was set as the legal boundary of Egypt. The stretch of the Nile from the Sacred Sycamore to the First Cataract was attached to the district of the First Cataract. In Hellenistic times this attached district was called Dodekaschoinos, which in Egyptian would be "twelve *atur.*" The *atur,* as I will explain later, was a unit of length such that slightly more than 14 (14 in practical computations) went into a degree. If the distance of 51′ between 23° 00′ and 23° 51′ north, the correct line of the tropic, is calculated as 12 *atur,* it means that counting exactly a degree would be 14.11765 *atur.* The Egyptians used two types of *atur:* an *atur* of 17,000 geographic cubits (7848.8 meters) and an *atur* of 15,000 royal cubits (7862.2 meters). Now, 51′ at latitude 23° to 24° is about 94,135 meters, whereas 12 *atur* of the first kind is 94,186 meters and 12 *atur* of the second kind is 94,346 meters.

Even though the district Dodekaschoinos was attached to Egypt purely for mathematical reasons, it continued to be included in Egypt into the Roman period.

I suggest that the establishment of the supplementary district Dodekaschoinos with a new southern boundary of Egypt at 23° 00′ north was linked with the transfer of the capital to Thebes, because there is a text which gives the dimensions of Egypt from the sea at Pelusium (eastern corner of the triangle of the Delta) to the end of the district Dodekaschoinos, that is, all along meridian 32° 38′ east. The distance is divided into two-thirds from Pelusium to Thebes and one-third from Thebes to the Sacred Sycamore. If we round the latitude of Thebes from 25° 42′ 51″ north to 25° 42′ north, the calculation is perfect:

31° 06′ to 25° 42′ north = 5° 24′
25° 42′ to 23° 00′ north = 2° 42′

When the southern boundary of Egypt is moved to the Sacred Sycamore by adding the district Dodekaschoinos, the Temple of Amon in Thebes is in a rational position not only in relation to arc of meridian, but also in relation to the extension of Egypt.

The text that gives the information just mentioned indicates also that the latitude of Thebes has a further peculiarity: at this latitude the degree of longitude is 9/10 of degree of equator.

II. EGYPTIAN UNITS OF LENGTH

1. All the measures of length, volume, and weight of the ancient world, including those of China and India, constituted a rational and organic system, which can be reconstructed starting from a fundamental unit of length. I have not yet completed the gathering of data concerning the units of pre-Columbian America, because these are difficult to obtain, since the metrology of the American continent has received meager attention; but the figures that I have succeeded in establishing so far suggest that the American units agree with those of the Old World. The units used in Europe up to the adoption of the French metric system were the ancient ones or modifications of them introduced for specific reasons. The ancient system of measures continues to be used today in the form of English measures; we find the basic units of the English system, such as the pound of 453.8 grams, used in Mesopotamia in the third millennium B.C.

The effort to reconstruct the original and unitary system of measures was started by scholars of the Renaissance as a result of the beginning of the age of geographical discoveries. Their investigations, although they took the form of antiquarian research, had two practical purposes: to interpret correctly the data provided by ancient geographers and to establish an absolutely reliable and fixed standard of length. Although the major concern of Renaissance investigators of measures was to establish the exact value of the ancient Roman foot, they were also concerned with a tradition to the effect that all measures were derived from the Egyptian ones. This is the reason why John Greaves went to measure the Great Pyramid of Giza, in order to complete his researches on the length of the ancient Roman foot. In Egypt Greaves met with Burattini, who had gone to measure the monuments of Egypt, in order to establish the linear starting point (for which he coined the name *meter*) in his proposal for a new metric system which would be strictly decimal, like the one later adopted as the French metric system. Greaves had the advantage of having spent a long time in Rome measuring buildings, vessels, and weights and of being provided with accurate measuring tools, based on English units; Burattini had the advantage of having already measured a number of Egyptian buildings. Greaves and Burattini joined forces in measuring the Great Pyramid of Giza, which they hoped would provide a solution to their problems. After this survey Greaves returned to England, leaving his measuring tools with Burattini, who continued the study of Egyptian monuments. On his return Greaves published the results obtained at Giza, results which were later interpreted by Newton. But Burattini had the ill luck to be robbed of his notes by Hungarian brigands while on his way to Poland. As a result, when he published his proposal for a decimal metric system, for lack of a better alternative, he advocated that one should start with the English foot and divide the cube of this foot decimally in order to obtain the units of volume and weight.

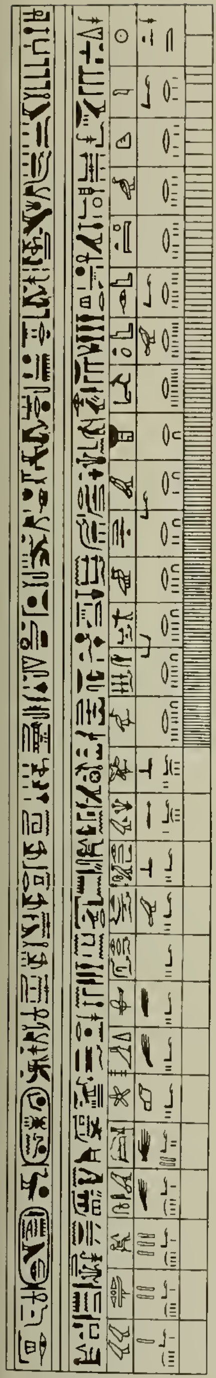
The study of Egyptian measures received a new impulsion with the Napoleonic expedition to Egypt and the consequent decipherment of Egyptian hieroglyphs by Champollion. This decipherment had been unsuccessfully attempted by Father Athanasius Kircher, who had sponsored Burattini's expedition to Egypt. In the first half of the nineteenth century, it was established that the Egyptians had a septenary system of linear units.

In the ancient world one measured by feet and cubits. The cubit is equal to 1 1/2 feet. The cubit is divided into 6 hands of 4 fingers each (24 fingers) and the foot is divided into 4 hands (16 fingers). The division of the foot into 12 inches, with which we are familiar, became common only with the Romans. According to the Roman reckoning the cubit is 16 inches. The inch was considered to be the thickness of the thumb; generally in the ancient world one preferred to reckon by fingers, assumed to be the thickness of the other four fingers. It must be kept in mind, however, that terms like foot, cubit, finger, and inch were introduced in order to give a name to units obtained scientifically, units which correspond only vaguely to the natural units of the same name.

Scholars of Egyptology concluded that the Egyptians had started with a foot of 300 millimeters and a corresponding cubit of 450 millimeters, divided into 16 and 24 fingers as in the rest of the ancient world, but then had adopted as their linear basic unit a cubit, called a royal cubit, of 525 millimeters. The royal cubit is composed of 7 hands, or 28 fingers: it is an ordinary cubit with a seventh hand added.

2. One can find examples of septenary units also outside Egypt. The use of measuring rods of seven feet is common in medieval and early modern Europe. A typical example of septenary units is the Russian *sajen'*, which is composed of 7 English feet and is divided into 3 *arshin* of 28 inches. The *sajen'* was the basis of the Russian system of measures until the Soviet government adopted the French metric system in 1918.

The reason for the occurrence of septenary units is that they were convenient in practical reckonings. Agrarian units of surface were arranged in a series in which each was double of the preceding one. It was assumed in practical



Egyptian measuring rule carved out of wood showing various fingers, palms, and cubits (at present in the Turin Musem).

reckonings that a square with a side of 100 was the double of a square with a side of 70 and the half of a square with a side of 140. This implies that $\sqrt{2} = 1.414214$, taken as equal to 1.4. A typical example of this reckoning is the area of 5000 square cubits, within which a Jew can move on the Sabbath, which is described by the Talmud as "the square of seventy cubits." When greater precision was desired in practical reckonings, one averaged the results of considering the diagonal of a square as 10/7 of the side and as 14/10 of the side ($1.42857 + 1.4/2 = 1.41428$).

Septenary units were used also in order to facilitate other practical reckonings. The height of an equilateral triangle being equal to $\sqrt{3}/2$ of the side, the relation can be taken as 7:6, since $12/7 = 1.71428$ and $\sqrt{3} = 1.73205$.

According to the septenary system of reckoning, the circumference was considered 22/7 of the diameter; the approximation $\pi = 3\ 1/7 = 3.142857$ is still used today as an adequate approximation in many problems of engineering.

The figure 22/7 used to obtain the value of π in practical reckonings is related to the fact that the ancients used both septenary and undecimal (i.e., eleven-based) units in order to achieve easy computations in practical reckonings. Undecimal linear units were common in the ancient and early modern world; an example of them is the English chain of 66 feet. An acre, originally a square with sides of 70 yards, is now 10 square chains (4840 sq. yards).

An important practical problem involving the number π was solved by the use of undecimal units. Units of volume were legally defined as cubes, but measuring vessels were built as cylinders. All that an ordinary potter, who could be an illiterate person, had to know was that, in order to construct a cylinder equal in volume to a given cube, he had to take the height and width of the cube and use them as the height and diameter of the cylinder, provided he measured the cylinder by a ruler based on a unit of length increased by 1/10. The procedure results in a cylinder of slightly excessive volume. If we assume a cube with a side of 10 fingers, its volume is 1000 cubic fingers. A cylinder with a diameter of 11 fingers and height of 11 has a volume of 1045.4 cubic fingers. But this small excess was automatically corrected in practice, since a measuring vase must have a rim and cannot be filled to the brim. A filling line marked on the measuring vase slightly below the brim took care of the difference. I first became aware of this procedure in interpreting cuneiform mathematical texts, but later I found it referred to in Athenian inscriptions and applied concretely in Athenian measuring vessels.

By combining calculations by the factor 7 and calculations by the factor 11, one could solve practically a number of geometric problems involving irrational numbers. This practice is one of the reasons why the builders of the Great Pyramid began their plan with a height of 280 royal cubits and a side of 440.

A simple example of the combination of reckoning by septenary and undecimal units is the following. As I have said, in agrarian units it was assumed that a square with the side of 100 is the double of a square with a side of 70 and half of a square with a side of 140. This procedure would result in units of the following surface:

49,000
100,000
196,000

In order to make the series more regular, the middle unit was often taken as a square with a side of 99, so that the series became:

49,000
98,010
196,000

When Herodotus reports the surface of the sides of the Great Pyramid, he reckons by units of surface calculating by the second pattern.

Although the use of septenary units had been common in ancient times and later, in Egypt the septenary cubit became a national symbol related to the essential structure of Egypt and of the cosmic order.

3. In the second half of the nineteenth century, some scholars of ancient measures tried to derive them from the Egyptian units of length. Although in the last fifty years it has become fashionable among scholars of ancient cultures to deny that they had any knowledge of a scientific system of measures, all serious scholars of ancient and medieval measures have always known that all measures of volume and weight are derived from the units of length. Units of volume were obtained by cubing the units of length. Units of weight were obtained by filling the units of volume with rain water at ordinary temperature; this water has the same density as distilled water at 4° Centigrade adopted by the French metric system, since in the earlier procedure the impurities of the rain water compensated for the higher temperature.

Friedrich Hultsch, who was the most authoritative investigator of ancient measures in the later part of the last century, concluded his lifelong research by announcing just before his death that all ancient measures could be derived from the Egyptian foot of 300 millimeters and from the corresponding ordinary (not septenary) cubit of 450 millimeters. He also supported the view expressed by others that the Egyptian unit of weight called *qedet,* of 9 grams, is the basic unit of weight of the ancient world.

But Hultsch left a difficulty unsolved. If we cube an Egyptian foot of 300 millimeters, we obtain a cube of 27,000 cubic centimeters or grams, which is divided into 3000 *qedet* of 9 grams. If we cube an Egyptian ordinary cubit of 450 millimeters, we obtain a cube of 91,125 cubic centimeters or grams, which is divided into 10,000 *qedet* of 9.1125 grams. Sample weights indicate that both *qedet* were used in Egypt. A *qedet* of 9 grams relates to a *qedet* of 9.1125 grams as 80:81.

The same discrepancy occurs all over the ancient world. Prince Mihail Sutzu, Director of the National Bank of Rumania, having dedicated his life to the study of ancient weights, in 1930 concluded that the *qedet* of 9 grams is the *bazele fundamentale ale metrologiei ponderale din antichitate,* but, in order to explain the mentioned discrepancy in weights, supposed that there had been a gradual decrease from a unit of 9.20 grams established in the neolithic period.

But in presenting this explanation Sutzu contradicted one of his basic assumptions, which is the amazing stability of measures throughout history. From the very beginning of literate cultures, documents indicate an extreme concern with the preservation of exact metric standards. The concern with precision seems to have lessened in the course of history. Early modern Europe was less careful than medieval Europe. The Greeks of the Hellenistic age were less careful than those of the classical age. Even though the Greeks of the classical age seem to have been obsessed with the problem of correct standards, they did not reach the subtlety of Egypt and Mesopotamia. One of the reasons why the study of the history of measures was actively pursued in the late Renaissance was that by that time standards had started to waver.

There were two factors which determined extreme concern with absolutely exact standards: units of length were used to measure geographic distances, and units of weight were used to measure gold and silver used as means of exchange.

The amazing stability of measures is indicated by the circumstance that the kilogram was established by relating it to the Paris livre which was directly related to the Roman *libra*. The official definition of the kilogram is such that the livre equals 489.5058466 grams. Since the livre was divided into 9216 grains (16 ounces of 24 scruples of 24 grains), the Paris grain according to this definition is 0.05311478 gram. Historically the Paris livre was established by fixing the Paris grains as 1/6100 of the ancient Roman *libra*, the Roman *libra* being 324 grams (5000 English grains) or 36 Egyptian *qedet*. If the original standard had been preserved, the grain of Paris would have been found at the moment of adoption of the French metric system to be 0.05311475 gram and the livre to be 489.5055737 grams. In substance the standard of the Paris livre and hence of the Roman *libra* appear to have been well preserved, even though those who established the French metric system did not consider the theoretical foundations of the livre, but simply averaged several sample weights which were available. However, scholars of the seventeenth century complained that Paris measures were not very clearly defined and had concluded that English units of weight were more exactly defined.

The English grain has remained stable as 1/5000 of a Roman *libra*. English weight units have not changed at all since Sumerian times. The oldest weights of which I have found mention in an archeological report are those excavated at Tepe Gawra in Iraq, near the present oil center of Mosul. The lowest strata of Tepe Gawra embody the very first steps of the transition from village life to urban life. The earliest weights of Tepe Gawra precede by about a millennium the invention of writing. According to my interpretation these weights are fractions of the present English ounce avoirdupois of 28.350 grams (1/16 pound, which is 7/5 of a Roman *libra*).

4. Before explaining why there was a *qedet* of 9 grams and a *qedet* of 9.1125 grams, I must deal with a much more serious difficulty met by Hultsch.

He assumed that all measures of the ancient world can be derived from the Egyptian foot, but could not solve the absolutely essential problem of explaining how the Roman foot of roughly 296 millimeters could be derived from the Egyptian foot of 300 millimeters.

The key to the solution of this problem was provided to me when in 1942 the archeologist August Oxé, at the end of lifelong research, published a monograph explaining that almost all units of volume and weight of the ancient world exist in two varieties, related as:

12.5	25	50	62.5	75	100	125	150
12	24	48	60	72	96	120	144

He called the first series units *brutto*, and the second series units *netto*. The reason for the existence of the second series is that it is impossible from the practical point of view to divide decimally a cube into smaller cubes.

Developing the discovery of Oxé, I arrived at the logical consequence that units of length must usually occur in two varieties, one which is the edge of a cube containing a unit *brutto* and one which is the edge of a cube containing a unit *netto*. The two varieties of units of length are related as $\sqrt[3]{25}:\sqrt[3]{24}$. I call the first group of units of length by the name of *natural* units and the second group by the name of *trimmed* units.

From an Egyptian cubit of 300 millimeters we derive:

Basic talent *brutto* of 27,000 cubic centimeters or grams
1000 Roman ounces of 27 cubic centimeters or grams
3000 Egyptian *qedet* of 9 grams

It follows that the cube of the Roman foot (which the Romans called *quadrantal*, or *pes quadratus*) must be 24/25 of the preceding unit:

Basic talent *netto* of 25,920 cubic centimeters or grams
960 Roman ounces of 27 cubic centimeters or grams
2880 Egyptian *qedet* of 9 grams

The Roman quadrantal or basic talent *netto* is divided into 80 librae of 324 grams (12 ounces or 36 *qedet*). The libra is equal to 5000 English grains.

Accordingly I could establish that the Roman foot relates as $\sqrt[3]{24}:\sqrt[3]{25}$ to the Egyptian foot of 300 millimeters, and hence is a unit of 295.9454 millimeters, which is a figure in agreement with the empirical evidence.

Having established the theoretical basis of the Roman foot and of the Roman quadrantal, I could dispose of a difficulty which had bedeviled scholars since the Renaissance. By examining the empirical evidence it had been established that the Roman foot existed in two varieties, one shorter (called *pes Statilianus* by Renaissance scholars) and one longer (called *pes Aebutianus*). Correspondingly, there were two varieties of Roman libra.

The explanation for this difference is that units of volume and weight may occur in two varieties related as 80:81, with a difference which I call discrepancy komma. In 1909 Jean Adolphe Decourdemanche, at the end of his book on Arabic measures, added a proviso explaining that all Arabic units of weight and volume occur in two varieties related as 80:81. My teacher Angelo Segré, in studying the measures of Hellenistic Egypt, found that, although the cube of the cubit is 3 3/8 of the cube of the foot, given that $(1\ 1/2)^3:1^3 = 3\ 3/8:1$, often this relation between the cube of the cubit and the cube of the foot is taken as a relation 3 1/3:1 for the sake of easy reckoning, with the result that there is a discrepancy of 1/80, since 3 1/3:3 3/8 = 80:81.

The most striking example of the discrepancy komma (1/80) is that next to the quadrantal (cubed Roman foot) of 80 librae there is a quadrantal of 81 librae. This larger quadrantal has an edge which constitutes a special Roman foot of 297.1734 millimeters (instead of 295.9454 millimeters), which was called geometric foot in the Middle Ages. The Roman foot of the geometric variety was the scientific foot of early modern science. Scientists began to calculate by the French *pied de roi* (which originally was the undecimal version, 11/10, of the Roman foot) after Picard used it in his famous calculation of the circumference of the earth, and Newton quoted Picard's figures in presenting the empirical proofs for the theory of gravitation. The *pied de roi* was used in calculating the length of the Paris meter, theoretically defined as 1/10,000,000 of the arc of meridian: the meter is 1/10,000,000 of 30,784,440 *pieds de roi,* which was then the assumed length of the arc of meridian from the equator to the pole.

By dividing the quadrantal of 81 librae into 80 librae, the Romans obtained a libra of 328.050 grams, which was called the *geometric libra* in the Middle Ages. The edge of the larger quadrantal, the Roman *geometric foot,* was the standard unit in the planning of most monuments of classical Athens.

The larger Roman quadrantal (81 regular librae = 80 librae of the geometric variety), cube of a Roman geometric foot 297.1734 millimeters, contains 26,244 cubic centimeters or grams. It survived up to recently as the Russian *chetverik* (this Russian term has the same meaning as the Latin *quadrantal*). The law of 1918 that introduced the French metric system in the Soviet Union fixed the *chetverik* at 26,239 cubic centimeters.

The reason for the small difference is that Czar Peter the Great, according to his westernizing policy, had the length of the Russian *sajen'* readjusted to make it equal to 7 of the feet used in England. But the exact standard of the English foot had been lost in the Elizabethan age, and the length of the English foot has wavered until in England there was established the Imperial Yard of 1824, which makes the foot equal to 304.79974 millimeters, and in the United States the foot was defined by the Paris meter as 304.8 millimeters (act of Congress of 1928). The reform of Peter the Great caused uncertainties in the definition of Russian measures. The action of one autocrat extended the damage caused by another. As far as I can understand the record, the problem of the length of the English foot arose when Queen Elizabeth, following her policy which aimed at reducing the power of the municipal body of London, downgraded the authority of the standard of Guild Hall (*pes Curiae Londinensis*), which was considered by scholars the best standard of English foot. Incidentally, Piazzi Smyth suggested that a way to reconstruct the authentic value of the English foot is to compare the actual dimensions of the King's Chamber of the Great Pyramid with the report of the survey conducted by Greaves.

On the other side, I have examined the reports about the dimensions of the Church of St. Sophia in Novgorod, the oldest stone monument of Russia, in order to establish what was the original value of the Russian counterpart of the English foot. From the point of view of my investigations, it is lucky that an effort has been made to restore this church exactly as it was before it was destroyed by the German army in World War II.

5. Once I was able to establish the relationship between the Roman foot and the Egyptian foot (the former being the trimmed version of the latter) and succeeded in clarifying the history of the units called Roman by distinguishing two varieties of libra related as 80:81, I came to the conclusion that the root of the ancient system of measures is not the Egyptian foot of 300 millimeters, but another unit which is the geographic foot of 307.7957 millimeters.

If we take 9/8 of a Roman quadrantal of 80 regular librae or 10/9 of a Roman quadrantal of 81 such librae, we have a unit of 90 librae, which metrologists call the *artaba*. Artaba is the Persian name of this unit. Metrologists employ it because after this unit was adopted as the official standard by the Persian Empire, the use of its Persian name became general in the ancient world: we find it in Greek, Latin, Hebrew, Syriac, and Arabic texts. But the unit itself is as old as any other known unit of the ancient world.

The artaba has the following contents:

29,160	cubic centimeters or grams
90	Roman librae
1080	Roman ounces of 27 cubic centimeters or grams
3200	Egyptian *qedet* of 9.1125 grams
3240	Egyptian *qedet* of 9 grams
450,000	English grains

The artaba was a unit of paramount importance in Egypt and several other areas of the ancient world, because it was the standard ration of wheat for a month. This was the ration for an adult free male; women, slaves, and children were assigned fractions of it. The artaba was also the standard monthly ration of rice in China.

In cuneiform mathematical and economic texts the most common unit of volume is a pint (*sila* in Sumerian, *gā* in Akkadian) of 486 cubic centimeters, which is 1/60 artaba. The pint of cuneiform texts is divided into 60 sheqels of 8.10 grams (9/10 of an Egyptian *qedet*).

The paramount importance of the artaba continued up to modern times. I have established that the key to the metric systems of medieval Europe is an ounce of 29.160 grams, which is 1/1000 of an artaba of water. This ounce was made important in Europe by the monetary reforms enacted by the Frankish Kings Pepin and Charlemagne. The artabic ounce was known in Europe as the Cologne ounce, because Cologne was the seat of one of the important mints of the Carolingian Empire. In England the artabic ounce was called ounce Tower, after the mint of the Tower of London.

In England the ounce Tower remained stable at 450 English grains (29.160 grams) or 16/15 of ounce Troy. The ounce Tower is no longer used today because it was used only to weigh coins. On the European continent the Cologne ounce remained less stable, because often it was computed as 451 grains (to my knowledge this figure is first mentioned in a document A.D. 1275). The reason for this shift was an effort to adjust the Cologne ounce to a shift in the Paris livre. The Paris livre was divided into 9216 grains (16 ounces of 24 scruples of 24 grains). For technical reasons of monetary economics, the Paris ounce had to be 22/21 of an artabic ounce. Hence, in the early Middle Ages the Paris ounce was 30.54857 grams and the Paris livre 488.77714 grams, with a grain of 0.0530357 gram. Since there were 6109.1 of these grains in the Roman libra of 324 grams, in the later part of the Middle Ages, in order to relate easily the Paris units to a well-established standard, the Paris grain was recalculated as 1/6100 of a Roman libra and the Paris ounce and livre were increased accordingly (livre of 489.50557 grams). The Paris grain (0.05311475 gram) came to be 50/61 of the English grain. This small and apparently reasonable readjustment of the Paris units was enough to create a spreading wave of uncertainty in the value of European weight units which did not come to rest for centuries. For instance, one can trace its consequences in metric and economic documents of the Low Countries, Scandinavia, and Russia.

Because of the increase in the Paris units, the Cologne ounce came to be often calculated as 451 English grains instead of 450. At the beginning of the nineteenth century, when the German states were taking steps toward national unity, it was thought expedient to try to unify the German coinage in terms of the Cologne ounce. A survey conducted in 1829 established that in Cologne itself the Cologne mark (8 ounces) was 233.8123 grams; 8 artabic ounces would be 233.280 grams and 8 ounces of 451 English grains would be 233.79840 grams. The standards of other German cities were found to be slightly different from that of Cologne, reaching a minimum with the mark of the mint of Bonn, which was

233.612 grams. On July 30, 1838, the German states signed a convention to establish a uniform monetary mark defined in terms of the French metric units as 233.855 grams; but the mine administration of Saxony continued to consider as correct the mark of Dresden, which had been set at 233.5804 grams in an assembly for the testing of monetary weights (*Münzprobationstag*) held at Regensburg in 1737. Apparently the assembly of Regensburg had followed the pattern of the medieval Assizes of Weights and Measures, who when called to resolve discrepancies between different standards of the same measure usually settled the matter by selecting an intermediary value. I may finally mention that when the French metric system was adopted in Spain, it was decreed that the pound of Aragon, composed of 12 ounces, would be thereforth considered equal to 350 grams; 12 artabic ounces is 348.720 grams.

6. The edge of the cube containing an artaba is a foot of 307.7957 millimeters (cubit of 461.6935 millimeters), which I call geographic foot, because it was the unit most commonly used in geographic measurements in all areas of the ancient world, Egypt being excepted for reasons that I will explain.

The multiple of the geographic foot is the stadium of 600 feet (400 cubits). The stadium is 1/600 degree, so that there are 360,000 geographic feet in a degree. It was assumed that a stadium (184.677 meters) corresponds to a double minute of march, implying that a man makes a step of 5 feet in a second. It was assumed that a man marching or a ship under oars covers 30 stadia (5540.3 meters) in an hour. Since it was assumed that a man can march or row for 10 hours a day, 300 stadia was considered the distance normally covered in a day. There are a great number of texts from Egypt and other areas of the ancient world which have not been understood, because they speak of 1,2,3,4, . . . days of march, when they mean a geographic distance of 30′, 1°, 1° 30′, 2°. . . . It was assumed that the speed of a ship under sail is 5/4 of that of a ship propelled by oars, so that a ship under sail covers 37.5 stadia in an hour and 900 stadia (1 1/2 degrees) in 24 hours.

In the ancient world the degree of latitude was usually reckoned as 360,000 feet (600 stadia). Sailors and travelers of the eastern Mediterranean and of the Middle East reckoned the degree of longitude as roughly 500 stadia, or 300,000 geographic feet (92,339 meters); this calculation is correct between parallels 34° and 35°.

The calculations of the degree of latitude as 360,000 geographic feet (240,000 geographic cubits) proves to be of Egyptian origin, since a degree of 110,806.5 meters proves to be correct at parallel 27° 45′ north, which is the middle latitude of Egypt according to the predynastic geodetic system, which counted 7° 30′ from Behdet to the southern limit of Egypt, latitude 24° 00′ north. According to the *Smithsonian Geographical Tables,* a degree at parallel 27° 45′ is 110,803.0 meters.

The Egyptians preferred to reckon by cubits (stadium of 400 cubits and degree of 240,000 cubits), because it is expedient to divide the circumference of the earth not only into 360 degrees but also into 24 hours. According to the second system a degree is equal to 4 minutes of time and a minute of degree is equal to 4 seconds of time. I shall deal with this matter more extensively later.

Two great scholars of this century who have dedicated their lives to the study of ancient measures concluded that these are so strictly defined and so rigorously organized that they must have a basis on some absolute natural standard. Since it is obvious from the reading of ancient texts that the ancients had a deep concern with cosmic time, with the movement of the vault of heaven, these two scholars concluded that the system of measures must have coordinated not only length, volume, and weight, but also time.

The first of these two scholars, Sir Flinders Petrie, whose major concern was Egyptian measures, thought that the starting point of ancient measures was the length of the pendulum. He advanced the theory that the Egyptians began with a pendulum that swings 100,000 times a day at the latitude of Memphis (29° 51′ north). Having established that this pendulum has a length of 740.57 millimeters, they would have taken as standard of length the side of a square the diagonal of which is the length of the pendulum. This would be the origin of the Egyptian royal cubit. Calculating by this procedure, the royal cubit would be 523.66 millimeters, but Petrie estimates it as about 524 millimeters.

Carl Friedrich Lehmann-Haupt, a scholar of ancient history who, after the death of Hultsch, took over the role of the great German specialist of ancient measures, making them his major concern up to his death in 1936, followed the same line of reasoning. Since he started his activities as one of the decipherers of the Sumerian language and was particularly competent in the reading of cuneiform mathematical texts, he argued that the ancient system of measures was organized in Mesopotamia from the pendulum that beats the second at latitude 30°. The early inhabitants of Mesopotamia would have taken the half of this length as their cubit (cubit of 491.16 millimeters according to Lehmann-Haupt).

The idea was not completely new: in the period of the adoption of the French metric system, there occurred to a scholar of ancient measures that the Roman foot might have been calculated as the length of the pendulum that beats the half-second.

Unfortunately, Petrie and Lehmann-Haupt were not so well informed about the history of measures as they should have been. Soon after Galileo discovered the law of isochronism of the pendulum, since scholars were debating among themselves the project for a new decimal system of measures, it was suggested by several of them that the new system should be based on the length of the pendulum, in order to link together time, length, volume, and weight. But in the course of the eighteenth century it was realized that the pendulum does not provide a reliable standard of length. First of all, it was established that the period of oscillation of the pendulum changes according to the latitude; this led to the discovery of the polar flattening of the earth. It was also successively established that the period of oscillation is influenced by the density of the earth and by any presence of large masses of matter, since the period depends on the gravitational pull. Hence, by the time of the adoption of the French metric system, it had been decided that the new decimal system should limit itself to coordinating length, volume, and weight.

When the Constitution of the United States was drafted, there was included a special clause to prepare the ground for the adoption of a new decimal system of measures, which was advocated by all enlightened people. When the French Revolution in one of its first steps put into law the decimal metric system, the Congress of the United States considered adopting the French system. But Thomas Jefferson, whom Congress respected as the authority on such matters, opposed the plan on the ground that the French system was inadequate, since it did not coordinate time with length, volume, and weight. This opposition from inside the camp of the progressive forces doomed the adoption of the decimal system in the United States.

Jefferson was correct in principle, and so were Petrie and Lehmann-Haupt. A truly desirable system of measures should coordinate time, length, volume, and weight, but what these people did not know is that the ancients had found an easy and reliable method to coordinate length with time. All that is needed is to relate the unit of length to the speed of the rotation of the vault of heaven, since this is the basis of our calculations of time. As I will explain later, today we calculate time by the length of the mean solar day, but since this is a highly artificial concept, astronomers set the length of the solar day by the apparent motion of the vault of heaven (sidereal time), which flows evenly.

The problem of coordinating time with the other measures is so important that after decades of research on ancient measures I was still fumbling for one element which would allow me to fit all my findings together, until Peter Tompkins ripped the veil from my eyes by pointing out to me that speed of rotation of the vault of heaven is 1000 geographic cubits a second.

The Egyptians set their standards of length in a manner that permits an easy correlation with time, but still the standard which was scientifically defined had to be the standard of length.

7. The tradition of what was the ancient procedure has been preserved by the scientist and mathematician Girolamo Cardano (1501–1576). Like other Renaissance scholars he was concerned with the establishment of an absolutely inalterable standard of length. In his book *De Subtilitate* (Chapter XVII, edition of Basel, 1553, p. 475) he discusses the length of the ancient Roman foot and passes from it to the problem of how to base length and weight on a *mensura perpetua*. He observes that such an absolute standard should be searched for in the heavens, but, since this is impossible for practical reasons, he declares that the standard is provided by the pyramids of Egypt, the Labyrinth of Thebes, cities like Cairo, and the river Nile. The meaning of this statement is perfectly clear, when we consider the geodetic system of Egypt, as I have reconstructed it; but its form is cryptic. This should not be surprising, since it is known that Cardano has been cryptic in announcing some of his major mathematical discoveries. It had been the practice of scientists and mathematicians up to the age of Newton to put into print the data which they considered of essential importance in a form such that the meaning would become obvious only after an explanation had been communicated orally, because this was the only method they had of protecting their copyright.

The Egyptians decided that the distance of 7° 30′ from Behdet to the southern boundary of Egypt should be reckoned as 1,800,000 geographic cubits. According to the *Smithsonian Geographical Tables* the interval from 31° 30′ to 24° 00′ is 831,091 meters. According to my findings 1,800,000 geographic cubits are 831,048 meters. The figures of the *Smithsonian Geographical Tables* are an estimate of the average length of the degree of latitude, based on the assumption that the earth is a regular geometric body. It would be necessary to consider what is the actual length of the degree in Egypt. Up to now I have deliberately avoided obtaining this information, because I did not want my interpretation of the texts to be influenced by the knowledge of the possible results.

In order to appreciate the nicety of the Egyptian figure, we must keep in mind that in the first French legislation the length of the meter was established by assuming that the arc of meridian is 30,794,580 *pieds de roi,* on the basis of the survey conducted in 1740. Later the length of the meter was revised to the present one, because according to the survey conducted in 1792–98 the arc of meridian is 30,784,440 *pieds de roi*. After this survey the meter was no longer revised, although it has been ascertained that the arc of meridian is about 2000 meters more than 10,000,000 meters.

8. From the geographic cubit, defined as 1/1,800,000 of the length of Egypt, there was derived the geographic foot of 307.7957 millimeters. By cubing this there was fixed the volume of the artaba as 29,160 cubic centimeters.

The artaba was divided into 64 pints of 455.6250 cubic centimeters, that is, into 64 cubes with a side of a hand (4 fingers = 1/4 foot). This unit is the standard pint of Egypt. The pint was divided into 50 *qedet* of 9.1125 grams, employed to weigh gold and silver used as a means of exchange. Sutzu is correct in concluding that, although the *qedet* of 9 grams is the more current unit of weight in advanced civilizations, the heavier *qedet* appears common in prehistoric or early times.

From the artaba there was derived a unit of 3 artabas, which is the cube of the Roman cubit. This is the origin of the Roman foot. There was also derived a unit which is the *brutto* version of the preceding one; since in the cube of the Roman cubit there are 9600 *qedet,* this second unit contains 10,000 *qedet* of 9.1125 grams. The edge of the cube which corresponds to this second unit is the ordinary Egyptian cubit of 450 millimeters. This cubit implies a foot of 300 millimeters. The cube of this foot is the talent of 27,000 cubic centimeters or grams, which was divided into 3000 *qedet* of 9 grams or 1000 Roman ounces of 27 cubic centimeters or grams. The *netto* version of this unit is the cube of the Roman foot (25,920 cubic centimeters or grams). Since the cube of the Roman foot is 8/9 artaba, this cube was divided into 80 librae of 36 *qedet* of 9 grams, whereas the artaba is composed of 90 librae. Three *qedet* of 9 grams makes the Roman ounce of which 1000 makes the cube of the Egyptian foot of 300 millimeters (27,000 cubic centimeters or grams). However, following the reckoning of a *qedet* of 9.1125 grams there continued to be in common use a larger quadrantal (Russian *chetverik*), the edge of which is the Roman geometric foot, and which contains 80 geometric librae

(81/80 of regular libra of 324 grams). This larger quadrantal is 9/10 of artaba.

The organization of the units according to this pattern had a practical purpose. The unit of 3 artabas was the cube of the cubit (443.9181 millimeter) called Roman, a unit of 87,470 cubic centimeters or grams. This was considered a unit *netto*, to which there corresponded a unit *brutto* (25/24) of 91,125 cubic centimeters or grams, which is the cube of the common Egyptian cubit of 450 millimeters. The units of 87,470 grams and of 91,125 grams, that is, the weight of the cubes of the Roman and of the common Egyptian cubits filled with water, are called by me basic load *netto* and basic load *brutto*. I have given them these names because they were considered the standard amount that could be carried by a pack ass. In Akkadian these units are called *imēru*, which means "ass." The Masoretic text of the Old Testament uses a different punctuation of vowels under the consonants to distinguish between the term *ḥmr* as referring to an ass and the same term as referring to the unit of measure, but there are puns in the Old Testament which indicate that one could confuse one meaning with the other. Since the language of measures is very international, there is a transfer of terms among Semitic, Indo-European, and Fenno-Ugrian languages, in which the same terms are applied at times to the measure and at times to the animal. Some easy examples are the following. In Hellenistic Egypt the ass was called *gomarion*, from *gomos*, "load"; the ass is called *gomari* in modern Greek. In Italian the ass is called *somaro*, from the Greek *sagma*, "pack saddle." The corresponding English word is *sumpter*, which corresponds to a German *Saumtier*, a term in turn corresponding to the Italian *bestia da soma*, "pack animal." In German *Saum* means "burden" and also refers to a large unit of measure. In Italian *salma* is both a large unit of weight or volume and a corpse carried on a stretcher, which has on the average the weight of what I call a basic load.

The cube of the foot was called talent in Greek or by equivalent terms in other languages of the ancient world. There was a basic talent *netto* of 25,920 grams and basic talent *brutto* of 27,000 grams, which were respectively the cube of the Roman foot of 295.9454 millimeters and the cube of the Egyptian foot of 300 millimeters. Names such as talent refer to the fact that these weights were considered half of the amount that could be transported by a man. It was assumed that a man transports burdens by suspending them at the two ends of a carrying yoke. At each end of the yoke there were weights, which ideally had to be identical; each of these weights was called a talent. It is evident that this is the origin of the idea of equilibrium and of the measuring scale. Incidentally, I may also mention that it was assumed that the carrying yoke has a length of 2 cubits or three feet.

9. Since the development of units from the artaba had started with the cube of the Roman cubit, which is equal to 3 artabas, there was developed a unit equal to 5 artabas. The edge of the cube containing 5 artabas is the origin of the Egyptian royal cubit. Five artabas were the volume of a basic load of barley (barley was assumed to have a specific gravity between 0.6 and 0.666).

The edge of the cube which contains 5 artabas was interpreted as the septenary version of the Egyptian cubit of 450 millimeters, that is, as a cubit of 7 hands (28 fingers) instead of the normal 6 hands (24 fingers). But, if we reckon exactly, the cube of the cubit of 525 millimeters contains 144,703.125 cubic centimeters, which is something less than 5 artabas = 145,800 cubic centimeters. A unit of 5 artabas should contain 16,000 *qedet*. By dividing the cube with an edge of 525 millimeters by 16,000 there is obtained a *qedet* of 9.043945 grams, which is intermediary between the *qedet* of 9 grams and the *qedet* of 9.1125 grams. The analysis of the distribution of the weights of Egyptian sample weights indicates that there were in use three standards of *qedet:*

9.000000 grams
9.043945 grams
9.112500 grams

Correspondingly, the study of the monuments and of the measuring rods indicates that there were three values of the royal cubit:

524.1483 millimeters
525.0000 millimeters
526.3231 millimeters

The first royal cubit is the edge of the cube containing 16,000 *qedet* of 9 grams. It is the standard of the Great Pyramid and of the immense complex of buildings erected by the architect Imhotep around the pyramid of King Zoser of the Third Dynasty. This royal cubit was the scientific unit of Egypt, employed in the calculation of geographic distances.

The second royal cubit was exactly 7/6 of the Egyptian cubit of 450 millimeters. It was the one most commonly used in ordinary life. It is the standard of the Second Pyramid of Giza.

The third royal cubit had the virtue of being the edge of the cube containing exactly 5 artabas (16,000 *qedet* of 9.1125 grams). It is the standard of the coffers of the mentioned two pyramids of Giza.

The royal cubit had the advantage of being a septenary unit, a type of unit which had been found convenient in the practical solution of problems involving irrational roots such as $\sqrt{2}$, $\sqrt{3}$, and π. But, when the reorganization of the Egyptian geodetic system with the unification of Egypt stressed the number 7 as the link between the dimensions of Egypt and the order of the heavens, the septenary royal cubit was raised to the status of a national symbol and became the official standard of the Egyptian monarchy.

It may be worth pointing out, in order to indicate how the great majority of scholars deal with these problems, that Eduard Meyer, whose ideas and method dominate contemporary history of antiquity and of Egypt in particular, explained the origin of the royal cubit by asserting that the Pharaohs demanded contractors to build by the cubit of 7 hands, but exercised their royal prerogatives by paying them as if they had employed the regular cubit of 6 hands (a discount of 37 percent). Let us not forget that the current opinions about the Egyptian ability to measure time astronomically are based on the calculations of Eduard Meyer.

10. According to the second geodetic system of Egypt, the length of Egypt, from the base line of the Delta (31° 06′ north) to the usual southern boundary at 24° 00′ north, was recalculated as 1,500,000 royal cubits of 524.1483 millimeters. This is the reason why the cubit of 524.1483 millimeters became the one used in geographic measurements.

This second calculation of the length of Egypt is derivative and, hence, is not as precise as the one that made the geographic cubit equal to 1/1,800,000 of the length of Egypt. The length of Egypt according to the dynastic system is 7° 06′; 1,500,000 royal cubits equals 786,222 meters. According to the *Smithsonian Geographical Tables,* the interval from 31° 06′ to 24° 00′ is 786,741 meters. There is a difference of about 1000 royal cubits.

For the sake of geographical calculations the royal cubit was given as multiple the *atur* of 15,000 royal cubits, so as to make Egypt equal to the perfect figure of 100 *atur*. The term *atur* literally means "river"; it could be translated as "river measure." It was understood that an *atur* (7862.2 meters) corresponds to an hour of navigation along the Nile.

The *atur* fitted the septenary spirit of the system of measures, since it could be assumed that a degree of latitude is 14 *atur*. This was a practical approximation, which was corrected by adding decimal points to the figure of 14 *atur,* reaching a maximum of 14.1 *atur* at the north of Egypt.

A degree of 14.1 *atur* is 110,857.4 meters. According to the *Smithsonian Geographical Tables,* degree 30°–31° is 110,857.0 meters.

The length of Egypt was divided into 14 *atur* for Northern Egypt and 86 *atur* for Southern Egypt. If we divide 100 *atur* by 7° 06′, we have a degree of 14.084507 *atur* = 110,735.6 meters, which is the length of the degree at parallel 23° 00′ (110,736 meters according to Helmert). A reason why the length of Egypt was extended south to the Sacred Sycamore, at 23° 00′ north, appears to have been that of giving a more exact scientific basis to the calculation of the royal cubit as being such that 211,267.605 royal cubits (14.0845 *atur*) makes a degree.

We shall see that the Pharaoh Akhenaten attacked the authority of the Temple of Amon at Thebes by questioning the scientific exactitude of the second geodetic system of Egypt and of the calculations by royal cubits. There is a possibility that the extension of the boundaries of Egypt from latitude 24° 00′ to latitude 23° 00′ north was part of the counterattack against the reforms of Akhenaten. The purpose may have been that of calculating the value of the royal cubit independently of the value of the geographic cubit.

III. COFFER OF THE GREAT PYRAMID

1. On the basis of my reconstruction of the Egyptian system of measures, it is possible to solve the riddle of the coffer placed inside the King's Chamber of the Great Pyramid.

Many investigators have tried to explain the dimensions of this coffer, but none has reached a positive conclusion. However, the majority of the investigators agree on two basic assumptions: the coffer embodies some numerical conundrum and the contents of the coffer corresponds to some standard of volume. According to my interpretation both of these assumptions are correct: the contents of the coffer is 8 cubic royal cubits = 40 artabas (1166.40 liters), and the walls were given a thickness such that the outside volume of the coffer is twice that of the contents, that is, 16 cubic royal cubits = 80 artabas (2332.800 liters).

The investigators who have preceded me have been hampered by not knowing that there were three possible values of the royal cubit. For this reason they could not realize that the standard of measure of the coffer is a royal cubit different from that employed in planning the King's chamber and the rest of the Pyramid. The King's Chamber was planned by the royal cubit of 524.1483 millimeters, because this is the standard of the Pyramid, chosen because this was the royal cubit usually employed by the Egyptians in calculating geographic distances. The coffer, on the other hand, was planned by the royal cubit of 526.3231 millimeters, because this was the unit employed in calculating the fundamental units of volume and weight.

Before the Cole survey of the dimensions of the Great Pyramid, the only datum available to scholars to determine the exact value of the cubit of the Pyramid was the dimensions of the King's Chamber. It was Newton who, on the basis of the survey conducted by Greaves, realized that the King's Chamber measures 10 by 20 cubits. Having established this fact, he calculated that the cubit of the Pyramid is 1732.5/1000 of an English foot and rounded the figure to 1732/1000. Calculating by the British Imperial standard foot established in 1824, the figures of Newton indicate a cubit of 528.0655 or 527.9131 millimeters. Newton was interested in the length of the Egyptian royal cubit, because he wanted to interpret the statement of Eratosthenes that a degree of latitude is 210,000 cubits.

Petrie proceeded to an extremely accurate survey of the dimensions of the King's Chamber, taking into account the fact that the blocks have been spread apart by the action of earthquakes. By deducting from the length of the sides the spaces which today separate the blocks, he concluded that the cubit of the King's Chamber is 20.632 ± 0.004 English inches $= 524.0523 \pm 0.1016$ millimeters. This empirical datum agrees with the figure of 524.1483 millimeters which I have obtained by considering the mathematical structure of the Egyptian system of measures and all the empirical evidence available.

The coffer is not calculated by the cubit of the King's Chamber, but the cubit of 526.3231 millimeters, because this cubit when cubed contains 145.800 liters = 5 artabas = 16,000 *qedet* of 9.1125 grams.

The reports about the dimensions of the coffer show some discrepancies, because the coffer was cut rather roughly. Petrie relates that an entire side was cut by the strokes of a huge saw, which at times was backed up after it had dented the stone as much as one inch out of plumb. However, by comparing the reports of Greaves, Piazzi Smyth, Petrie, and others, I have identified the intended dimensions of the coffer, since I have the advantage of knowing the exact value of the unit of measurement.

The coffer was computed in hands of 1/7 of the cubit of 526.3231 millimeters. Its inner dimensions are:

Width:	9 hands =	676.70 mm
Length:	26.3 hands =	1977.47 mm
Height:	11.6 hands =	872.19 mm

The corresponding figures in the reports of Greaves and Petrie are:

26.616 English inches = 676.15 mm	26.81 inches = 680.97 mm
77.856 English inches = 1,977.54 mm	78.06 inches = 1982.72 mm
34.32 English inches = 871.73 mm	34.42 inches = 874.27 mm

The report of Smyth agrees substantially with that of Greaves. Petrie's figures are slightly excessive, because he computed the inner dimensions by deducting the thickness of the walls from the outer dimensions, and he thought that it would be proper to measure the walls at the point of their minimum thickness.

The lateral walls were intended to be 2 hands thick, so that the outside dimentions are:

Width: 13 hands = 977.46 mm
Length: 30.3 hands = 2278.23 mm

Petrie's figures for these two dimensions are:

38.50 English inches = 977.90 mm
89.62 English inches = 2276.35 mm

The height of the outside was intended to be 2 cubits = 14 hands, but in order to establish a link between the coffer and the rest of the Pyramid these two cubits were calculated by the cubit of the Pyramid and the King's Chamber. Two cubits of 524.1483 millimeters is 1,048.29 millimeters. In terms of the cubit of 526.3231 millimeters, this means 13.9422 hands; possibly the figure was rounded to 13.9333 hands = 1,047.63 millimeters. I assume that the bottom of the coffer was given a thickness of 2.333 hands = 175.44 millimeters (Petrie reports 6.89 inches = 175.01 millimeters). I assume that the height was 13.9333 hands = 1,047.63 millimeters (Petrie reports 41.31 inches = 1049.27 millimeters).

According to Greaves's figures the contents of the coffer is 71,118 cubic inches = 1,165.428 liters. According to Petrie's figures the contents is 72,033 cubic inches = 1,180.405 liters; I have explained why Petrie overestimated the inner dimensions. According to my interpretation the contents is 2745.72 cubic hands. Now, 2744 cubic hands is 1,166.400 liters = 8 cubic cubits = 40 artabas.

If the outside of the coffer is 13 by 30.3 by 13.933 hands, its volume is 5488.3 cubic hands. Now, 5488 cubic hands is 16 cubic cubits = 80 artabas.

Since the two volumes of the coffer are 8 and 16 cubic cubits, it is not possible to be certain that a measurement by artabas was in the mind of the builders, although I cannot think of any other reason why the builders should have chosen the cubit of 526.3231 millimeters, unless they intended to choose the cubit which when cubed has a contents of exactly 5 artabas. A clearer proof that the calculation was intended to be by artabas is provided by the similar coffer of the Second Pyramid of Giza.

2. From the dimension of the sides of the Second Pyramid of Giza, it can be established that it was planned by the royal cubit of 525 millimeters. Nevertheless, as in the case of the Great Pyramid, the coffer was planned by the cubit of 526.3231 millimeters.

Petrie reports the following data about the coffer of the Second Pyramid, expressed in English inches:

	Length	Width	Height
Outside:	106.68 = 2,709.67 mm	41.97 = 1,066.04 mm	38.12 = 968.25 mm
Walls:	21.95 = 557.53 mm	15.28 = 388.11 mm	8.53 = 216.66 mm
Inside:	84.73 = 2,152.14 mm	26.69 = 677.93 mm	29.59 = 751.59 mm

As in the Great Pyramid, the coffer was planned in hands (1/7) of the cubit of 526.3231 millimeters. The dimensions are the following:

	Length	Width	Height
Outside:	36 = 2,706.80 mm	14.2 = 1,067.68 mm	12.88 = 968.43 mm
Walls:	7.4 = 566.40 mm	5.2 = 390.98 mm	2.88 = 216.54 mm
Inside:	28.6 = 2,150.41 mm	9 = 676.70 mm	10 = 751.89 mm

Petrie's figures imply an inside volume of 1,096.554 liters. According to my interpretation the volume is 2574 cubic hands = 1094.137 liters. If we assume that the volume was intended to be 2572.5 cubic hands = 1093.500 liters, the contents of the coffer corresponds to:

7.5	cubic royal cubits
37.5	artabas
12	basic loads *brutto*
120,000	*qedet* of 9.1125 grams
121,500	*qedet* of 9 grams

The contents of this coffer is 15/16 of the contents of the coffer of the Great Pyramid.

Because the Second Pyramid had been planned by the royal cubit of 525 millimeters, the coffer, although measured by the cubit of 526.3231 millimeters, indicates a volume expressed best of all in basic loads *brutto;* the basic load *brutto* is the cube of the cubit of 450 millimeters, which is the common cubit coresponding to the royal cubit of 525 millimeters.

Petrie's figures imply an outside volume of 2796.883 liters. According to my interpretation the volume is 6584.25 cubic hands = 2798.786 liters. If we assume that the outside volume was intended to be 6585.4 cubic hands = 2799.360 liters, the volume corresponds to:

19.2	cubic royal cubits
96	artabas
32	basic loads *netto*
307,200	*qedet* of 9.1125 grams
311,400	*qedet* of 9 grams

The outside volume of this coffer is 6/5 that of the coffer of the Great Pyramid.

The coffer of the Second Pyramid was planned so as to embody the key units of the Egyptian system of volumes:

Artaba of 29,160 cubic centimeters (cube of the geographic foot)
Basic load *netto* of 87,480 cubic centimeters (cube of the Roman cubit)
Basic load *brutto* of 91,125 cubic centimeters (cube of the Egyptian common cubit)

IV. DEGREES OF LATITUDE

1. The calculation of the dimensions of Egypt by royal cubits was less precise than that by geographic cubits, but it had the advantage of stressing the number 7 as the key to the dimensions of Egypt and as the link between the structure of Egypt and the order of the cosmos.

Following the septenary system of measurement, the stadium, a tenth of minute of degree, was reckoned as 350 royal cubits (183.45 meters). This stadium is somewhat shorter than the stadium of 400 geographic cubits (600 geographic feet = 184.68 meters). It implies a degree (600 stadia to the degree) of 210,000 royal cubits = 110,071.1 meters. But the calculation of the stadium as 350 royal cubits was considered a first approximation which could be employed in practical computations. Just as in the calculation by *atur*, a degree of latitude was considered basically equal to 14 *atur*, but in exact calculations a decimal point was added to the figure of 14, so in exact calculations a few cubits were added to the figure of 350 royal cubits to a stadium.

In round figuring the Egyptians calculated the stadium at the equator as 354 stadia; but more accurate figures were known. By this round figure they obtained an equatorial minute of degree (10 stadia) of 1855.485 meters, which is 88 millimeters more than the figure of the International Spheroid (1855.398 meters). A stadium of 354 cubits implies an equatorial circle of 76,464,000 cubits = 40,078,491 meters, whereas according to the International Spheroid the equatorial radius is 6,378,388 meters ± 18 meters, so that the equator would be 40,076,594 meters ± 113 meters. Since the Egyptians preferred to count by 90 degrees of equator, the figure of 354 cubit for a stadium of equator contains a numerical game, such as frequently occurs in ancient computations for mnemonic reasons. Ninety degrees of equator is 54,000 stadia of 354 cubits.

Assuming a stadium of 354 royal cubits, a degree of equator is 212,400 cubits, which is a good round figure. We shall see that the Egyptians estimated the exact figure as between 212,380 and 212,392 cubits.

An absolutely exact calculation of the length of the equator was a matter of scientific interest, whereas the Egyptians put much greater stress on the exact calculation of the length of the degrees of latitude, since the anchor of their geodetic conceptions was the course of the Nile.

For the stadium of latitude of the equator they used the figure of 351.6 cubits = 184.2905 meters, which is as exact as any modern calculation can be. According to the Clarke Spheroid a minute of latitude at the equator is 1842.787 meters; according to the International Spheroid it is 1842.925 meters. We shall see that the base of the Great Pyramid is calculated by a stadium of 351.6 cubits.

To those who may not be conversant with these matters, I must explain that, since the shape of the earth is irregular, modern scholars have tried to construct a regular geometric figure, called the spheroid, the dimensions of which fit as closely as possible the actual dimensions of the earth. Different scholars have constructed different spheroids, in part because they have based their work on surveys conducted in different areas of our planet. For instance, in the United States many agencies and institutions continue to use the spheroid calculated by the English geodesist Clarke in 1866, because its data fit rather well with the shape of the earth in North America. Many scholars prefer the computation published by the German Helmert in 1907. But the calculation most usually considered authoritative by scholars is that completed by the American Hayford in 1910, known as the International Spheroid. This calculation is based on a gigantic survey conducted under the auspices of the British Empire from the tip of South Africa to the Equator and then up to the Mediterranean along the Nile. This survey happens to overlap the Egyptian calculations along the course of the Nile.

The stadium of latitude increases as one moves to the north from the equator, reaching the value of 354 cubits, equal to the length of the stadium of equator, between parallel 55° and parallel 56°. It reaches a maximum estimated as 355 cubits at the pole. This figure of 355 cubits for the stadium of latitude at the pole, which indicates a minute of 1860.726 meters, was a convenient round figure which was refined in exact reckonings. A stadium of 355 cubits implies a polar degree of 213,000 cubits = 111,643.6 meters; if 1/2000 was the amount added to the latter figure we would have 213.106.5 cubits = 111,699.4 meters. According to the *Smithsonian Geographical Tables,* degree 89°–90° is 111,699.3 meters.

For navigation along the Nile, there was used the following formula for the length of the degrees of latitude:

211,500 cubits = 110,857 meters at latitude 31° 06′
211,300 cubits = 110,753 meters at latitude 24° 06′
211,100 cubits = 110,648 meters at latitude 15° 36′

Latitude 15° 36′ north is the latitude of the confluence of the White Nile with the Blue Nile.

2. One of the major difficulties of ancient mathematical science was that it could not rely on printed tables, although some numerical tables, such as exponents, roots, and logarithms, are occasionally found in cuneiform tablets. Even maps were so drawn that the key positions could be memorized. The lack of the printing press is the reason why in ancient mathematics we find a variety of formulas and mnemonic devices for obtaining trigonometric functions. In the same spirit the Egyptians had developed a simple formula for calculating the length of the degree of latitude at all parallels between the equator and the pole.

The scheme was based on the circumstances that the Egyptians used three values for the length of the degree of latitude at the equator—an exact value based on a stadium of 351.6 cubits and two rounded values:

A. Exact value. Stadium of 351.6 cubits, degree of 210,960 cubits = 110,574 meters.

B. Value rounded to degree of 211,000 cubits = 110,595 meters.

C. Value rounded to arc of meridian of 19,000,000 cubits, degree of 211,111 = 110.654 meters.

Value *B* was considered exact for a degree at 9° and value *C* for a degree at 16°.

The length of the degree was calculated by taking the second value, 211,000 cubits, and assuming that each degree is longer than the preceding degree by a number of cubits equal to the number of the degree.

Degree	Cubits added to degree	Cubits added to length of degree at 0°
1°	1	1
2°	2	3
3°	3	6
4°	4	10
5°	5	15
6°	6	21

This pattern was followed up to degree 36°, which is 36 cubits longer than the degree at 35° and 666 cubits longer than the degree at 0°. For six degrees, from 37 to 42°, the amount added to each degree is 37 cubits. For the following six degrees, from 43 to 48°, the amount added to each degree is 38 cubits. Then for six degrees, from 49 to 54°, the amount added is again 37 cubits. For the remaining 36 degrees, from 55 to 90°, the amount added is the same as that applied to the first 32 degrees but in the inverse order.

The scheme gives immediately the length of the degrees from 24 to 58°, that is, for 35 degrees. For the first 23 degrees and for the last 32 there are introduced simple corrections:

(1) For the first eight degrees, from 1 to 8°, the amount is added to the exact value of the degree (value *A*, 210,960 cubits to degree). From a degree at 9° one begins to count by value *B* (211,000 cubits), but 45 cubits is deducted from the amount added to this degree; this deduction is reduced by 3 cubits for each of the following 13 degrees, until 3 cubits is deducted from 23°.

3. At 90° the amount added according to the scheme is added to a basic degree calculated by value *C* (211,111 cubits). For the 32 degrees from 59 to 90°, an adjustment is

Degree	Cubits added to each degree	Cubits added to 0° degree	Correction	Egyptian ESTIMATE, meters	Helmert's ESTIMATE, meters
1°	1	1		110,575	110,573
2°	2	3		110,576	110,574
3°	3	6		110,577	110,575
4°	4	10		110,580	110,577
5°	5	15		110,582	110,579
6°	6	21		110,585	110,582
7°	7	28		110,589	110,586
8°	8	36		110,593	110,591
9°	9	45	−45	110,595	110,596
10°	10	55	−42	110,602	110,602
11°	11	66	−39	110,609	110,609
12°	12	78	−36	110,617	110,616
13°	13	91	−33	110,626	110,624
14°	14	105	−30	110,635	110,633
15°	15	120	−27	110,640	110,642
16°	16	136	−24	110,654	110,652
17°	17	153	−21	110,664	110,662
18°	18	171	−18	110,675	110,673
19°	19	190	−15	110,687	110,684
20°	20	210	−12	110,699	110,696
21°	21	231	− 9	110,712	110,709
22°	22	253	− 6	110,725	110,722
23°	23	276	− 3	110,738	110,736
24°	24	300		110,753	110,750
25°	25	325		110,766	110,764
26°	26	351		110,779	110,779
27°	27	378		110,793	110,794
28°	28	406		110,809	110,810
29°	29	435		110,823	110,826
30°	30	465		110,839	110,843
31°	31	496		110,855	110,861
32°	32	528		110,872	110,878
33°	33	561		110,889	110,895
34°	34	595		110,907	110,913
35°	35	630		110,926	110,931
36°	36	666		110,944	110,949

Degree	Cubits added to each degree	Cubits added to 0° degree	Correction	Egyptian ESTIMATE, meters	Helmert's ESTIMATE, meters
37°	37	703		110,964	110,968
38°	37	740		110,983	110,987
39°	37	777		111,003	111,006
40°	37	814		111,022	111,025
41°	37	851		111,041	111,044
42°	37	888		111,061	111,063
43°	38	926		111,081	111,083
44°	38	964		111,101	111,103
45°	38	1002		111,120	111,122
46°	38	1040		111,140	111,142
47°	38	1078		111,160	111,162
48°	38	1116		111,180	111,181
49°	37	1153		111,200	111,201
50°	37	1190		111,219	111,220
51°	37	1227		111,238	111,239
52°	37	1264		111,258	111,258
53°	37	1301		111,277	111,277
54°	37	1338		111,297	111,296
55°	36	1374		111,316	111,315
56°	35	1409		111,334	111,334
57°	34	1443		111,352	111,352
58°	33	1476		111,369	111,370
59°	32	1508	+ 3.5	111,388	111,388
60°	31	1539	+ 7	111,406	111,405
61°	30	1569	+10.5	111,423	111,422
62°	29	1598	+14	111,440	111,439
63°	28	1626	+17.5	111,457	111,455
64°	27	1653	+21	111,473	111,471
65°	26	1679	+24.5	111,488	111,487
66°	25	1704	+28	111,503	111,502
67°	24	1728	+31.5	111,518	111,517
68°	23	1751	+35	111,531	111,531
69°	22	1778	+38.5	111,547	111,544
70°	21	1794	+42	111,558	111,557
71°	20	1814	+45.5	111,570	111,570
72°	19	1833	+49	111,582	111,582
73°	18	1851	+52.5	111,593	111,594
74°	17	1868	+56	111,604	111,605
75°	16	1884	+59.5	111,616	111,616
76°	15	1899	+63	111,624	111,626
77°	14	1913	+66.5	111,633	111,635
78°	13	1926	+70	111,642	111,643
79°	12	1938	+73.5	111,650	111,651
80°	11	1949	+77	111,657	111,659
81°	10	1959	+80.5	111,664	111,666
82°	9	1968	+84	111,671	111,672
83°	8	1976	+87.5	111,677	111,677
84°	7	1983	+91	111,682	111,682
85°	6	1989	+94.5	111,687	111,686
86°	5	1994	+98	111,692	111,690
87°	4	1998	+101.5	111,696	111,693
88°	3	2001	+105	111,699	111,695
89°	2	2003	+108.5	111,702	111,696
90°	1	2004	+111.11	111,704	111,697

made for a transition from value *B* to value *C*. Thus, to a degree at 59° there is added 111.11/32 cubits, or practically 3.5 cubits ($32 \times 3.5 = 112$); to a degree at 60° twice as much is added; to a degree at 61° there is added three times as much.

This scheme gives values of the degree of latitude which differ most from the one we use today in the area near the pole. This could be connected with the fraction that the Egyptians used in calculating the polar flattening of the earth. I shall deal with this fraction in a following chapter. According to the scheme, the degree between parallel 89° and the pole is 213,115.11 cubits = 11,703.9 meters. According to the Clarke Spheroid the minute of degree of latitude at the pole is such that the corresponding degree is 111,699.36 meters; but in 1880 Clarke revised the figure to 111,702,06 meters. According to the International Spheroid the figure is 111,700 meters.

4. The scheme which I have presented provides excellent values for the length of the degree of latitude, but probably was intended to be only a practical device, not the most exact calculation. There is evidence which suggests that efforts were made to calculate the lengths of the degrees with greater mathematical refinement.

The Egyptians invented the column as an architectural element. If one observes the decoration of Egyptian columns with a scientific attitude, he will recognize that the column represents the map of Egypt: the capital is Northern Egypt and the shaft is Southern Egypt. This explains why among the Greeks, who learned the use of the column from the Egyptians, for the Doric order, the most conservative of the Greek orders, there was the rule that the shaft should be six units high and the capital one unit high. In the Greek orders the base of the column preserves the arrangement on three horizontal lines, which are the symbol of the tropic of Cancer (parallels 24° 06′, 24° 00′, and 23° 51′ north). The column basically represents the three meridians of Egypt and through its curvature suggests the extension of the system of meridians to the east and west of Egypt. But, since the column is circular, the structure of the column was related to the problem of presenting the map of Egypt as part of a cylindrical projection of the surface of the earth from the equator to latitude 31° 06′ or latitude 31° 30′ north. The elaborate numerical rules for the proportions of Greek columns, which archeologists treat as numerological superstitions, can be explained when one considers the two interrelated problems of describing mathematically the curvature of the earth and of projecting a curved surface on a flat map. The theory of conic sections, which is considered the highest achievement of Greek mathematics, may have been developed in order to solve these problems. Greek columns taper from the bottom to the top, but to the rectilinear line of the shrinking there is applied a curved line, so that the column seems to swell slightly toward the middle. If we consider the scheme I have presented for the calculation of the lengths of the degrees, a scheme in which a basic simple progression was modified by the addition of another progression, we can understand why Greek columns diminished in diameter from bottom to top according to a combination of two lines. In the case of the columns of the Parthenon, the added curvature, called *entasis* by the Greeks, is a hyperbolic curve, but in other temples we meet with more complex mathematical curves. It may be enough to say this much here: if one assumes that the bottom of the colonnade of the Parthenon represents the equator and its top the latitude of Athens, the proportions of the entire colonnade can be readily explained.

V. TEXTUAL EVIDENCE

For lack of space, it is impossible for me to present here the evidence for what I have stated to be the Egyptian estimates of the length of the degrees of latitude, since this evidence was obtained by gathering scores of scattered pieces of information, the interpretation of which often involves delicate issues of textual interpretation. But the preoccupation with geographical distances was so dominant in Egyptian civilization that one can find many documents the meaning of which is obvious; several of these documents are well-known texts. It has taken me a great deal of painstaking research to fit these documents together, in order to arrive at a unified view of what was the Egyptian system of geography; but the interpretation of single documents *per se* in many cases did not present difficulty. What is difficult to explain is why Egyptologists have stubbornly refused to accept these documents at their face value. In order to illustrate how Egyptologists operate in order to slough off the evidence, I shall present two examples of such nature that the issues involved can be understood by the non-specialist.

Inscribed Cubit Rules

1. In 1921 the famous Egyptologist Ludwig Borchardt wrote a report on three Egyptian measuring rules found at the Temple of Amon in Thebes. These three royal cubit rules

bear an identical inscription. The inscription appears to be a traditional one; for reasons of style the text of the inscription has been ascribed to the Old Kingdom, although the rules themselves belong to a later period. It is known that at times measuring rules were given a sacred meaning, although nobody has ever asked why; it should be evident to the reader of these pages why a measuring rule could be a sacred object for the Egyptians. The cubit rules studied by Borchardt, according to his report, seem to be of the type used as sacred objects rather than as instruments of actual measurement.

Borchardt did not test the length of these rules, but concentrated his attention on the inscription. The essential meaning of the inscription is open and clear, even though a professional Egyptologist may find difficulty with some of the hieroglyphs, as it often happens when archaic hieroglyphic texts were copied centuries later when the language and the writing style had changed. The inscription states that the distance between Behdet and Syene, the area of the First Cataract, is 106 *atur*, and divides this distance into 20 *atur* from Behdet to a place called Pi-Hapy, and 86 *atur* between Pi-Hapy and Syene.

Borchardt considered the evident possibility that the distances should be understood as differences of latitude, but dismisses it outright: "one must absolutely exclude the possibility that the ancients may have measured by degrees." No further words are added to justify this drastic pronouncement. Then he states that it must be a matter of measurements taken along the actual course of the Nile, the only measurements of which the Egyptians were capable. By referring to modern data about the length of the line of navigation along the Nile, he concludes that the inscription expresses a rough estimate.

He proceeds by remarking that the inscription provides an excellent opportunity to establish the value of the important Egyptian linear unit *atur*. He observes that by reading documents that contain calculations in *atur* one gathers that the value of the *atur* in royal cubits must be expressed by numbers such as 5000 or 10,000. Finally, he concludes that, given the length of the course of the Nile from one end to the other of the country of Egypt, the *atur* must be 20,000 royal cubits.

I have concluded that the *atur* is 15,000 royal cubits (7862.225 meters), and this inscription bears me out. The difference of latitude between Behdet and the southern limit of the First Cataract is 7° 30′. Now, 106 *atur* is 1,590,000 royal cubits = 833,395.8 meters. The distance between 24° 00′ and 31° 30′ is 831,091.6 meters according to the

Smithsonian Geographical Tables. The Egyptian figure is in excess by 2300 meters, or 2/7 *atur*. The excess is not surprising, since the calculation of the length of Egypt as ending at Behdet was originally related to the geographic cubit and not the royal cubit. I have explained that the geographic cubit was defined as 1/1,800,000 of the length of Egypt to Behdet. In *atur* of 17,000 geographic cubits, this length could be expressed as 106 *atur* (1,802,000 geographic cubits) = 831,971.7 meters, with only a small excess over the initial figure of 1,800,000 geographic cubits = 831,048.4 meters.

The calculation of the length of Egypt to Behdet as 106 *atur* of 15,000 royal cubits has the virtue of indicating the length of the arc of meridian from the equator to the pole; since the length of Egypt to Behdet is 7° 30′, it is 1/12 of this arc. Multiplying 106 *atur* by 48, we have a great circle of 5088 *atur* = 40,002,998 meters, which is an excellent figure (212,000 cubits to a degree); Helmert's figure of 40,008,268 meters differs by less than an *atur*.

The purpose of the inscription on the rules which were found at the Temple of Amon in Thebes is to stress the scientific value of the calculations by the septenary royal cubit, which was a matter of essential political interest to this temple, as I will explain in the second part of this chapter.

The calculation of the length of Egypt as 106 *atur* had also the purpose of indicating by one of the usual numerological games that the average degree of latitude is 212,000 royal cubits = 111,119.4 meters; 212,000 was the Egyptian round figure for the average length of the degree of latitude (stadium of 353,333 royal cubits). If the average degree is identified with the middle degree, the degree at parallel 45°, this figure is only 2 cubits short of the Egyptian estimate of 212,002 cubits = 111,120.5 meters for this degree. The estimate of the *Smithsonian Geographical Tables* is 111,121.0 meters.

2. The inscription on the rules divides the interval of 106 *atur* into 86 *atur* from Syene to Pi-Hapy and 20 *atur* from Pi-Hapy to Behdet. It occurs immediately that the two figures must refer to Northern and Southern Egypt. But the figure of 20 *atur* is slightly too much for Northern Egypt and that of 86 *atur* is slightly too little for Southern Egypt.

If the degree is calculated as 212,000 royal cubits, 20 *atur* = 300,000 cubits is too much for the interval between Behdet and the apex of the Delta, since 1.4° × 212,000 = 296,800 cubits. Conversely, 86 *atur* would be 1,290,000 cubits, whereas the distance from 24° 00′ north to the apex is 6.1°, and 6.1° × 212,000 = 1,293,200 cubits. In either case there is a difference of 3200 cubits. Hence, the breaking point in the calculations must be somewhat south of the apex of the Delta.

Even though Egyptologists ignore scientific geography, there are specialists of Egyptian toponymy, that is, the study of local names. These have wondered about the identification of the locality of Pi-Hapy, "House of the Nile," mentioned in the inscription we are discussing. They have observed that in Egyptian texts Pi-Hapy is usually mentioned together with Kher-aha, although Pi-Hapy is a different place. They have concluded that Pi-Hapy was on the right bank of the Nile about 2 kilometers south of Kher-aha. But specialists of Egyptian toponymy have failed to identify Kher-aha, which was a fundamental point of Egyptian geography; Kher-aha, called Kerkasoros by the Greeks, was the apex of the Delta, the point 30° 06′ north, 31° 14′ east, at the southern tip of the island al-Warraq. Pi-Hapy, called Nilopolis by the Greeks, was on the right bank of the Nile, facing the southern tip of the island al-Warraq. Since the Nile in its course comes to the island al-Warraq from the west, the point Pi-Hapy was on meridian 31° 14′ east and could be considered to be on the right bank of the Nile directly opposite the apex of the Delta, or point Kher-aha. The width of the Nile between Kher-aha and Pi-Hapy, measured along meridian 31° 14′ east, fits well with what I have calculated to be the distance between the apex and Pi-Hapy (3200 royal cubits = 1,677 meters).

The breaking of the distance of 106 *atur* into a segment of 20 *atur* by establishing a new reference point called Pi-Hapy may have been influenced by the calculation of the length of Egypt up to the base line of the Delta as 100 *atur* (1,500,000 royal cubits).

In the inscribed royal cubit rules, the original estimate of 106 *atur* of 17,000 geographic cubits was interpreted in terms of 106 *atur* of 15,000 royal cubits, in order to link more closely the dimensions of Egypt (1/12 of arc of meridian counting to Behdet) to the measurements of the arc of meridian. As I have stated, 12 × 106 *atur* = 1272 *atur* = 19,080,000 royal cubits = 10,000,749.6 meters is an excellent estimate of the length of the arc of meridian, obtained with an extreme economy of reckoning. Let us not forget that the French metric system was established on the assumption that the arc of meridian is 10,000,000 meters. Even today in practical reckoning we take 111,111.1 meters as the round figure for the average degree of latitude, whereas the figure of 106 *atur* for the length of Egypt indicates a round figure of 212,000 cubits = 111,119.4 meters, which is more precise, and is almost perfect if we take 212,000 cubits to mean the length of the degree at the middle parallel.

1. Because Egyptologists have ignored the issue of geodetic points and of the linear units, the figure of the revolutionary Pharaoh Akhenaten has turned out to be the most mysterious and controversial in the long history of the Egyptian monarchy, although this Pharaoh was unusually articulate and self-expressive in his utterances. The archeologist Cyril Aldred, who is the author of the most recent study of the reign of Akhenaten, begins his book (page 11) with this observation.

> With the possible exception of Cleopatra, no ruler of Ancient Egypt has provoked a greater flow of ink from the pens of historians, archaeologists, moralists, novelists and plain cranks than the Pharaoh Akhenaten who governed almost half the civilized world for a brief span during the fourteenth century B.C.

The Pharaoh Akhenaten.

The reason why even "plain cranks" write interpretations of the historical role of Akhenaten is that professional scholars have given the example. Because they have resisted accepting the solidly documented facts, established scholars have devoted their energies to debating theories such as that Akhenaten was impotent, was a practicing homosexual, or a woman masquerading as a man; there are historians who profess to be informed about the intimate relations between him and his wife, the beautiful Nefertiti. Since the picture of Akhenaten has remained indefinite and blurred, scholars have used it to project their own emotions. Those who do not like Akhenaten present him as a psychopath and dispute about the clinical definition of his illness. In the middle are those who describe him as a playboy Pharaoh. Those who admire him have chosen to portray him either as some sort of Christian evangelist, an Anabaptist preacher thrown into the midst of the history of Egypt, or, at the opposite end of the psychological personality scale, as an *artiste* type, bent on freeing Egyptian culture from its formalistic tradition in order to release untrammeled individualistic self-expression. If one were to look for a common denominator among all the conflicting interpretations, one fact could be considered as universally accepted, in spite of the heated controversies, namely, that Akhenaten was as far as possible from being a rational scientific thinker. Nevertheless, the documentary evidence suggests a style of thought that today we would call scientific naturalism.

There is a phrase which occurs again and again in the pronouncements of Akhenaten and represents his effort to summarize his program by a slogan: "Living in *maet.*" This is so obvious that Aldred declares (page 67):

> There is in Akhenaten's teaching a constant emphasis upon *maet*, "truth," as is not found before or afterwards.

It is agreed that *maet* was the central concept of Egyptian civilization and that the role of a Pharaoh was to be the defender and the living embodiment of *maet*. This concept was so basic in Egyptian culture that Aldred has no difficulty in explaining it in a few words (page 25):

> The king was the personification of *maet*, a word which we translate as "truth" or "justice," but has the extended meaning of the proper cosmic order at the time of its establishment by the Creator. For it was believed that the gods had first ruled Egypt after creating it perfect.

Akhenaten, his wife Nefertiti, and two daughters (Berlin Museum).

The reader can easily grasp what was meant by *maet* by referring to what I have said about the geodetic system of Egypt. But, having admitted what is indisputable, that Akhenaten saw himself as the Pharaoh who would truly uphold *maet*, Aldred stops cold and does not draw the implications. Like other interpreters, he wanders afar and regales us with a chapter entitled "The Pathology of Akhenaten."

2. If instead of trying to imagine what were the hieroglyphic notes of the psychoanalyst of the royal family, we consider the documented facts, the most important action in the revolutionary reign of Akhenaten proves to be the establishment of a new capital for Egypt, the city of Akhet-Aten, "Resting-point of Aten." The miles-long remains of the buildings of this city have been found and excavated in the locality today known as Tell el-Amarna. During the reign of Akhenaten a substantial percentage of the national resources was dedicated to the construction of this city.

Scholars of the last century, who had not yet adopted the psychologizing fashion, at least recognized the political meaning of the shift in the location of the capital of Egypt. Akhenaten intended to cut at the root the power of the priests of the Temple of Amon in Thebes, who through their control of the national oracle, identified with the god of this temple, had usurped the royal functions. But what these scholars did not know is that the Temple of Amon was the geodetic center of Egypt, the "navel" of Egypt, being located where the eastern axis (32° 38′ east) crosses the Nile, at the parallel which is at 2/7 of the distance from the equator to the pole (25° 42′ 51″ north), and that the god Amon was identified with the hemispheric stone which marked this point.

The new city which was intended to replace Thebes as the capital and geodetic center of Egypt was planted in a position which seems most undesirable in terms of what we would consider the function of a capital city. Some scholars have interpreted this fact as further evidence of the mental derangement of its founder. It was in an area of difficult access, where there had never been any known significant center; some scholars have doubted whether even villages had existed there. It did not provide large flat areas for a major urban development. When maintenance was suspended after the fall of Akhenaten, large sections of the new buildings were washed away by the rainwater rushing down torrentially from the surrounding cliffs. Even the climate was inferior to that of many other areas along the course of the Nile. Unless one assumes that there was a compelling mathematical reason for choosing this location, one must agree that there is justification in claiming that what is often called the "Tell el-Amarna Revolution" was the product of a playful young man, or a religious fanatic, or a degenerate obsessed with his sex problems. Akhenaten himself relates that his courtiers raised objections to the selection of the new site, although he states that it was pointed out to him directly by his father, the god Aten.

The new capital for the god Aten, who was raised to the status of the one true god, was set at latitude 27° 45′ north, at the middle point between the northernmost point Behdet and the southern limit of Egypt at latitude 24° 00′ north. The longitude could not be equally as significant, since the capital had to be on the banks of the Nile. It was one degree east of the western axis of Egypt, that is, 30° 50′ east.

The longitude, although it was not as crucial as the latitude, was significant according to the system that the Egyptians used to describe the east coast of Africa. In order to describe this coast, down to the equator, the

Aerial view of the Tell el-Amarna (RAF photo).

Egyptians used a system of right triangles, in which one side was one of the three axes of Egypt and the other a perpendicular to it; the hypotenuse usually indicated the course of a segment of the east coast of Africa. The most important of these triangles was one obtained counting from Behdet 19° 30′ south along the central axis of Egypt and then 19° 30′ to the east, to reach a point 12° 00′ north, 50° 44′ east, near Ras Alula (11° 59′ north, 50° 46′ east), a point which was considered the extreme limit of the Arabian Gulf. The ancients took the Gulf of Suez, the Red Sea, and the Gulf of Aden as a single entity, the Arabian Gulf, which at times they described as a river similar to the Nile. The geographical point in question is called Notou Keras, "horn of the East," by Strabo; it had a counterpart in the "horn of the West," the innermost point of the Gulf of Guinea on the west coast of Africa. The segment of parallel reaching the "horn of the East" from the meridian of Behdet marks the basic latitude 12° 00′ north, halfway between the equator and the basic latitude 24° 00′ north, and bisects Lake Tana, the source of the Blue Nile. The Nile was considered to have two sources, one at the equator (White Nile) and one at latitude 12° 00′ north (Blue Nile). This system of calculations for the geography of the area east of the course of the Nile has an importance which carries beyond ancient history, since the establishment of a geodetic point 10° south of Behdet and 10° east of the western axis of Egypt explains the origin of the religious importance of Mecca. The essence of this system of calculations was that points to the east of Egypt were identified by drawing perpendiculars to the course of the Nile. Considering this system in relation to the position of Akhet-Aten, if one counts east from it as much as it was south of Behdet, that is 3° 45′, one reaches the sea at a point presently called island Ghānim (off Cape Az Zaytīyah, called Drepanon Promontory by Ptolemy, which is at 27° 47′ north, 33° 35′ east); Cape Az Zaytīyah together with the island south of it was considered the southernmost limit of the Gulf of Suez on the Egyptian side; it was assumed that the line drawn from Behdet to this point gave the course of the coast of Egypt on the Gulf of Suez.

3. The most revealing pieces of evidence uncovered in the area of the new capital established by Akhenaten are the so-called "Boundary Stelae." Along the outskirts of the new city there have been found huge inscriptions, either cut on pillars or cut on the cliffs, which contain a text substantially identical in the fourteen samples which have been uncovered so far. These inscriptions proclaim what was for Akhenaten the leading idea behind the establishment of the new capital.

The inscribed text relates in detail the rituals performed in the establishment of Akhet-Aten, "Resting-point of Aten"; but the greatest emphasis is placed on the setting of two boundary pillars, one at the extreme north and one at the extreme south of the sacred territory of the city, at a distance of 6 *atur*, 3/4 *khe*, and 4 cubits from each other. After setting these pillars the King took a solemn oath, to be repeated at regular intervals, never to remove or displace them and to restore them in the same identical place in case they were moved or damaged.

It should be obvious that the figure of 6 *atur*, 3/4 *khe*, and 4 cubits, given with numerical precision, is the key to the reason for the establishment of the new capital. Nevertheless, only one Egyptologist has made an effort to interpret these figures. This effort was a half-hearted one; it ignored Egyptian geographical texts and parallel occurrences of the terms *atur* and *khe* in Egyptian writings. Nevertheless, ever since, scholars quote this interpretation if they bother to mention the dimensions of Akhet-Aten in dealing with its establishment. The interpretation took as a starting point the distance between the relatively northernmost and the relatively southernmost of the fourteen inscriptions which have been found, and divided this distance by 6 to conclude that an *atur* must be 4000 royal cubits. It can be objected

Boundary stelae at Tell el-Amarna.

that the pillars which in some cases were erected to carry the text of the inscription cannot be the boundary pillars of which the inscription is speaking, since the latter must be of such a nature and form that their position could be established to the inch. It stands to reason that when, after the collapse of the revolution, masons were sent to demolish or deface the monuments of the accursed Akhenaten, not sparing even the tombs of the members of his family, the work of destruction must have started with the boundary pillars; we are not likely to find them, unless broken pieces were scattered around. In any case, the Egyptian texts which mention distances measured in *atur* positively exclude that an *atur* can be as short as 4000 royal cubits (2097 meters).

As to the *khe*, the interpretation stated in a hit-or-miss manner that it is equal to 100 royal cubits. Nobody asked why Akhenaten should have selected a figure refined not only to 3/4 of *khe*, but also to 4 cubits. It was a matter of such precision that the inscribed text indicates that even knocking the limit markers or hitting them with stones would interfere with their function.

According to Egyptian practice, geographic distances could be measured either in geographic cubits or in royal cubits. The natural multiple of the geographic cubit was the stadium, called *khe* in Egyptian, of 400 geographic cubits (600 geographic feet), whereas the natural multiple of the royal cubit was the *atur* of 15,000 royal cubits. But the two systems were merged by using an *atur* of 15,000 royal cubits (7862.2 meters) and an *atur* of 17,000 geographic cubits (7848.8 meters), and a *khe* of 350 royal cubits (183.45 meters) and a *khe* of 400 geographic cubits (184.68 meters). In the case of the inscriptions of Akhet-Aten, the occurrence of the figure of 3/4 of *khe* suggests that a calculation by geographic cubits is involved, since 3/4 of a stadium of 350 royal cubits would be an odd figure. It is my understanding that the dimensions of the district of Akhet-Aten were:

	6 *atur* of 17,000 geographic cubits
	3/4 of a stadium of 400 geographic cubits
	4 geographic cubits
Total:	102,304 geographic cubits = 47,233.1 meters

4. Even without considering the exact value of the units mentioned by Akhenaten, the figure of 6 *atur* should have rung a bell in the mind of Egyptologists, calling to their attention the traditional figure of 106 *atur* for the length of Egypt. Akhenaten wanted to emphasize that the "Resting-point of Aten" was at the middle point of Egypt. By giving to the new geodetic center a dimension of 6 *atur*, he left 50 *atur* from it to Behdet and 50 *atur* from it to parallel 24° 00′ north. This was particularly significant since there was another basic estimate of the length of Egypt as 100 *atur*, from the base line of the Delta (31° 06′ north) to parallel 24° 00′ north.

Before proceeding any further I must remind the reader that the traditional figure setting the length of Egypt at 106 *atur* did not intend to convey information only about Egypt itself, but also to indicate the length of the arc of meridian, 12 × 106 *atur*.

Since the length of the geographic cubit was defined by considering the distance from Behdet to parallel 24° 00′ north equal to 1,800,000 cubits, if the district of Akhet-Aten had had an extension of 0° 25′ 30″, it would have had a length of 6 *atur* = 102,000 cubits. This length was increased to 6 *atur*, 3/4 stadium, 4 cubits = 102,304 cubits, in order to indicate that the average degree of latitude on earth is 240,715 cubits.

The figure of Akhenaten indicates that the average degree of latitude was estimated as 240,715 cubits, since 0° 25′ 30″ of a degree of 240,715 is 102,303.875 cubits. A degree of 240,715 cubits is 111,136.6 meters; the corresponding arc of meridian is 21,664,375 geographic cubits = 10,002,301 meters. Hayford's figure is 10,002,286 meters.

Akhenaten wanted to prove that Thebes could not properly claim to be the geodetic center of Egypt and that he had chosen the geodetic center conforming to an absolutely rigorous interpretation of *maet*, the cosmic order of which the dimensions of Egypt were an embodiment. In order to follow absolutely exact standards of measurement, he reverted to the predynastic geodetic system which counted in geographic cubits starting from Behdet. This system was more precise than the system which counted in royal cubits (septenary units) starting from the base line of the Delta, making Egypt equal to 100 *atur* of 15,000 royal cubits. Thebes could claim to be a geodetic center only in terms of the second system, which is septenary and makes the meridian of Thebes coincide with the eastern corner of the Delta. In terms of the system based on the predynastic capital of Behdet, there could be no question that Akhet-Aten is the "true and just" navel of Egypt.

This conclusion implies that one should reevaluate the entire historical role of Akhenaten, taking as the starting point what he himself considered the initial step in his program to establish true and just conformity with *maet*. There is a possibility that his revolutionary reforms, which extended from religion to art and family relations, were understood as a general return to predynastic ideas and practices.

5. Since the Egyptian monarchy set the style for the trappings of royal power thorughout the world, the prescriptions of Akhenaten about the dimensions of the territory of his capital did not remain without parallel in history. A striking parallel can be found in what may appear a most unlikely time and place, Saxon England.

Scholars are so bent on principle to interpret the history of measures and measurement in terms of the most crude primitivism, that in most works of history that deal with English measures one reads that the English foot was originally set by the length of the foot of an English king. The name of the king whose lower extremities were so decisive varies from scholar to scholar, although, when one thinks about it (which is not done in matters of measurement) kings of average human size should be excluded. There is agreement among scholars that the king in question reigned in the centuries following the Norman conquest, since it is assumed and often stated that before this time England did not have set units of measure. A variant of the fairy tale about the English foot is provided by the historians who tell us that it was not a matter of the foot but of the arm of a king which decided the length of the yard (three feet). Usually the length of the arm of King Henry I (1068–1135) is mentioned in this connection.

Such statements are made in spite of the fact that it is not necessary to be a specialist in the history of measures to find out that a foot equal to the English foot was the basic standard of Russia, from the time of the first available historical records to the Soviet revolution. I grant that it takes a specialized historical training to trace the linear standard of England and Russia to the ancient Orient, but I may also observe that there are well known Greek temples which have been planned in English feet, and that archeologists of English and American nationality have studied them without realizing what they had before their eyes.

Historians could have developed less benighted notions about the origin of English measures, even without extending their horizon beyond the British isles, because there is a law of King Athelstan (924–940) which defines the length of the English foot. The text of this law is included in the standard collections of medieval English laws. The words of law of Athelstan were repeated exactly in the legislation about measures issued by King Henry I. The law of Athelstan provides the most fundamental text for the study of English measures, but it has been ignored.

Athelstan prescribed that the king's girth shall extend from the royal residence for a distance of 3 miles, 3 furlongs, 9 acres, 9 feet, 9 palms, and 9 barleycorns. The King's girth was the area considered a direct extension of the King's place of residence and as such the area in which the King's peace was in force. This was the area in which attacks on private persons were crimes against the Crown.

The picturesque language of the law means that the King's girth extends for a radius of 18,250 feet, since it is a matter of the following units:

mile	5280 feet
furlong	600 feet
acre	66 feet
palm	3/4 foot
barleycorn	1/3 inch

The law employed a form of expression which had a particular numerological rhythm and at the same time defined the value of the multiples and submultiples of the foot.

My understanding of the law of King Athelstan is that the radius of the King's girth was defined as 3 minutes of latitude. The King's girth extended 6 minutes or 1/10 of degree from north to south. This implies that a degree was understood to be 365,000 English feet, which is the length of the degree at the latitude of towns like Winchester.

A more detailed analysis of the law of Athelstan belongs to a study of English measures. What is important to stress here is that the English foot was defined by length of a stretch of 1/10 latitude around the king's place of residence. The political conditions of the feudal society of Saxon England were very different from those of Pharaonic Egypt, but the method used by King Athelstan in order to relate his power to the system of measures and to the cosmic order bears a remarkable similarity to that adopted by the Pharaoh Akhenaten.

VI. DEGREES OF LONGITUDE

1. When the Egyptians fixed the value of their fundamental unit of length, the geographic cubit, they chose as standard degree the degree of latitude at 27° 45′ north, taken as the middle latitude of Egypt. When they recalculated the dimensions of Egypt in terms of royal cubits, they chose as the middle latitude 27° 33′ north. These latitudes were chosen taking into account the length of a degree of longitude at the equator. Latitude 27° 45′ is the half of latitude 55° 30′ and latitude 27° 33′ is the half of latitude 55° 06′. The Egyptians assumed that at the two higher latitudes a degree of latitude is equal in length to a degree of equator.

According to the *Smithsonian Geographical Tables,* a degree of latitude at parallel 55° 30′ is 111,324.7 meters, but probably the Egyptians calculated it as 361,680 geographic feet = 111,323.5 meters: this degree is equal to the fundamental degree of 360,000 geographic feet (600 stadia) plus 2.8 stadia or plus 1/214.28. According to the *Smithsonian Geographical Tables* a degree at parallel 55° 06′ is 111,317.3 meters. According to the Egyptian table of the lengths of the degrees of latitude which I have reconstructed, it is 212,378.5 royal cubits = 111,317.3 meters. This length could be expressed also as 361,660 geographic feet = 111,317.4 meters, that is, as 600 stadia plus 2.7666 stadia. This implies that the Egyptians estimated the equatorial circle either as 130,204,800 geographic feet = 40,076,478 meters or as

130,197,600 geographic feet = 40,074,261 meters. I suspect that they began with an estimate of 130,200,000 geographic feet (degree of 361,666 feet = 360,000 feet plus 1/216) = 40,075,000 meters, and then modified the figure in order to establish a relationship between the equatorial degree and the degree of the middle latitude of Egypt. The Egyptian estimate agrees with our current ones: the equator is 40,075,452 meters, according to the Clarke Spheroid and 40,076,596 meters according to the International Spheroid.

Very revealing is that a base line was marked along parallel 45° 12′ north on the north side of the Black Sea. This base line started from the mouth of the Danube, cut across the Crimea, and ended at the foot of the Caucasus. Beginning from this base, Russia was surveyed for a length of 10 degrees, along the three meridians which formed the three axes of Egypt, up to latitude 55° 12′ north. The river Dnieper was understood to be a symmetric counterpart of the Nile, running between the same meridians. Key positions along the course of the Dnieper were identified with corresponding key positions along the course of the Nile, up to the point of transferring Egyptian place names to Russia. The information about the existence of this geodetic system is provided by the description of a map of Russia which is based on it. The description of the map indicates that it was used at the end of the sixth century B.C., but the map may be older; in any case there are other sources of information about the base line which indicate that it was marked in very early times.

The figures of the geodetic system on which the map of Russia was based are most intriguing. The base line at parallel 45° 12′ north suggests that it was decided that it is at this latitude that the degree of latitude has a length equal to the average length of the degree of latitude. The fact that the meridians of Egypt were followed for 10° up to parallel 55° 12′ north suggests that it was decided that a degree of latitude at this parallel is equal to the length of a degree of equator.

The designation of 45° 12′ north for the location of the average degree indicates what the Egyptians assumed to be the degree of ellipticity of the earth. According to the *Smithsonian Geographical Tables,* the length of the degree of latitude at the point 45° 12′ north is 111,134.9 meters; from this figure we would get an arc of meridian of 10,002,141 meters. According to the Egyptian table of the length of the degrees of latitude that I have reconstructed, the degree at the point 45° 12′ north is 212,028.6 royal cubits = 111,134.4 meters; this length implies an arc of meridian of 10,002,099 meters. According to the *Smithsonian Geographical Tables* the degree ending at parallel 55° 12′ is 111,319.3 meters; if this is taken as the length of the degree of equator, the equatorial circle is 40,074,948 meters. According to the Egyptian table of the length of the degrees of latitude, the degree at 55° 12′ north is 212,381 royal cubits = 111,319.1 meters; this would indicate an equatorial circle of 76,457,160 royal cubits = 40,074,890 meters (stadium of equator = 353.96833 cubits).

2. In performing astronomical observations it is necessary to express differences of longitude in terms of units of time. The equator and all parallels are divided into 360 degrees, but considering the rotation of the earth it is expedient to divide the equator and all parallels into 24 hours. Given 360/24 = 15, a minute or a second of time is equal to 15 minutes or 15 seconds of degree.

In astronomical calculations, there are employed two different kinds of time, solar time and sidereal time. Solar time is our ordinary time. Solar time assumes that the day is the interval between two successive passages of the sun at the meridian. The length of the day so defined varies greatly according to the seasons of the year; it varies by more than 1/90. The reason for this variation is that the speed of the earth along its orbit around the sun is not constant and that the apparent motion of the sun around the earth does not follow the line of the equator, but of that of the ecliptic. Hence, in ordinary life we reckon by mean solar time, which is obtained by assuming that a fictitious sun moves along the celestial equator at a speed equal to the average speed of the sun along the ecliptic.

Mean solar time is a highly artificial concept and we can use it because we have mechanical clocks. The ancients calculated by sidereal time, which they could measure by observing the apparent movement of the vault of heaven. Sidereal time has the advantage of flowing evenly. There are small variations due to the nutation of the earth under the influence of the gravitational pull of the moon and the planets; but these variations are too small to be relevant to the calculations we are considering.

A sidereal day is the interval between two passages of a star at the meridian. A sidereal day is shorter than a solar day. If one observes a star at the meridian today, that star will be again at the meridian in less than a solar day. In other words, if one counts by solar time, the vault of heaven rotates about one degree more than a full circle in a day. The difference between mean solar time and sidereal time can be easily computed, because in a year the vault of heaven makes exactly one more circle around the earth than the number of circles made by the sun.

Hence the ancients could reckon:

$$\frac{\text{Solar time}}{\text{Sidereal time}} = \frac{366}{365} = 1.00273972$$

or more precisely:

$$\frac{\text{Solar time}}{\text{Sidereal time}} = \frac{366.25}{365.25} = 1.00273785$$

They did not need a formula more precise than the second one; today we reckon by the ratio 1.00273791.

The ancients simplified this complex matter by counting by the speed of movement of a point at the equator. That speed was taken by them as constant; the infinitesimal variations in speed of the rotation of the earth on its axis are relevant only to some calculations of modern astronomy.

The speed of a point at the equator in terms of mean solar time was obtained by dividing the length of the equator into 24 hours = 1440 minutes = 86,400 seconds. But the ancients were concerned particularly with the speed of a point at the equator in terms of sidereal time. A minute of time (solar time) corresponds to the length of 15 minutes of degree of equator. A minute of time (sidereal time) is equal to the same length multiplied by 365.25/366.25, that is, it is shorter.

3. When the Egyptians standardized their system of measures by establishing that the degree at the middle latitude of Egypt is 240,000 geographic cubits (360,000 geographic feet = 600 stadia) or that 1/48 of great circle measured from 24° 00′ north to 31° 30′ north is 1,800,000 geographic cubits, they must have had in mind the following equivalence:

1 second (sidereal time) = 1000 cubits
1 minute (sidereal time) = 60,000 cubits =
1/4 length of degree of latitude in Egypt

This calculation was convenient, but implied an equatorial degree (degree of latitude in Egypt × 1.00273785) of 111,109.8 meters, which is slightly too short; it is the length of a degree of longitude at about 3° 30′ from the equator.

In order to obtain the right length of the second and minute of sidereal time, one must take as reference a degree of latitude further north than Egypt. The degrees at the latitudes of Dodona and Delphi provided the correct values.

Classical Greece was not a unified country, being divided into cities proudly clinging to their absolute political independence; but, most incongruously, it had a national oracular center, just as Egypt, a strongly unified country, had a national oracular center at the Temple of Amon in Thebes. In Greece there were two centers which competed

Another Greek conception of an *omphalos* as derived from the Egyptians.

Omphalos of Delphi depicted with two pigeons (usually facing each other), evidently carrier pigeons used for establishing geographic distances. According to Greek legends, a central geodetic point was obtained by loosing two birds of equal strength and using the mean of the time employed in flight. This would allow for differences in wind current and other variables. By repeated flights even more accurate measurements could be obtained.

for the role of national oracle, Dodona and Delphi. The oracle of Dodona was considered more ancient and many Greeks considered it more authoritative, but it was at a practical disadvantage because it was located beyond the limits of solidly Greek territory in an area of most difficult access. In modern Greece, which extends more widely than ancient Greece, Dodona is near the Albanian frontier. The position of the oracle of Delphi, even though not as surprising as that of the oracle of Dodona, was peculiar; it was located in the mountains, north of all major centers of Greece.

The Greeks narrated that two doves flew from the temple of Amon in Egypt in order to establish the oracles of Dodona and Delphi. In ancient literature and iconography the flight of two doves is the standard symbol for the stretching of meridians and parallels.

Because the oracle of Delphi was less isolated, it received more attention and consequently we are better informed about it. Delphi was considered the geodetic center of Greece. The god of Delphi, Apollo, whose name means "the stone," was identified with an object, the *omphalos*, "navel," which has been found. It consisted of an ovoidal stone (the ovoidal shape indicated the lengthening of the degrees of latitude as one moves north) covered by a net. The net was the symbol of what even today we call the net of meridians and parallels. The *omphalos* of Delphi was similar to the object which represented the god Amon in Thebes, the "navel" of Egypt. In 1966 I presented to the annual meeting of the Archeological Institute of America a paper in which I maintained that historical accounts, myths, and legends, and some monuments of Delphi, indicate that the oracle was established there by the Pharaohs of the Ethiopian Dynasty. This is the reason why the Greek portrayed Delphos, the eponymous hero of Delphi, as a Negro.

The relevance of the latitude in the location of Delphi is indicated by a number of Greek accounts which associate Delphi with Sardis, the capital of the kingdom of Lydia in Asia Minor, which is on the same parallel (38° 28′ north).

The role of geography in the oracular importance of Delphi is indicated also by the method employed in obtaining oracular responses. Modern scholars who have been impervious to the rational elements of ancient thought and prefer to ignore that Apollo, the god of Delphi, was a god of reason and scientific thought, are generally inclined to think that the oracular responses were given by a priestess who, put in a trance by drug fumes, uttered gibberish. But there is abundant pictorial evidence which shows vividly how the oracle was consulted. An object which resembles a roulette

Egyptian *omphali* with twin birds. Carrier pigeons are depicted in Egypt as early as the Fourth Dynasty, and were evidently used to establish parallels and meridians from prehistoric times. Homing pigeons, which fly in a straight line (as the crow flies!), could cover the more than five hundred miles from one end of Egypt to the other in a single day.

wheel, and actually is its historical antecedent, was centered on top of the *omphalos*. The spinning of a ball gave the answers; each of the 36 spokes of the wheel corresponded to a letter symbol.

In studying ancient computing devices, I have discovered that they were used also to obtain oracular answers. This is the origin of many of the oracular instruments we still use today, such as cards and ouija boards. The psychological foundation of this phenomenon is simple. If I have a problem in interpreting an ancient text or an archeological report, I "consult" my calculating machine which "gives me the answer." By stretching this imagery further, one could assume that the calculating machine is an oracle. The roulette wheel of Delphi originally was a special kind of abacus for calculating in terms of angles.

The latitudes of Dodona and Delphi are significant. The length of the degree of latitude at the parallels of these two oracular centers gave the length of the minute or second of sidereal time, that is, the distance covered by a point at the equator in a sidereal minute or second of rotation of the earth.

Dodona is at 39° 32′ north. According to the *Smithsonian Geographical Tables* a degree at this parallel is 111,014.0 meters. This means that the degree must have been calculated as 360,673 geographic feet (360,000 plus 1/535) = 111,013.6 meters. If we multiply this length by 1.00273785, we obtain 361,660 geographic feet, the length of the degree of latitude at parallel 55° 06′, which is equal to the length of a degree of longitude at the equator.

If the figures employed in the reckoning of Dodona are rounded to a degree of 360,600 geographic feet and to a second of sidereal time of 1001.666 geographic cubits (that is, 1000 plus 1/600), we obtain the length of the degree of latitude at the parallel of Delphi, which is 38° 28′ north. A degree of 360,600 geographic feet is 110,991.1 meters; a degree at parallel 38° 28′ is 110,993.5 meters according to the *Smithsonian Geographical Tables* and 110,992.1 meters according to the Egyptian table of the length of degrees of latitude. Latitude 38° 28′ north may also have been chosen because it is at the standard distance of 6′ from latitude 38° 34′ north, which is at 3/7 of the distance from the equator to the pole, whereas the Temple of Amon in Thebes was set at 2/7 of this distance.

4. Metrologists of the past have wavered in establishing the value of the geographic foot (and hence of the artaba), because they confused this unit with a similar one, the Greek foot, which is about half a millimeter longer.

Roman writers mention a Greek foot which is 25/24 of the Roman foot and a Greek stadium which is equal to 600 Greek feet or 625 Roman feet. The Romans used the two units in conjunction. Roman roads were divided into miles of 5000 Roman feet, but at times between the milestones there were smaller markers which divided the road into 8 Greek stadia ($8 \times 625 = 5000$). In giving itinerary distances, writers of the Roman period usually reckon by Roman miles on land and by Greek stadia at sea.

Because Roman authors indicate that the degree is 75 Roman miles or 600 Greek stadia, since the Renaissance metrologists have been concerned with establishing the exact value of the Greek foot; but in examining the empirical evidence they met with data that appear conflicting, for the reason that they did not separate sources of information which apply to the geographic foot. Travelers and sailors of the eastern Mediterranean and the Middle East used to assume that a degree of latitude is 600 geographic stadia (110,806 meters) and a degree of longitude is 500 geographic stadia (92,339 meters); Greek and Roman travelers and sailors used to assume that a degree of latitude is 600 Greek stadia = 75 Roman miles (110,980 meters) and a degree of longitude is 500 Greek stadia = 60 Roman miles (92,483 meters). As a result scholars have confused information concerning two different types of units. The confusion occurs easily, unless one assumes high standards of precision and accuracy in ancient measurements, since we have:

Geographic foot	= 307.7957 millimeters
Geographic cubit	= 461.6935 millimeters
Greek foot	= 308.2764 millimeters
Greek cubit	= 462.4147 millimeters

A degree of latitude of 600 Greek stadia = 75 Roman miles is correct at parallel 37° 42′, which is the latitude of Mycenae. The system of calculation used by the Greeks and Romans goes back to the Mycenean ancestors of the Greeks.

Archeologists assume that, if the Greeks of the classical period measured badly, the Greeks of the Mycenean age did not measure at all. It is assumed that when the Myceneans erected their buildings they placed one stone on top of another without much of a plan. However, we know that the Myceneans were engaged in extensive long-distance trade and through it they accumulated huge quantities of gold of African origin; long-distance navigation and exchange of precious metals were the two activities which created for the ancients the most compelling need for exact standards.

By examining the dimensions of Mycenean citadels, I have established that they were planned by a foot which is 15/16 of the Roman foot, a foot of 277.4488 millimeters. This foot has been called Oscan or Italic by metrologists of the last century, who noticed its occurrence in pre-Roman Italy and in the earliest remains of Rome. I call this foot Mycenean.

The Mycenean foot not only is 15/16 of the Roman foot of 295.9454 millimeters, but also is 9/10 of the Greek foot of 308.2764 millimeters. The Greek foot is 25/24 of the Roman foot and $25/24 \times 16/15 = 400/360 = 10/9$.

A degree of 360,000 Greek feet (75 Roman miles), a degree of latitude at the parallel of Mycenae, is equal to 400,000 Mycenean feet. The occurrence of the factor 4 indicates that a calculation by time units is involved, since there are 4 minutes of time in a degree. A minute of time is equal to 100,000 Mycenean feet. Hence, by using the Greek cubit and the Mycenean foot, one could obtain the following easy formula:

Second of time = 1000 Greek cubits
Minute of time = 100,000 Mycenean feet

These units are slightly too short for a second and a minute of sidereal time. If we take the degree of 360,000 Greek feet = 400,000 Mycenean feet = 110,979.5 meters and multiply it by 1.00273785, we obtain a degree of 360,986 Greek feet = 110,283.4 meters, which is the length of a parallel circle at about 1° 30′ from the equator.

But the numerical structure of the units indicates how the exact length of the degree of equator was obtained by introducing an easy correction. One starts with these data:

1000 Greek cubits = 1 second of time
Day of 86,400 seconds = 86,400,000 Greek cubits
100,000 Mycenean feet = 1 minute of time
Day of 1440 minutes = 144,000,000 Mycenean feet

These figures can be modified as follows:

Equator = 86,666,666 Greek cubits = 40,075,939 meters
Equator = 144,444,444 Mycenean feet = 40,075,939 meters

Similarily, one may start with the Greek foot and obtain

100 Greek feet = 1 second of degree
Circle of 1,296,000 seconds = 129,600,000 Greek feet

The last figure can be modified to

Equator = 130,000,000 Greek feet = 40,075,939 meters

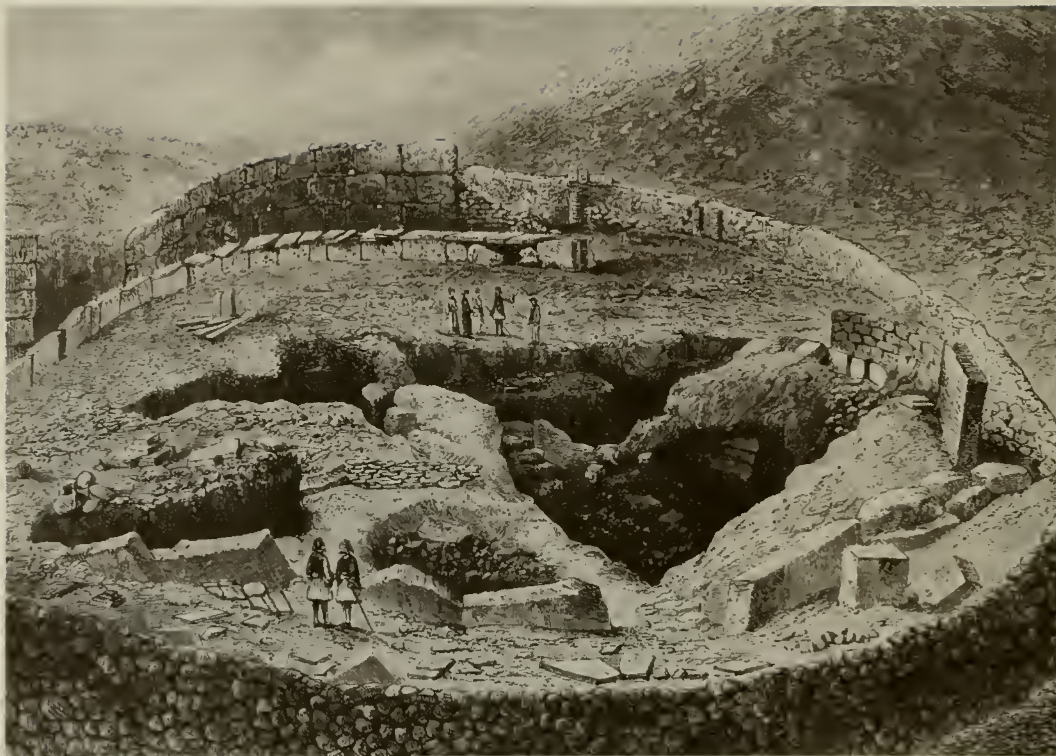
All that was needed in order to obtain the exact length of the equator was to assume that a circle is equal to 1,300,000 seconds of degree, instead of 1,296,000.

It is possible that this formula was used to calculate the actual length of the solar day in the different seasons of the year. Today almanacs assign the value of 1200 to the length of the mean solar day and list a figure greater or smaller than 1200 in order to indicate the actual length of the solar day for each day of the year. Possibly the ancients proceeded in a similar way, assigning the value of 1300 to the mean solar day.

Archeologists and historians assume that the Myceneans had no concern with science, but the most famous remains of Mycenean civilization proclaim otherwise.

Lion Gate at Mycenae.

The best known monument of Mycenae is the entrance gate which today is called the Lion Gate, because he who approaches the city is overpowered by a huge relief sculpture on the triangular capstone of the entrance; the relief consists of a column between two facing lions. The column is sandwiched between two sets of parallel horizontal lines. At the bottom the column rests on a support on which three parallel lines are strongly marked. These three lines are the same three lines which occur in the hieroglyphic symbol for Southern Egypt; they represent the tropic of Cancer, which was identified with parallels 24° 06′, 24° 00′, and 23° 51′ north. The column represents the three basic meridians of Egypt; the curvature of the column suggests the development of the system of meridians to the east and the west of Egypt. On top of the capital of the column (symbol for Northern Egypt) there rests what appears to be a segment of a floor. This segment of floor is on three levels. The bottom and the top levels are two horizontal lines, whereas the middle level consists of four circles. I have explained the significance of the factor 4 in the Mycenean system of linear units. The top part of the relief represents the parallel of Mycenae.



The grave circle at Mycenae excavated by Schliemann. A geodetic point for astronomical observation similar to the circular henges and mounds of the second millennium B.C. elsewhere in Europe.

The two lions which face each other on the sides of the column represent a circle closing on itself. The easiest way to convey the meaning of this symbol is to refer to pieces of ancient jewelry which consist of a bracelet open at one side with a head of a lion on each open end. The lions represent the summer solstice. The stance of the lions, with the front paws on the line of the tropic and their hind paws extending below it (this stance will later become the heraldic symbol of the lion rampant), indicates the spread of the zodiacal band north and south of the ecliptic. The ancients established their astronomical system when the spring equinox was in Taurus, which ceased to be true at the beginning of the second millennium B.C.; for them the point zero of the sky was between the two horns of Taurus. Today we count from the constellation of Aries, although the spring equinox has not been in Aries since the time when the Roman Emperor Antoninus Pius (A.D. 138–161) celebrated the end of the age of Aries and introduced new cults and religious beliefs in accordance with the beginning of a new cosmic age. When the spring equinox was in Taurus, the summer solstice was in Leo.

The cosmological meaning of the Lion Gate of Mycenae should not have been lost to archeologists, since next to this gate there is the second most impressive relic of ancient Mycenae, the so-called Grave Circle. It consists of a circular arrangement of stone blocks. If excavators had not been completely blinded by their belief in the primitiveness of the Myceneans, they would have immediately assumed that this circle must have some cosmological meaning. Instead the Smithsonian Institution spent time and energy to proceed to measurements of the skeletons found buried within the circle, arriving at the conclusion that they were bones of ordinary size men and not of giants. But the dimensions of the stone circle have not received attention; it may be enough to report here that the inner diameter of the circle is 100 Mycenean feet.

When the first circuit of walls of Mycenae was erected, the Circle was outside the walls directly in front of the Gate; the middle of the Gate is on the line of the north-south diameter of the Circle. Later the circuit of the walls was extended so as to include the Circle within the citadel.

5. A splendid illustration of the Mycenean system of linear units is provided by the Parthenon of Athens.

The Parthenon of Athens is the only Greek temple which has been surveyed with an adequate level of accuracy. But unfortunately for my investigation of the dimensions of Greek temples, the system of proportions of the Parthenon is an aberrant one. I have established the mathematical formula that determined the dimensions of Greek temples and the mathematical formula that determined the dimensions of Mycenean throne rooms; the Parthenon conforms to the latter and not to the former. The reason is that the Parthenon was built as a replacement on a larger scale of the Temple of Athena destroyed by the Persians, when they sacked Athens in 480 B.C. The old Temple of Athena in turn was built on top of a Mycenean throne room, some remains of which have been found by deep excavations. For this reason the Parthenon was planned in Mycenean feet, whereas most of the other monuments of the Acropolis of Athens were planned in Roman feet. However, the major dimensions of the outer colonnade of the Parthenon were so chosen that they could be expressed also in Greek feet, which was easy since Mycenean foot and Greek foot relate as 9:10.

For the study of the Parthenon we can rely on data that are satisfactory for some of the major dimensions, because at the middle of the last century an English architect and scholar of the history of architecture, Francis Cranmer Penrose, who was also an outstanding dilettante astronomer, on the basis of reports on the mathematical curvatures of the lines of the temple became convinced that the Parthenon

The so-called Treasury of Atreus at Mycenae built into a mound with corbeled roofing similar to the Maes-Howe mound.

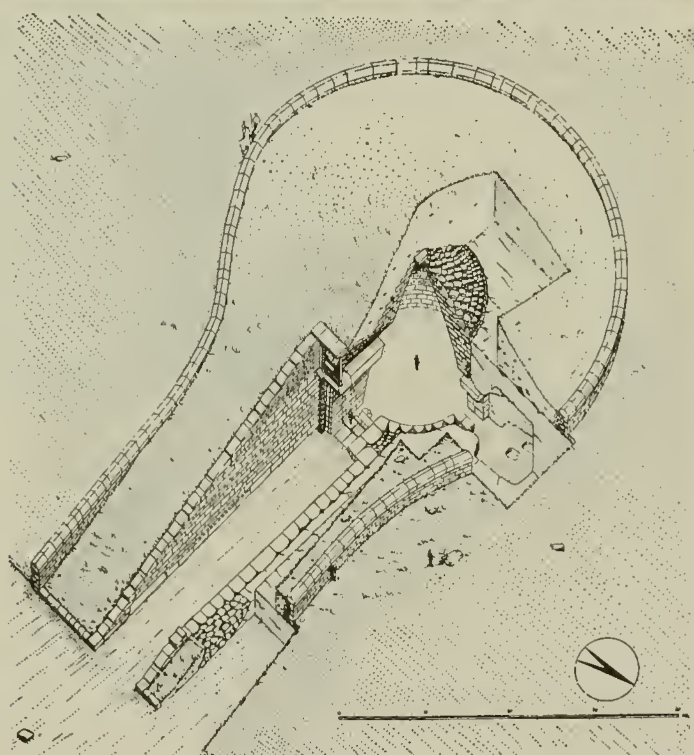
had been planned and executed with high standards of mathematical skill. In order to prove his point he measured it accurately with the precision of one-thousandth of an English foot.

Penrose, however, was ridiculed by archeologists, and no other Greek temple has been surveyed with comparable care ever since. The Archeological Institute of America does not support any survey or publication which does not assume that the maximum precision achieved in construction of reference foot rules by the ancient Greeks was a fifth or at the very best a tenth of centimeter. Naturally, the precision achieved in the construction of buildings was much less than the precision of the official reference rules.

Penrose was not able to convince scholars of his major contention, because he was obsessed as an architect with the notion that buildings should have perfectly square corners. He put this notion into practice when he planned the building of the British School of Archeology in Athens, of which he was director for two short periods, after its foundation in 1882. Because of this obsession, when Penrose found that the western front of the Parthenon is longer than the eastern front and that the south flank is longer than the north flank, he concluded that this was the result of mistakes in construction. His opponents were quick to point out that, if it is so, his major contention is disproved.

Penrose believed that the difference in the lengths of the sides of the Parthenon results from mistakes in the marking of the four corners which were intended to be perfectly square. In reality, the four corners of the Parthenon

Nineteenth-century view of the Parthenon.



The Treasury of Atreus at Mycenae (isometric view, after Hood), which has a striking resemblance to the Maes-Howe burrow and appears to have been designed for azimuth and zenith observation, like the subterranean chambers of the pyramids.

were not intended to be exactly square, but to deviate by set small amounts from a right angle, as is the case with the four corners of the Great Pyramid. I have established that the west front of the Parthenon was intended to be 1/48 of a Mycenean foot longer than the east front, and that the south flank was intended to be longer than the north flank by the same amount. The two longer sides join at the southwest corner, which is also higher in level over the other three corners. Taking these intended deviations into account, the actual findings of Penrose about the length of the sides agree almost perfectly with the theoretical dimensions obtained by mathematical principles.

Even with the intended lengthening of the west and south sides, the northeast corner, which joins the two most important sides, could have been a right angle, but instead it was acute by a figure close to a minute of degree. Unfortunately, Penrose measured the angle of this corner rather casually, because he thought that the lack of exact squareness was the result of a mistake in construction, and nobody else has tested the angle of this corner again in more than 120 years.

East end of the Parthenon.

There are many problems in the architecture of the Parthenon that cannot be solved, because archeologists prefer to go on building fanciful theories rather than establish the facts by an accurate survey. It is a basic principle of epistemology that our ability to reject erroneous theories increases in proportion with the precision and accuracy of the measurements; the converse is true, and this is what archeologists like, because, as they put it, it permits the spirit to soar. For instance, if one were to accept the loose standards of measurement dogmatically adopted by the Archaeological Institute of America, it would not be too difficult to present an argument to the effect the the surface of the earth is concave.

In the specific case of the Parthenon, I can point out that Penrose tested the orientation of the north flank, and that on the basis of his finding I could establish that the Parthenon is correctly oriented according to the latitude and longitude of Athens. But details of construction have led me to realize that the orientation of the inner part of the temple, the cella, was a trifle different. Since the difference of azimuth between the two longitudinal axes of the Parthenon has never been tested, I am left in the dark about the fine points in the orientation of the Parthenon.

An essential datum is that there are similarities between the mathematical structure of the Parthenon and that of the Great Pyramid. In both constructions the corners deviate deliberately from a right angle. I have established that the elevation of the fronts of the Parthenon was calculated by the factor φ and that the elevation of the flanks was calculated by the factor π. According to the data available, I have interpreted the elevation of the Great Pyramid to be such that the north side was calculated by the factor φ and that the west side was calculated by the factor π.

Here, I will deal only with the horizontal dimension, width, of the two fronts of the Parthenon, because it is directly connected with the Mycenean system of measures.

Before Penrose proceeded to a careful measurement of the sides of the Parthenon in the winter 1846–47 (the season of winter was deliberately chosen in order to reduce the effects of changes in temperature which may be macroscopic under the sun of Greece), an attempt at careful measurement was conducted in 1753, under unfavorable political and physical circumstances, by the painter James Stuart and the architect Nicholas Revett, who had become interested in the measurements of ancient buildings while studying in Rome. The expedition of these two English antiquarians had been carefully planned and created great stir in Europe at the time. One of their specific aims, indicated in the campaign for the raising of the necessary funds, was to ascertain the exact length of the Greek foot and by inference of the Roman foot, which is 24/25 of Greek foot. The Parthenon is called *Hekatompedon,* "one hundred foot temple," in Greek texts and these texts indicate also that its width was 100 feet. Earlier visitors to the Parthenon had concluded that the two fronts of the temple measured 100 Greek feet. For this reason Stuart and Revett provided themselves with highly reliable instruments of measurement and paid the greatest attention to the measurement of the two fronts.

They were so concerned with the length of the Greek foot that they reported the dimensions of the temple in such a way as to arrive at the results that were expected. Their figures for the length of the fronts are scanty. But they arrived at the conclusion that the value of the Greek foot is 12.137 English inches = 308.2795 millimeters, which agreed well with what scholars had estimated to be the length of the Roman foot (24/25 of Greek foot). According to my reckonings the Greek foot is 308.2765 millimeters.

Stuart and Revett used a yard rule prepared by the famous instrument-maker John Bird of London. A few years later (1762) Bird prepared a yard rule on behalf of the Parliamentary Committee appointed in 1758 "to inquire into the original standards of weight and measure of this kingdom." Although Bird had to follow the instructions of the committee, it can be presumed that the rule he built in 1762 did not differ in a manner significant for the present research from those he had built earlier. The Bird rule of 1762 was the main basis in the calculation of the Imperial Standard Yard made legal by Parliament in 1824.

What Stuart and Revett did not know is that the fronts of the Parthenon were intended to be slightly more than 100 Greek feet.

If the fronts had had a length of 100 Greek feet = 111.111 Mycenean feet = 111 1/9 Mycenean feet, they would have had a length equal to a second of degree of latitude at the parallel of Mycenae (37° 42′ north), whereas the latitude of Athens is 37° 58′ north.

The fronts of the Parthenon were planned to have a length of 100 1/5 Greek feet = 111 1/3 Mycenean feet. This length was increased by 1/48 of a Mycenean foot on the west front. Hence, the lengths of the fronts, according to my interpretation, was:

Eastern front = 30,889.3 millimeters
Western front = 30,895.1 millimeters

Penrose reported the following findings:

Eastern front = 101.341 English feet = 30,888.7 millimeters
Western front = 101.361 English feet = 30,894.8 millimeters

The western front is better preserved.

These figures prove how accurate was the planning of the Parthenon and how justified was Penrose in testing the dimensions of this temple with the greatest care of which he was capable.

But all the horizontal lines of the Parthenon have a parabolic curvature. The sides of the temple have a double parabolic curvature: they are curved upward and inward. The spacing of the columns proves that dimensions that were relevant were those measured along the parabolic line.

The two parabolic curvatures increased the length of the sides. What I have been able to establish with certainty is the effect of the combined double parabolic curvature on the edge of the sides, because of necessity the spacing of the columns which were placed all along the sides had to be based on the actual length of the edge of the sides. The two curvatures added 8/48 = 1/6 of foot to the length of the fronts, so that the eastern front measured 111 1/2 Mycenean feet = 100.35 Greek feet = 30,935.5 millimeters, when measured along the edge of the blocks. But in calculating the width of the temple one should consider only one parabolic curvature, the curvature upward, that is, in substance, the curvature of the floor. Before expressing exact conclusions I would like to see the results of a new survey of the curvatures of the Parthenon, but I can definitely state that the width of the temple measured along the curvature of the floor was halfway between 111 1/3 and 111 1/2 Mycenean feet, that is, close to 111 5/12 feet = 30,912.4 millimeters.

If we add to this amount the 1/48 foot added to the western front, we have a length of 111 7/16 feet = 30,918.2 millimeters. This length would indicate an equatorial degree of 111,305.5 meters and an equatorial circle of 40,069,988 meters.

It can be concluded that the width of the fronts of the Parthenon was intended to indicate the length of a second of degree of longitude at the equator. But further testing of the dimensions of the Parthenon is necessary in order to establish what was exactly the length of the second of degree that the builders had in mind.

As I have indicated, the Mycenean system of measures, which was followed by the Greeks of the classical age, assumed an equatorial circle of 144,444,444 Mycenean feet and hence a second of degree of equator of 111.45404 feet. This would imply a width of the Parthenon of 30,922.8 millimeters.

VII. DIMENSIONS OF THE GREAT PYRAMID

1. Since the dimensions of the Great Pyramid have been endlessly debated, and studies of them have often degenerated into mysticism, it is proper that in approaching the subject I clarify my method. The essence of my method is to be absolutely pedestrian. I have spent years of my life in trying to ascertain the exact length of the Roman foot, eliciting from the academy the reaction that it is a disgrace for a classical scholar to waste energy on such mechanical trivialities. Similarly, after reading scores of studies on the architecture of the Parthenon, I set myself two tasks: to determine the length of the foot employed in the construction, and to compare item by item all available modern

reports on the actual dimensions of this temple. I followed this line of research although I was warned by the learned that a person guilty of such *banausia,* which in Greek means behavior worthy of a manual wageearner, would always remain blind to the lofty mind of the ancient Greeks. In dealing with the geometry of the Pyramid, I have taken as starting points my conclusions about the length of the Egyptian royal cubit and the survey of the dimensions of the Pyramid conducted by Cole, who was not an Egyptologist but a professional surveyor.

Up to now the Cole survey has been neglected. Trust has been put on the survey conducted by Petrie, but, although Petrie considered himself an expert of measurements (he started his career as an Egyptologist under the guidance of his father, who was an engineer) and used all the diligence of which he was capable, his survey proves to have arrived at misleading results when compared to that of Cole.

In order to justify my method, I shall refer to another great scientific issue which, as we shall see, happens to be related to the problem of the dimensions of the Pyramid. In the *Principia* Newton argued that because of the centrifugal force generated by its rotation, the earth must be flattened at the poles. Reasoning purely on mechanical grounds, he concluded that the polar flattening is 1/230, which means that the polar radius is shorter than the equatorial radius by 1/230 of the latter. The calculation was based on the assumption, which is not true, that the earth is a homogeneous fluid body. Following the survey of Picard, for which Newton waited before publishing his *Principia* in 1686, other scholars of the French Académie des Sciences applied themselves assidiously to the problem of determining by geodetic surveys what was the actual shape of the earth. Their results were contradictory, but they were such that for seventy years after the publication of the *Principia* the empirical evidence could be understood to indicate that the earth, far from being flattened at the poles, was elongated. This caused most serious controversies in the field of physical theory. I have reexamined the records of this gerat debate to find that the French scholars were successful in advancing mathematical theory, in developing correct methods of triangulation, and in refining the techniques of astronomical observation, but had neglected the need of setting a reliable unit of linear measurement. The several surveys of the length of the degree of latitude, up to and including the famous survey conducted by Father Ruggiero Boscovich in Italy in 1751–53 (a survey which took as a starting point the Roman milestones of the Appian Way), kept using standards of the *pied de roi* which were different from each other.

The history of these surveys is a comedy of errors. This was sensed by the keen mind of Voltaire who, when Maupertuis announced triumphantly that his survey of the degree conducted in Lapland had proved that the earth is flattened at the poles, called him *le grand aplatisseur*, "the great flattener," building a pun on the extracurricular activities of Maupertuis with a Lappish maid.

The difficulties of scientists arose from the circumstance that the original standard of the *pied de roi* had been lost. The *pied de roi* used to be a fraction of the ancient Roman foot, and good reference standards of the Roman foot and of the *pied de roi* were kept by French trade guilds. But, the French absolute monarchy followed a policy of eliminating the public functions of the guilds. Finally the minister Colbert issued an ordinance prescribing that the only reference rule that could be used should be that kept at the Châtelet, the seat of royal administration and justice in Paris. But the standard of the Châtelet was poorly defined and badly protected from accidental damage. This is the reason why many scholars could arrive at the startling scientific conclusion that the earth is elongated at the poles. The intellectual confusion came to a rest because the engraver Langlois built his own private standard of the *pied de roi*, by assuming that the *pied de roi* is the edge of a cube that contains 70 Paris livres of water. Langlois's standard was used in establishing the Paris meter of the French metric system.

2. Although Petrie's survey of the length and orientation of the sides of the Great Pyramid proves to be unreliable, his survey of the dimensions of the King's Chamber proves to be superior to the several ones conducted since the seventeenth century. Since Petrie's survey of the King's Chamber has established that the royal cubit of the Pyramid measured 524.05235 $\pm$ 0.1016 millimeters, it permits the conclusion that the royal cubit employed in the construction was 524.1483 millimeters.

Cole began his survey of the length and orientation of the sides of the Pyramid by trying to establish the exact location of the corner points. By an extensive sounding of the foundations, he located the corner points with a possible margin of error which he estimated as follows:

West side:	30 millimeters at either end
North side:	6 millimeters at either end
East side:	6 millimeters at either end
South side:	10 millimeters at the west end
	30 millimeters at the east end

Next, Cole examined the alignment of the four sides and concluded that they meet to form angles which deviate as follows from a right angle:

Northwest corner:	−0° 00′ 02″
Northeast corner:	+0° 03′ 02″
Southeast corner:	−0° 03′ 33″
Southwest corner:	+0° 00′ 33″

I interpret these data to mean that the west side was drawn first and that the north side was intended to be perfectly perpendicular to it. The east side was intended to be at an angle of 3′ with the perpendicular to the north side, and the south side was intended to be at angle of 30″ with the perpendicular to the west side. In other words, the four corners were intended to deviate from a right angle according to the following pattern:

Northwest corner:	0
Northeast corner:	+3 minutes
Southeast corner:	−3 1/2 minutes
Southwest corner:	+ 1/2 minute

Having established the alignment of the sides according to the figures mentioned above, Cole calculated the length of the sides to be the following:

West :	230,357 millimeters
North:	230,253 millimeters
East :	230,391 millimeters
South:	230,454 millimeters

There is a contradiction in Cole's report about the length of the north side. In the summary of the lengths of the sides, Cole states that this side is 230,253 millimeters; but in an earlier part of his report he states that the north side is divided into a segment of 115,090 millimeters and a segment of 115,161 millimeters (total of 230,251 millimeters) and confirms these figures by explaining that the difference between the two segments is 71 millimeters. This contradiction is most unfortunate, because it is a conclusion of mine that the lengths of the two segments of the north side provide a key to the determination of the vertical dimensions of the Pyramid. I am inclined to infer that Cole found the north side to have a length of 230,251 millimeters.

I interpret Cole's figures to mean that the basic length of the side was 439 1/2 cubits = 230,363.18 millimeters. According to Cole the average length of the sides is 230,363.25 millimeters. Each side was intended to have a length of 1 1/4 stadia according to the stadium of 351.6 cubits; for the Egyptian this was the stadium (1/10 minute) of the degree of latitude at the equator. The perimeter of the Pyramid was intended to be 1758 cubits = 921,452.71 millimeters; Cole reports a perimeter of 921,453 millimeters. The perimeter was intended to be equal to 1/2 minute of latitude at the equator. The length of the minute of degree of latitude at the equator was calculated 3516 cubits = 1842.905 meters; it is 1842.925 meters according to the International Spheroid.

In the calculation of the Pyramid the royal cubit was divided into 24 fingers, each finger being 21.8395 millimeters. Egyptian measuring rods indicate that the royal cubit, which in principle is composed of 28 fingers (fingers such that 24 make an Egyptian common cubit), at times was divided into 24 fingers according to the ordinary division of the cubit. There are Egyptian measuring rods in which the royal cubit is divided into 28 fingers on one face and 24 fingers on the other face.

The west side was drawn first and then the north side was drawn perpendicular to it. The south and the east sides were at an angle different from a right angle with the two neighboring sides. This caused variations in the length of the sides, but steps were taken in order to assure that the average length of the sides remained 439 1/2 cubits.

The south side was intended to be at an angle 90° 00′ 30″ with the west side. Reckoning by tangent 0° 00′ 30″, this would cause a lengthening of the east side of 33.494 millimeters. Apparently this lengthening of the east side was computed as 1 1/2 fingers = 32.758 millimeters. The lengthening of the east side was compensated in part by shortening the west side by 1/4 of finger. In other words, the south side was moved backward by 1/4 of finger. The west side came to be 439 1/2 — 1/96 cubits = 230,363.1778 — 5.4597 millimeters = 230,357.72 millimeters. The east side was lengthened by 1 1/4 fingers, so that it came to be 439 1/2 + 5/96 = 230,363.1778 + 27.2994 = 230,390.48 millimeters.

The western side was rotated at the middle point by 3 minutes, so as to shorten the north side and to lengthen the south side. Multiplying the length of half of a side by tangent 0° 03′ 00″, there would be a shortening and a lengthening of 100.519 millimeters, which could be understood as 4 5/8 fingers = 101.008 millimeters. Since the east side had been lengthened by 1 1/4 fingers and the west side had been shortened by 1/4 finger, there remained an increase of a finger to be compensated. Hence, the north and south sides were shortened by 1/2 finger each. In other words, the east side was moved backward by 1/2 finger.

The length of the north side came to be 439 1/2 cubits — 4 5/8 fingers — 1/2 finger = 439 55/192 cubits = 230,251.250

millimeters. The length of the south side came to be 439 1/2 cubits + 4 5/8 fingers − 1/2 finger = 439 129/192 cubits = 230,453.266 millimeters. The difference between the two sides is 74/192 cubits = 202.016 millimeters.

This analysis of the method followed in planning the base of the Pyramid arrives at the striking conclusion that my estimates of the lengths of the sides, based on theoretical principles, do not differ by a millimeter from those obtained empirically by Cole (length of sides expressed in millimeters).

	My estimate	Cole's report
West side:	230,357.72	230,357
North side:	230,251.25	230,251
East side:	230,390.48	230,391
South side:	230,453.27	230,454
	921,452.72	921,453

3. In his survey Cole paid attention to a detail which in my opinion provides the key to the entire geometrical structure of the Pyramid. The Egyptologist Borchardt had noticed that, at about the middle of the north side, a small line is marked on the pavement which extends outward from the bottom of the Pyramid. Cole measured the position of this line and found it to be at a distance of 115,090 millimeters from the northwest corner and 115,161 millimeters from the northeast corner, with a difference of 71 millimeters between the two distances. He stated that this line is "probably the original line of the axis." Cole apparently did not pay much attention to this detail, since he reported also that the north side has a length of 230,253 millimeters. Reginald Engelbach, in presenting Cole's findings to the academic world, failed to notice the discrepancy in Cole's figures. I suspect that the figure of 230,253 millimeters for the length of the north side crept into the Cole report as a result of a mistake of 2 millimeters in placing the end of the tape against the pin that marked the position of the line of the axis.

If the north-south axis of the Pyramid is off center, it follows that the apex was off center. Petrie, when he surveyed the slope of the Pyramid, on the basis of preliminary tests suspected that each face of the Pyramid had a different slope, but did not try to establish whether this suspicion was justified. Instead he concentrated his efforts on establishing the slope of the north face, which is the best preserved one. As far as I know, none of those who tried to interpret the geometry of the Pyramid on the basis of Petrie's report considered the possibility that the four faces of the Pyramid had different slopes. Nobody has ever utilized Cole's survey in order to interpret the geometry of the Pyramid. If the four faces have different slopes, it follows that the apex is off center.

I have concluded that the north side had a length of 439 55/192 cubits = 230,251.250 millimeters. Hence, I understand Cole's figure to mean that the line which divided the north side into two parts is at a distance of 219 137/192 cubits = 115,162.479 millimeters from the northeast corner, and a distance of 219 55/96 cubits = 115,088.771 millimeters from the northwest corner. The difference between the two segments is 27/192 cubits = 73.708 millimeters. I suspect that there was a mistake of 2 millimeters in setting the end of the tape against a pin at the middle of the north face; this is the reason why Cole reports that the north side has a length of 230,253 millimeters with an excess of 2 millimeters. This type of mistake is common in surveying.

A great number of those who have tried to explain the geometry of the Pyramid can be placed into one of these two categories: those who conclude that the Pyramid was calculated by the factor π, and those who believe that the Pyramid was calculated by the factor φ. In my opinion both explanations are correct, in the sense that the slope of the west face was calculated by the factor π and the slope of the north face was calculated by the factor φ. The inclination of the other two faces was affected by the fact that the angles at the northeast and the southwest were more than right angles.

For reasons that I shall explain below, I have concluded that the height of the Pyramid was either 279.53 cubits = 146,515.174 millimeters or a figure very close to 279.53 cubits.

According to what I have said above, the distance of the apex from the west side was 115,088.771 millimeters. If the west face was calculated by the factor π, the height of the Pyramid had to be $\pi/4$ of the base of the meridian triangle of the west side. Now, 146,515.174 millimeters relates to 115,088.771 millimeters as 0.78550752, which would imply $\pi = 3.142030$. If π was reckoned as 3.1420, the height would have been 146,516.522 millimeters. By the exact value of π, the height would have been 146,535.569 millimeters.

Because of Cole's report we know the distance of the apex from the west side, but we do not have direct information on the distance of the apex from the north side. However, it can be presumed that the west-east axis was not displaced from the middle position. It can also be presumed that the line of the west-east axis was set according to the basic length of sides, before the length of the sides was altered by the widening of the southwest and northeast corners. Since the basic length of the sides is 439 1/2 cubits = 230,363.178 millimeters, it can be presumed that the apex was at a distance of 219 3/4 cubits = 115,181.589 millimeters from the north side. If this is the length of the base of the meridian triangle of the north face, and the height of the Pyramid is 279.53 cubits = 146,515.174 millimeters, the base of the meridian triangle of the north face is 0.78614103 of the height. If the north face was calculated by the factor φ, the height should have been equal to $\sqrt{1/\varphi}$ of the base of the meridian triangle. If one had recokoned by the exact value of φ, the height would have been 146,513.250 millimeters. If the height was 146,515.174 millimeters, as I tentatively assume, and the northern half of the north-south axis was 115,181.589 millimeters, $\sqrt{1/\varphi}$ was reckoned as 0.786141 (the exact value is 0.7861514) and hence $1/\varphi$ was reckoned as 0.61801767.

If $1/\varphi$ was reckoned as 0.6180, the height would be 146,517.274 millimeters, which would imply $\pi = 3.141985$. Therefore, I would conclude that the height possibly was reckoned as 279 15/28 cubits = 279.53714 cubits = 146,518.169 millimeters. According to Petrie the slope of the north face is 51° 50′ 40″ ± 1′ 05″. If the north face had been calculated by the exact value of φ, the slope would have been 51° 49′ 38″. This angle can be easily calculated, because if the meridian triangle of the north side is calculated by φ, the secant and the tangent of the angle of the slope must be equal to each other, that is, must be equal to $\sqrt{\varphi}$. If the west side had been calculated by the exact value of π, it would have had a slope 51° 51′ 14″.

4. Most interpreters agree that the Pyramid had a height of 280 cubits. Even Borchardt, who is so opposed to the idea that Egyptians had any knowledge of mathematics that he calls Herodotus an "idiot" for having said that the Pyramid was calculated by φ, agrees that the Pyramid had a height of 280 cubits.

In general one could establish a consensus of the responsible interpreters to the effect that the meridian triangle of the Pyramid was the following:

Height:	280 cubits
Base:	220 cubits
Apothem:	356 cubits

In my opinion, this triangle was purely the starting point of the calculations. It was chosen in order to indicate the relation π and the relation φ, since 22/28 is the value of $\pi/4$ used in practical reckonings ($\pi = 3\ 1/7$), and

356/220 = 89/55 = 1.6181818 is an approximation to the value of φ according to the initial terms of the Fibonacci series. But the initial meridian triangle was modified for several reasons, the first one being that it is impossible to construct a right triangle with sides 280, 220, and 356, since we have:

$$\begin{aligned} 280^2 &= 78{,}400 \\ 220^2 &= 48{,}400 \\ 356^2 &= 126{,}736 \end{aligned}$$

We have seen that the basic length of the sides was reduced to 439 1/2 cubits (semiside of 219 3/4).

In my opinion, the height of 280 cubits was chosen in order to indicate the polar flattening of the earth. The Egyptians calculated the polar flattening as 1/280, but this was a round figure adopted on the assumption that the order of the cosmos must be septenary.

Information about the Egyptian estimate of the size and shape of the earth is provided by Chapter LXIV of the *Book of the Dead*. This chapter was the most important one: reciting it was considered almost as effective as reciting the entire book. In one of the papyri of the *Book of the Dead* there is an annotation to the effect that this chapter was found in the shrine of the solar boat during the reign of Udimu, the fourth or fifth Pharaoh of the First Dynasty. Chapter LXIV states that the spirits of the Nether World (that is, all that is below the surface of the earth) are 4,601,200 and that each is 12 cubits high. The occurrence of the factor 12 indicates that it is a matter of geographic cubits. Now, 12 × 4,601,200 cubits = 55,214,000 cubits = 138,036 geographic stadia, is equal to two diameters of the earth. In order to explain the figure of 138,036 stadia, one must assume that the Egyptians reckoned as if the polar flattening occurs only in the northern hemisphere. On the basis of this assumption the figure of 138,036 stadia can be decomposed into the following four earth radii:

34,538 stadia	= 6,378,388 meters = equatorial radius
34,538 stadia	
34,538 stadia	
34,422 stadia	= 6,356,966 meters = polar radius
138,036 stadia	

These figures imply that the flattening of the North Pole is 116/34,538 = 1/297.74.

With extreme economy of numerical expression the Egyptians had arrived at values which are as good as the best modern ones. The figure for the equatorial radius happens to coincide to the meter with that calculated by Hayford. But Hayford calculated the polar flattening as 1/297. Helmert, however, set the polar flattening at 1/298.3, a figure which has been adopted in several of the recent surveys and calculations of the size of the earth which aim at achieving the maximum possible exactness.

At the beginning of the dynastic period the above mentioned figures were revised in order to make them fit into the septenary system of measures and cosmic order. The polar flattening was set at 1/280. This was achieved by decreasing slightly the polar radius and increasing slightly the equatorial radius. The equator which used to be reckoned as 217,000 geographic stadia = 40,074,999 meters, was calculated by a stadium (1/10 of minute) of 354 royal cubits, which made it 40,078,476 meters. It is conceivable that the data mentioned in the *Book of the Dead* was reinterpreted as follows:

34,540 geographic stadia = 6,378,758 meters = equatorial radius
34,540 geographic stadia
34,540 geographic stadia
34,416 geographic stadia = 6,355,858 meters = polar radius
138,036 geographic stadia

The figure of 1/280 for the polar flattening was adopted because it fits into septenary reckoning also in a second and more subtle way. If the polar flattening is 1/280, the arc of meridian is 0.7840 of equatorial diameter. Now, 0.784 = $280^2/100,000$ = 78,400/100,000. This is the reason why Herodotus put emphasis on the fact that the surface of each face of the Pyramid is 78,400 square cubits, being equal to the square of the height, which is 280 cubits. However, the figures reported by Herodotus apply only to the initial plan of the Pyramid. When the figures were further refined the height was calculated as 279.53 cubits. If the polar flattening is 1/297.74, the arc of meridian is 0.7408 of equatorial diameter. This means that an arc of meridian is $0.78408/\frac{1}{4}\pi = 279.53/280$ of a fourth of equator. Hence, the height of the Pyramid in the final plan indicated the correct figure for the polar flattening.

VIII. ADDITIONAL REMARKS ON THE DIMENSIONS OF THE GREAT PYRAMID

1. Herodotus provides only two pieces of information about the dimensions of the Great Pyramid. He states that the surface of each face is equal to the square of the height, which means that the Pyramid was calculated by the Golden Section (by the factor φ). He states also that this surface of each face is equal to 8 Egyptian acres. The Egyptian acre is a square with a side of 1000 royal cubits (2747 square meters). The Egyptian acre, the amount plowed in a day, is similar to the Roman acre (*jugerum*), which is 2524 square meters. Herodotus's figure indicates that he had in mind a

height of 280 royal cubits. He reckoned by half acres, which, as I have explained earlier, were taken to have sides of 70 cubits. If the Pyramid has a height of 280 cubits, the square of the height is 16 half acres (78,400 square cubits). If Herodotus assumed a side of 440 cubits, in order to have this surface the faces should have had an apothem of 356.4 cubits; but if he assumed a side of 439 1/2 cubits the apothem should have been 356.8 cubits. But Herodotus's figure for the surface of the faces was not intended to be exact.

The Roman geographer Pomponius Mela (I,9) paraphrases Herodotus in these terms: *quatuor fere soli jugera sua sede occupat, totidem in altitudinem erigitur,* "it occupies almost four acres with its base, and it rises as much in height." Mela expresses himself awkwardly, but the main point is clear. In order to make the reckoning more easily comprehensible he counts by double acres which have sides of 140 cubits. If the Pyramid had a height of 280 cubits, it would be immediately clear that the square of the height is 4 (double) acres. But Mela states that the surface of the faces and the square of the height is *almost* 4 acres. It was a current practice in all ancient cultures to double units of measure, while continuing to refer to them by the name of the simple unit. Mela erroneously speaks of the surface of the base, whereas it is a matter of the surface of the faces. The error probably originated through an inept translation from a Greek author who used the technical term *epipolēs,* which means "in elevation, by the lateral surface," but may also mean "in surface." The same error occurs in Pliny. It is likely that the error in translation originated with Varro, who almost certainly was the common source of Mela and Pliny. The polymath Varro, who lived in the first century B.C., proves inept in mathematical matters, and Mela and Pliny were certainly no more adept in these matters. But, the text of Mela, in spite of its shortcomings, supports my contention that the height of 280 was merely an initial figure in the calculation of the Pyramid, a figure which was reduced in the course of the development of the calculation.

I have analyzed all other ancient authors who provide information about the dimensions of the Pyramid. By a careful collation of their words and phrases, I have established that they all draw, directly or indirectly, on a single source. These authors wrote in Greek or in Latin during the first century of the Roman Empire. They are the historian Diodorus of Sicily (I, 63), the geographer Strabo (XVII, 1, 33), the encyclopedist Pliny the Elder (XXVI, 12, 78–80), and the engineer Philon of Byzantium (*Wonders of* *the World,* II). Their common source is the Greek grammarian Agatharchides of Cnidus, who toward the end of the second century B.C. was guardian to one of the Ptolemy kings of Egypt. Quotations from Agatharchides' lost works indicate that he wrote extensively on the geography of Egypt, with particular emphasis on natural science.

The interesting feature of Agatharchides' report about the dimensions of the Pyramid is that he excludes the pyramidion from the reckoning. We know from the descriptions of other pyramids that the very top of the structure was a small pyramid of metal, usually a precious metal such as gold or silver, which shined in the sun. From Agatharchides' account one gathers that the Great Pyramid of Giza was topped by such a pyramidion, "small pyramid," as the Greeks called it. In the case of this Pyramid, at least, the pyramidion was used to achieve a mathematical result.

In ancient mathematics extensive recourse was made to a mathematical procedure which we no longer use, but which was extremely convenient. If the square root of a number cannot be expressed by an integer, the number is conceived as the product of two integers of which the second is the same as the first, but increased or decreased by a small quantity, usually the unit. Similarly, if the cubic root of a number cannot be expressed by an integer, the number is conceived as a cube in which one side is longer or shorter than the others. For instance, the number 8400 is conceived as a cube with sides 20, 20, and 21. This procedure is called *basi* in Sumerian. I have established that the calculation by what I call near-squares and near-cubes was common not only in theoretical mathematics but also in architecture, land surveying, and the construction of measuring vessels.

The procedure just described was applied in geometry by removing a small part of a figure. For instance, a problem of geometry could be solved by cutting off a slice from a side of a parallelogram. Most commonly the procedure was applied by cutting off a corner of a triangle; this is the reason why the part cut off is called *gnōmōn* in Greek. Most usually *gnōmōn* means "pointer of a dial" in Greek; hence, the term applies perfectly in our case in which the top of the Pyramid was conceived as cut off in the computation presented by Agatharchides.

An essential point of Agatharchides' account is that he describes the Pyramid as having an apothem which measures a stadium up to the pyramidion and having a side which measures 1 1/4 stadia. The term stadium has a double meaning: it refers to 1/10 minute of degree and it refers to a specific unit of measurement. Agatharchides uses the term in both senses.

I have already indicated that the base of the Pyramid has a length of 1 1/4 times 351.6 royal cubits, which for the Egyptians was the length of the stadium (1/10 minute) of the degree of latitude at the equator. From the authors who drew on Agatharchides we gather that he said that the perimeter is 5 stadia, that is, 1/2 minute of degree.

One would have expected the perimeter of the Pyramid to have been calculated by the length of the degree of longitude at the equator, but the builders instead calculated by the degree of latitude, because their concern was the length of the arc of meridian. From Agatharchides we learn that the apothem up to the pyramidion had a length of a stadium, that is, 1/10 of a minute of degree. This permits us to understand what was the specific function of the pyramidion. Since the degrees of latitude increase in length from the equator to the pole, the apothem of the Pyramid up to the pyramidion gave the length of the shortest degree of latitude, the degree at the equator. The pyramidion may have been graduated, giving the length of all the degrees from the equator to the pole. According to Egyptian reckonings, the stadium of the degree of latitude at the equator is 351.6 royal cubits and increases to a length which at the pole the Egyptians assumed to be 355 cubits in practical reckonings and slightly more than 355 cubits in exact reckoning. The apothem of the full Pyramid came to be something less than 356 cubits.

Agatharchides interprets the dimensions of the Pyramid also by taking the word stadium as referring to the stadium of 600 geographic feet. The geographic stadium was the unit most commonly used by the ancients in calculating geographic distances. A stadium was 600 geographic feet, and 600 stadia made a degree. This calculation was correct for the degree of latitude at the middle latitude of Egypt, for the latitude of the capital built by the Pharaoh Akhenaten. According to Agatharchides the side of the Pyramid is 1 1/4 stadia or 750 feet (230,847 millimeters), and the apothem is a stadium or 600 feet. The side of the base of the pyramidion is 9 feet. The figures indicate that Agatharchides was not concerned with presenting the actual dimensions of the Pyramid, but in illustrating the mathematical principles according to which the Pyramid had been conceived.

The figures quoted from the text of Agatharchides by later authors suggest that he began his analysis of the meridian triangle of the Pyramid by presenting a triangle with the following dimensions:

Height:	480 feet
Base:	377 feet
Apothem:	610 feet

This approach gives excellent values of φ and π.

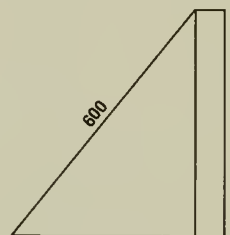
$$\varphi = 610/377 = 1.6180371 \text{ (exactly } \varphi = 1.6180339887)$$
$$1/\varphi = 377/610 = 0.6180328 \text{ (exactly } 1/\varphi = 0.6180339887)$$
$$\pi/4 = 377/480 = 0.785\,41666$$
$$\pi = 3.14166$$

It is impossible to construct a right triangle with sides 480, 377, and 610, since we have:

$$480^2 = 230{,}400$$
$$377^2 = 142{,}129$$
$$610^2 = 372{,}100$$

But the calculation I mention is less off the mark than the calculation by the triangle 280, 220, and 356, which was the one with which the builders of the Pyramid actually began.

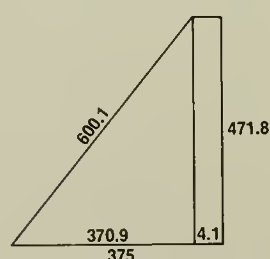
Having started with the mentioned meridian triangle, Agatharchides cut off the side so as to reduce the apothem to 600 feet and the base to 371 feet, excluding the part of the base below the half of the pyramidion.



Since Pliny in quoting Agatharchides does not give the length of a side of the pyramidion (which another author describes as being 9 feet), but the combined length of two sides, I have concluded that the pyramidion had an average side of 9 feet, but had different lengths of different faces.

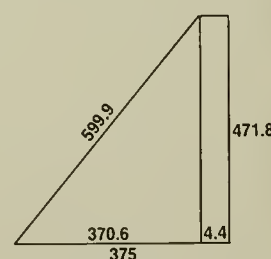
I presume that Agatharchides presented two different meridian sections of the Pyramid, one calculated by the factor φ and one calculated by the factor π.

By φ:



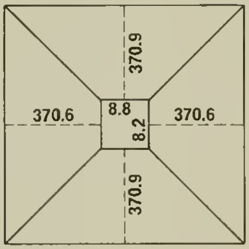
$1/\varphi = 0.61806368$

By π:



$\pi = 3.1420090$

The two possible meridian sections were combined so as to obtain two faces calculated by π and two faces calculated by φ. The Pyramid seen from above would have had the following dimensions:



Like Herodotus, Agatharchides was not concerned with reporting the exact dimensions of the Pyramid, but with presenting the general principles of the mathematics of the Pyramid. This was the point which was of the greatest interest to a Greek audience.

I do not pretend to have reconstructed the authentic reckoning of Agatharchides, but I feel confident that I have understood the general drift of his interpretation. It seems to me that he intended to improve on the presentation of Herodotus, who had only mentioned the factor φ, by stressing the roles both of the factor φ and of the factor π. Agatharchides wanted also to emphasize that the dimensions of the Pyramid were related to the length of the degree of latitude. This was a point of essential importance which had not been mentioned at all by Herodotus.

2. The Egyptians ascribed the invention of the art of building with stone to Imhotep, vizier and architect of King Zoser, who reigned about fifty years before the building of the Great Pyramid. And in fact there has not been found any important building made only of stone blocks which dates before the reign of Zoser. The Egyptians described Imhotep as a sort of Leonardo da Vinci of Egypt, mathematician, scientist, engineer, and architect. Not many years after his death he was made into a demigod, son of Ptah, the god of craftsmen and technicians. Up to recently there were Egyptologists who insisted that Imhotep was a legendary figure. One argument was that there is no other instance in Egyptian history of an ordinary person having bene divinized. But more basic was the argument that a person with all the gifts ascribed to Imhotep could not have existed in the Old Kingdom. It is only in the last few years that it has been definitely accepted that Imhotep was a real person, since it has been possible to gather some specific details of information even about his physical appearance. His genius was recognized even during his life, since King Zoser

covered him with all sorts of honors, although he was a man of humble origin.

But, even though it is now granted that the Egyptians were not living in dreams when they idolized the genius of Imhotep, Egyptologists have failed to investigate what were the scientific achievements of Imhotep other than that he was the first one to have designed a pyramid, the step pyramid of Saqqara. This pyramid is just one element in an enormous group of buildings which is known as Zoser's Complex. This group of buildings is not only so extensive but also so elaborate that nothing of the sort was produced again in the long history of Egypt. In spite of this, not one Egyptologist has tried to investigate this monument and other constructions directed by Imhotep in terms of what the Egyptians said were his talents. Scholars are willing to grant that a man with the name of Imhotep walked on the land in Egypt, but they are not yet willing to grant that Egypt could have produced a mind like his.

The French archeologist Jean Philippe Lauer has dedicated many years to the study of Zoser's Complex. He is a highly competent archeologist and essentially factual and realistic. Actually he has been criticized for insisting too much on technical problems of architecture. For instance, the German Egyptologist Herbert Ricke has disputed point by point Lauer's interpretation of the monuments of Zoser's Complex, claiming that the architecture must be understood in terms of the conflict between the psychological attitudes of nomadic hunters and that of sedentary agriculturists. But Lauer has learned how far the academic community is willing to go in tolerating rational thought in the area of ancient studies. In 1944 he published a short paper in which he tried to deal with the geometry of the pyramids and enlisted the cooperation of a professional mathematician, Paul Montel. But, four years later, when he published the book, *Le Problème des pyramides,* he backtracked and dismissed any mathematical interpretations.

In reporting about Zoser's Complex, Lauer keeps stumbling into mathematical problems, but ignores them. For instance, he found that the wall that surrounds the entire Complex forms a rectangle 544.90 by 277.60 meters. He concludes that it is a matter of a dimension of 1040 by 530 cubits. I would understand that the intended dimensions were 545,114 by 277,799 millimeters, according to the cubit of 524.1483 millimeters. Lauer is surprised at meeting with the figure of 1040 cubits, whereas he would expect 1000 cubits, and explains it away by assigning arbitrarily 40 cubits to the thickness of the walls. But in another part of his work he points out that the same proportions occur in some First Dynasty royal tombs which have dimensions of 54 by 27 meters. It may be enough to point out here that the dimensions of the enclosure of Zoser's Complex are based on the near-square with sides 52 and 53, a mathematical entity of which I have spoken earlier. It is a matter of two near-squares with sides of 520 and 530 royal cubits. It is relevant to what follows that such a near-square has a diagonal of 742.49579, which is 6 times 123.749.

Lauer notices in Zoser's Complex four instances of the occurrence in important positions of the anomalous dimensions of 123 cubits, whereas in the Complex dimensions are generally decimal multiples of the cubit. One of the most impressive remains of the Complex, the monumental entrance gallery, has a length of 123 cubits. Lauer suggests that the Egyptians may have been fascinated by a magic number composed by the first three integers. This is a way of shunting off a problem by appealing to that undefinable entity called magic and by implying, at the same time, that the Egyptians, and their hero Imhotep in particular, were frivolous in matters of mathematics.

Lauer did not realize that the number 123 is an expression in terms of integers of the number $2/\varphi = \sqrt{5} - 1 = 1.236068$. In his book on the pyramids Lauer had denied the occurrence of the factor φ in their architecture.

It is a matter of the right triangle with an angle of 36° which the Egyptians called *mr*. I have suggested that the name *To-Mera,* which the Egyptians gave to their country, was a reference to this triangle. If a right triangle has an angle of 36° and the longer side is 100, the hypotenuse is $2/\varphi\ 100 = 123.6068$, the other side being 72.6542.

Since I have argued that the Great Pyramid was calculated both by the factor φ and by the factor π, I might point out here that there is a close relation between these two numbers, which goes beyond the fact that there is a numerical similarity between $\pi/4 = 0.7853981$ and $\sqrt{1/\varphi} = 0.7861514$. The number φ was used to obtain the value of circular functions, since we have

$$
\begin{aligned}
\sin 18^\circ &= \cos 72^\circ = 1/2\varphi \\
\sin 54^\circ &= \cos 36^\circ = \varphi/2 \\
\sec 36^\circ &= \operatorname{cosec} 54^\circ = 2/\varphi \\
\sec 72^\circ &= \operatorname{cosec} 18^\circ = 2\varphi
\end{aligned}
$$

In practical reckonings the right triangle with an angle of 36° was taken as a triangle with a side of 100 and a hypotenuse of 123. The side opposite the angle of 36° was taken as being 72; this permits us to calculate in terms of half degrees all the trigonometric functions of the angles between 0° and 36°. Since the angle of 36° is 2/5 of a right angle and 1/10 of a full circle, one can calculate from the mentioned triangle the trigonometric functions for all angles.

This is the reason why the triangle *mr* was considered the basic constituent of the cosmic order.

In order to recognize the importance of the right triangle with an angle of 36°, one may start by considering how much attention it received in Euclid's *Elements*. It plays an even greater role in early Greek mathematics. The symbol of the Pythagorean sect, the five-pointed star, was a combination of such triangles.

I have explained that the right triangle with a hypotenuse of 123 was a practical simplification of the triangle of 36° built according to the Golden Section. A further simplification was the right triangle with sides related as 3:4:5. If this triangle is enlarged to the scale of the one with hypotenuse of 123, it has sides 120, 100, and 75, instead of 123, 100, and 72.

I need to point out that the Great Pyramid incorporates the relation 4:5 in the proportion between the length of the apothem up to the pyramidion and the length of the side. This provides a point of transition to an analysis of the dimensions of the Second Pyramid.

The Great Pyramid tried to compress a great number of mathematical relations, whereas the Second Pyramid limited itself to embodying the triangle *mr*.

The basic idea of the Great Pyramid was that it should be a representation of the northern hemisphere, a hemisphere projected on flat surfaces, as is done in mapmaking. This was the principle according to which was built the ziggurat of Babylon, the biblical Tower of Babel, and according to which were built the earlier pyramids. The Great Pyramid was a projection on four triangular surfaces. The apex represented the pole and the perimeter represented the equator. This is the reason why the perimeter is in relation 2π with the height. The Great Pyramid represents the northern hemisphere in a scale 1:43,200; this scale was chosen because there are 86,400 seconds in 24 hours. But then the builders became concerned with the problem of indicating the ratio of polar flattening of the earth and the length of the degrees of latitude which depends on the ratio of this flattening. Next, they incorporated into the Pyramid the factor φ as the key to the structure of the cosmos. The Second Pyramid, on the contrary, limits itself to embodying the trangle *mr*, which is based on the number φ, at least as far as I have been able to establish up to the present moment.

According to Petrie's survey the sides of the Second Pyramid have the following lengths:

West: 215,278 millimeters
North: 215,186 millimeters
East: 215,269 millimeters
South: 215,313 millimeters

The royal cubit of this pyramid is that of 525 millimeters. The basic length of the sides is 410 cubits = 215,250 millimeters.

The meridian triangle of the pyramid is a triangle with proportions 3:4:5. The base is 205 cubits, the height is $4/3 \times 205 = 273.33$ cubits, and the apothem is $5/3 \times 205$ cubits = 341.66 cubits.

Reckoning by third of cubits, we have:

Base: 123×5
Height: 164×5
Apothem: 205×5

Possibly the pyramid was calculated by a rod of 5/3 of a cubit, which is called *nbyw* (*nebiu* in Coptic).

It is clear that this pyramid was intended to incorporate the number 123 as a round figure for $2/\varphi$.

The slope of the pyramid is the same as the angle of problems 67–69 of the Rhind Papyrus. The tangent $164/123 = 1.3333$ corresponds to a slope 53° 07′ 48″. The angle of the apothem with the height is 36° 52′ 12″. This angle was intended to be an approximation to the perfect angle 36°.

The geometry of the Second Pyramid could be considered crude in relation to the sophisticated one of the Great Pyramid, but it emphasizes the importance that the Egyptians attached to the triangle *mr*.

3. Petrie's survey of the Second Pyramid helps in clarifying the problem of the orientation of the sides of the Great Pyramid.

Petrie reported that the four sides of the Second Pyramid are oriented as follows:

West	side:	0° 04′ 21″	west of true north
North	side:	0° 05′ 31″	north of true east
East	side:	0° 06′ 13″	west of true north
South	side:	0° 05′ 40″	north of true east

Petrie warns that the triangulation of Egypt existing at his time did not permit him to establish the direction of north with absolute certainty. Hence, his figures can be taken only as an indication of the angle of the sides in relation to each other.

Petrie's figures prove that the deviation from the right angle in three of the four angles of the Great Pyramid was intentional and not the result of mistakes in construction, as claimed by professional archeologists. The north side of the Second Pyramid is shortened in relation to the south side, as it occurs also in the Great Pyramid. But in the Second Pyramid the shortening of the north side and the lengthening of the south side was achieved by constructing a more regular figure. The base of the Second Pyramid has the shape of a trapeze or a trapezoid. The north and south sides were drawn parallel to each other. Possibly the west side was intended to be at an angle of one minute with the north-south axis, and the west side was intended to be at an angle of half a minute with the north-south axis.

In any case the approximate findings of Petrie indicate that, if one proceeded to a new survey of the Second Pyramid and then surveyed the orientation of the sides of other pyramids and possibly of other major constructions of the Old Kingdom, one could recognize a pattern on the basis of which it could be established what was the purpose in making the angles of pyramids and possibly of other major constructions different from a right angle. It is impossible to formulate a reliable explanation for the differences among the angles of the base of the Great Pyramid without establishing what was the general practice in establishing the angles of the base of pyramids.

I have come across the same difficulty in dealing with the dimensions of Greek temples. I have ascertained that the four angles of the Parthenon were intended to deviate slightly from a right angle. Further, in the case of the Parthenon the north side is shorter than the south side, as in the case of the two major pyramids of Giza. But it is impossible to advance hypotheses in order to explain the differences among the angles of the Parthenon, as long as the angles of other temples are not surveyed so as to make possible the identification of a regular pattern.

There is one further problem to be considered in relation to the orientation of the faces of the Great Pyramid. The west face, which in my opinion was drawn first and is the basic face, is not oriented to the north, but is oriented 2′ 30″ west of true north.

This deviation from orientation to the north is the result of the precession of the equinoxes.

From cuneiform texts one gathers that in Mesopotamia there was a distinction of roles between the mathematician who formulated the general plan of a building and the architect who executed the plan. Whether this distinction existed in Egypt or not, it can be assumed that in the construction of a pyramid the first step was the drawing of a mathematical plan. This plan would include the alignment of the stars to be observed in establishing the direction of the north. If my interpretation of Egyptian sky charts is correct, the line that indicates the north used to be marked so as to pass through the celestial pole and through the pole of the ecliptic.

In any case, it appears that there was drawn a plan of the Great Pyramid which included the calculation of the stars to be observed in order to obtain the direction of the north. After this plan was drawn, the ground of the Pyramid had to be cleared in order to proceed to the ceremony called "stretching of the cord," which for the Egyptians was the equivalent of our laying of the first stone. This ceremony had the purpose of establishing the direction of true north and, as the Egyptians saw it, suspending the building from the sky by tying the building with an imaginary string to the axis of rotation of the vault of heaven.

If there had passed exactly three years from the drawing of the plan to the ceremony of the "stretching of the cord," the clustering of stars, which gave the exact north of the moment of the drawing of the plan, would give an orientation 2′ 30″ west of north, because of the precession of the equinoxes, which displaces the star taken as the polar star in practical calculations to the west at a rate of about 50″ a year.

The Second Pyramid too is oriented west of true north, but unfortunately Petrie's figures for the orientation of this pyramid are not exact, as he himself warns.

The question to be asked is whether the incorporation of the rate of the precession of the equinoxes into the dimensions of the Great Pyramid and of the Second Pyramid was accidental or intended. I am inclined in favor of the second alternative, since in the case of the Great Pyramid the angle corresponds exactly to three years in the precession of the equinoxes. In their book *Hamlet's Mill* de Santillana and Dechend have used mythological and iconographic evidence in order to prove that all ancient cultures of the world were deeply preoccupied with the phenomenon of the precession of the equinoxes. They intended to prove that the movement by which the celestial pole in about 25,920 years (Platonic year) makes a full circle around a point called the pole of the ecliptic was conceived as the basic movement in the life of the universe. This cycle determined all other movements, including biological developments, and determined the length of human life (taken as equal to 72 years, or the time that it takes the celestial pole to move a degree) as well as historical events. The authors of *Hamlet's Mill* have kept their conclusions vague, probably in the hope that thereby their findings would be less readily attacked by the academy. They open their book with the statement: "This is meant to be only an essay. It is a first reconnaissance of a realm well-nigh unexplored and uncharted." This is a most gentle way for a professor of the history of science at the zenith of his career to present a thesis which, if accepted, should have the impact of a Copernican revolution on current conceptions of the development of human culture. Since the essence of my method is quantitative, I cannot indulge in the luxury of such linguistic niceties. I have collected a mass of numerical evidence which shows that the inhabitants of the ancient world were acquainted with the rate of the precession of the equinoxes and attached a major significance to it. But in order to deal with this evidence, I would have to open an entirely new topic. I beg the indulgence of the reader in asking him to remain satisfied for the moment with the mere hint that there is yet another lesson about the level of Egyptian science to be drawn from the stark nakedness of the Great Pyramid.

GLOSSARY OF NAMES AND TERMS

Abd-al-Latif (1179–1231)	Arab historian who taught medicine in Baghdad. Author of one of the early Arab histories of Egypt: *Relation de l'Égypte*. In 1220 he explored the Great Pyramid, reporting that he came out of it "more dead than alive."
Abdullah Al Mamun (d.833)	Caliph of Baghdad, son of Harun al-Rashid. Patronized literature and science; built an astronomical observatory outside Baghdad; ordered a degree of latitude to be measured across the plain of Palmyra. Is reputed to have broken into the Great Pyramid in 820 in search of treasures, but to have come away empty-handed after opening the way to the King's Chamber.
Agatharchides of Cnidus	Greek historian and geographer who lived in the time of Ptolemy Philometor (181–146 B.C.) and dealt with the geography of the Near East.
Akhnaten (1388–1358 B.C.)	Revolutionary pharaoh of the Eighteenth Dynasty who changed his name from Amenophis IV, and broke with the priests of Amon at Thebes. He built a new capital, Akhtaten, between Thebes and Memphis near the site of Tell el-Amarna. Of his religious reform, which was monotheistic and recognized the sun as the symbol of living energy, Petrie remarked: "no such grand theology had ever appeared in the world before."
Akhtaten (Resting point of Aten)	Capital built by the young pharaoh Akhnaten at the predynastic geodetic center of Egypt, halfway between the Tropic and the Mediterranean coast, near the site called Tell el-Amarna. The city, which was decorated with splendid temples and palaces, was destroyed after Akhnaten's death.
Ali Gabri (1830–19?)	Arab guide, sometimes referred to as Alee Dobree, who was an assistant to Howard-Vyse, Piazzi Smyth, Sir Flinders Petrie, and Moses B. Cotsworth over a period of nearly seventy years, helping them explore and measure the Great Pyramid.
Alvarez, Luis Walter (1911–)	Nuclear physicist. Professor of physics at Lawrence Radiation Laboratory, Berkeley, California. Nobel Prize winner for physics in 1968. Developer of radar. Helped develop A-bomb and flew in B-29 observer following the plane that bombed Hiroshima. One of the youngest members to be elected to the National Academy of Science. Author of several scientific articles. Adapted spark chamber to X-ray the pyramids with cosmic rays.
Amèlineau, Emile (1850–1915)	Studied Egyptian and Coptic under Maspero. Did much excavating but was criticized by Petrie and Maspero for unscientific methods. Professor of history of religions in École des Hautes Études in Paris, where he died in 1915. Author of several volumes on ancient Egyptian history and science.
Amenemhet	Four Pharaohs of the Twelfth Dynasty, the first of which reigned from ca. 1991 to 1962 B.C.

Amon	A god who was related to the wind, promoted to an imperial divinity at the beginning of the Twelfth Dynasty as Amon-Ra. Amon was considered the creator of other gods, and to have had no beginning and no end.
Ancient Empire	From the Third to Sixth dynasties, variously estimated, but approximately 2780 to 2280 B.C. There is little historical data on this period, most of the relevant papyri having disappeared. Under the influence of King Zoser and his architect Imhotep, brick structures gave way to stone. The political center was at Memphis.
anomalistic year	365 days, 6 hours, 13 minutes, 48 seconds. The time it takes the earth to return in its elliptical orbit to the point nearest the sun —about 4¾ minutes longer than the sidereal year.
apothem (of a pyramid)	The distance from the apex down one face to the center of a base side.
Arya-Bhata (b. 476–?)	Hindu astronomer and mathematician, author of Aryabhatiya which gave the rules of mathematics as known in his time. Most of his work deals with astronomy and spherical trigonometry. Gave a value for π of 3 177/1250, or 3.1416. Taught that the daily rotation of the heavens was an appearance due to the earth's rotation on its axis.
Aten	God of the solar orb, raised to a prime position by Akhnaten. Represented by a golden disc radiating rays that end in hands. Was considered a universal deity who could have held sway over a universal empire.
azimuth	Angle of arc around the horizon, or angular distance of an observed point from geographic north (or other fixed point).
Ballard, Robert T.	Australian engineer who made a study of the pyramids in 1882 which he wrote up in "The Solution of the Pyramid Problem; or, Pyramid Discoveries with a New Theory as to Their Ancient Use."
Barnard, Professor F. A. P. (1809–1889)	President of Columbia University (1864) and president of the American Association for the Advancement of Science. An authority on weights and measures, he took issue with the conclusions about the Pyramid drawn by Piazzi Smyth and other pyramidologists.
Behdet	Town in lower Egypt which was the capital of Egypt in predynastic times. In Ptolemaic times it was the capital of a nome and was known to the Romans as Hermopolis Parva. In Stecchini's reconstruction of the ancient geography, Behdet was the northern limit of Egypt, 7 1/2° north of the Tropic.
Belzoni, Giovanni Battista (1778–1823)	Italian explorer and adventurer. A large and powerful man, six feet seven inches, who exhibited himself in feats of strength. He came to Egypt to demonstrate a hydraulic machine he had invented, but when the machine proved unsuccessful he turned to archeology and discovered several tombs as well as the entrance to Kephren's pyramid. A narrative of his exploits was published in 1820.
Biot, Jean Baptiste (1774–1862)	French physicist, professor of mathematics at Beauvois and professor of physics at the Collège de France. A prolific writer, he covered a wide field of physical science, becoming a member of the Academy of Sciences and a commander of the *Légion d'Honneur*. He was especially interested in the astronomy of the ancient Egyptians.

The Book of the Dead	An Egyptian collection of hermetic inscriptions and papyri purportedly providing funerary and ritual texts.
Borchardt, Ludwig (1863–1938)	German Egyptologist. Studied Egyptology at Berlin University under Professor Johan Erman. Worked at Philae in Egypt in 1895, and conducted many excavations in subsequent years. Inaugurated the great Catalogue of Cairo Museum with Professor Gaston Maspero. Founded German Institute of Archeology in Cairo. A bibliography of his many writings was issued in 1933.
Bouchard, Pierre-François-Xavier, Captain (1772–1832)	Engineer working on Fort Julien near Rosetta, 70 kilometers east of Alexandria, in 1799 found the Rosetta Stone as part of an old wall.
Brugsch, (Pasha) Karl H. (1827–1894)	German Egyptologist sent to Egypt by the Prussian government in 1853. Consul general in Cairo, 1864, then professor of Egyptology at Göttingen, 1868. Director of School of Egyptology in Cairo. Published a demotic grammar, a hieroglyphic dictionary, and a history of Egypt.
Brunés, Tons	Danish consulting engineer and Freemason who devoted a score of years to resolving the problems of ancient geometry. In 1967 he published a six-hundred-page two-volume book, *The Secrets of Ancient Geometry,* in which he attempted to substitute a "Sacred Cut" for the Golden Section or phi relation.
Budge, Sir Ernest Alfred Wallis (1857–1934)	Orientalist. Keeper of Egyptian and Assyrian Antiquities at the British Museum. Large published output including popular and semipopular works. Compiled an Egyptian dictionary, and a full edition of *The Book of the Dead.*
Burattini, Tito Livio (16?–1682)	Italian follower of Father Athanasius Kircher. Made several trips to the Great Pyramid and took measurements with Greaves which were used by Newton in his first calculations for the theory of gravitation. A Venetian by birth, Burattini spent the better part of his maturity in Poland. Author of works on standards of measure and the use of pendulums.
Cabala	A system of mystical interpretation of Scriptures practiced by certain medieval Jewish rabbis and certain Christian sects, on the assumption that Scriptures have an occult meaning.
Campbell, Patrick, Colonel (1779–1857)	Army officer and diplomat. British consul general in Egypt, 1833 to 1840. Associate of Colonel Howard-Vyse in exploration of pyramids, who named for him one of the construction chambers above the King's Chamber in the Great Pyramid.
Cardano, Girolamo (1501–1576)	Milanese doctor, mathematician, and astronomer, author of several books. His works in mathematics include treatises on arithmetic and algebra. He referred to ancient traditions as indicating the Great Pyramid incorporated an earth commensurate unit of measure of great exactness.
cardinal points of the compass	North, east, south, west.
cartouche	An oblong figure containing a Pharaoh's name.
Cayce, Edgar (1877–1945)	American clairvoyant whose thousands of readings while in trance are filed in a foundation created in his memory at Virginia Beach, Virginia. Had many memories as a being at the time of Atlantis and the construction of the Pyramid, but readings lack solid data.
Cassini, Gian Domenico (1625–1712)	French astronomer and geodesist of Italian origin, founder of a family of geodesists. He measured meridian arc through Paris.

	Was assisted by his son Giacomo (1677–1756), who was assisted by his grandson Cesare Francesco (1714–1784). His great-grandson, Giacomo Domenico, also a geodesist and astronomer, was born in Paris in 1747 and died 1845.
Caviglia, Giovanni Battista (1770–1845)	Genoese mariner, owner and master of a trading vessel in the Mediterranean based on Malta. Regarded himself as a British subject. Explored the pyramids and the Great Sphinx, from whose base he had great quantities of sand removed. An ingenious excavator, he discovered the outlet to the well in the Great Pyramid and was in charge of several hundred men excavating for Colonel Howard-Vyse until they quarreled. Caviglia was given to occultism and mysticism, and spent his final years in Paris as a protégé of Lord Elgin.
celestial equator	A great circle produced by projecting the earth's equator outward to the celestial sphere.
Champollion, Jean-François (1790–1832)	At 16 at the Academy of Grenoble, Champollion presented a thesis in support of Father Athanasius Kircher's idea that Coptic was a degeneration of ancient Egyptian. The discovery of the Rosetta Stone by Napoleon's troops helped Champollion to decipher the system of ancient Egyptian hieroglyphs.
clinkstone	Compact grayish rock which clinks like metal when struck.
clinometer	A device to measure angle of slope.
Cole, J. H.	British surveyor who carried out the official survey of the Great Pyramid for the Egyptian government in 1925. His measurements made it possible to know the dimensions of the base of the Pyramid to within a few millimeters, and put an end to years of controversy.
corbeled masonry	An arrangement of stones in which successive courses project beyond those below.
Cotsworth, Moses B. (1859–1943)	British legislative enthusiast who wrote a series of pamphlets and books advocating a more rational almanac and demonstrating how the pyramids, obelisks, Druid circles, and mounds were erected as yearly almanacs. Expatriated to Canada, where he died during World War II.
Cottrell, Leonard (1913–)	British author of several books on Egyptian history and the pyramids. Writer and producer for radio and television.
Davison, Nathaniel (?–1783)	Accompanied Edward Wortley Montagu on his travels in the East. Arrived at the Great Pyramid in July of 1765, where he discovered the first construction chamber over the King's Chamber, which has since been named for him. Was later British consul general at Algiers until his death in 1783.
decans	Ten-day periods marked by the passage of constellations by which the Egyptians divided the year into thirty-six units.
declination	Angular distance of a heavenly body north or south of the celestial equator; analogous to latitude on the stellar vault.
Dendera	Ancient site of a Ptolemic temple compound about 60 kilometers north of Luxor on the east bank of the Nile dedicated to Hathor and Isis. Several temples are believed to have been constructed on the site, attributed to Cheops, Pepi I, and earlier monarchs. A zodiac on the ceiling of an upper room was removed and is now on display at the Louvre where it has been the object of heated controversy as to its age and significance.

Denon, Baron Dominique Vivant (1747–1825)	French antiquary and man of letters. Joined Napoleon's expedition and made many remarkable drawings. Published *Voyage dans la basse et la haute Egypte,* 1802, which was an instant success; translated into German and English. Appointed director-general of French Museums.
Didoufri	Fourth Dynasty king who succeeded Cheops and preceded Kephren.
Diodorus Siculus	Greek historian of the first century B.C. Published a history, or *Bibliotheca historica*, the first surviving book of which deals with Egypt, to which he traveled about 60 B.C. In his geography he quotes various lost sources.
diurnal pattern	The apparent movement of the stars in each rotation of the earth.
Dümichen, Johnnes (1833–1894)	German Egyptologist. Professor of Egyptology, Strassbourg, 1872–1894. Several publications. Traveled frequently to Egypt.
dynasties	Thirty dynasties of Egyptian kings were listed by the priest Manetho, from Menes to Ptolemy II Philadelphus. Though erratic, the list has formed the basis of Egyptian history for succeeding Egyptologists.
Edfu	Ancient temple said to have been built during the Third Dynasty. Capital city of second nome of Upper Egypt on the west bank of the Nile, 100 miles downstream from Thebes. Site of huge sandstone temple dedicated to Horus, constructed in Ptolemaic times, and found half buried in the sand by Napoleon's forces during their campaign in Upper Egypt.
Edwards, I. E. S. (1909–)	British author and Egyptologist. Keeper of Egyptian Antiquities British Museum since 1955. Visiting professor at Brown University, 1953–1954.
Egyptian mysteries	Secret knowledge of the cosmos possessed by initiates.
Elephantine	Island in the Nile just north of the first cataract, which was used as a geodetic point. Known as the city of the elephants, capital of the first nome in Upper Egypt on the border of Nubia. Opposite Syene, the modern Aswan.
Engelbach, Reginald (1880–1946)	British engineer and Egyptologist. Assisted Petrie in several digs. Appointed Chief Inspector in Upper Egypt for the Services des Antiquités. Keeper of Cairo Museum 1931. Published work on obelisks and Egyptian masonry.
equinox	Time at which the sun crosses the equator in March and September (vernal and autumnal) when day and night are of equal length all over the earth.
Fibonacci, Leonardo Bigollo (1179–1250)	Italian mathematician, known as Leonardo da Pisa. His *Liber Abaci* (1202) was for years a standard work on algebra and arithmetic. In *Practica Geometriae* (1220) he organized and extended material in geometry and trigonometry. The Fibonacci series, which he popularized in Europe in the thirteenth century, appears in the construction of the Great Pyramid several millennia earlier.
Fibonacci series	A sequence of numbers in which each is the sum of the two previous numbers—1, 2, 3, 5, 8, 13 . . . The limit of this series gives the exact value of φ.
Firth, Cecil Mallaby (1878–1931)	British Egyptologist. Served thirty years in Service des Antiquités.
geodetic gnomon	A vertical pillar whose shadow can be used to determine time, distance, and latitude.

Golden Section (ϕ proportion) — Division of a line (or geometric figure) so that the proportion of the smaller section to the larger is the same as that of the larger to the whole. For example, in the line below, the Golden Section is such that AB:AC = AC:CB.

A ——————— C ———— B

Greaves, John (1602–1652) — Mathematician and antiquarian. Son of Rector of Colemore in Hampshire. Educated at Baliol College, Oxford. Professor of geometry at Gresham College, London. Traveled to the East to collect Arabic and Persian manuscripts. Made the first accurate survey of the Great Pyramid during a trip to Egypt in 1639. Author of *Pyramidographia*. Appointed Savilian professor of Astronomy in reign of Charles I; dismissed by Roundheads.

Hapy — The animating spirit of the Nile, self-engendered; lord of the fish represented by an androgynous divinity crowned by a papyrus reed.

Hathor — Egyptian goddess, originally a personification of the sky. In the Dendera cult, Hathor was considered the wife of Horus. The Greeks identified Hathor with Aphrodite.

heliacal rising (or setting) — Observation of a star as close as possible to the rising or setting of the sun.

heliocentric pattern — The arrangement of the planets in orbits around the sun.

Heliopolis (or On or Annu) — Northeast of Cairo on the edge of the desert; believed to be the capital of a prehistoric state. City of the Sun, embellished by a series of kings from the Third Dynasty on, it was the seat of temple of priests who numbered as many as twelve thousand. Ancient center of theological learning. It was reduced by Alexander the Great in the fourth century B.C. One of the earliest obelisks was found still standing at Heliopolis.

Herodotus (484–425 B.C.) — Greek historian born in Asia Minor. Visited Egypt towards the end of the first Persian domination. In his *History* he devoted a book (called Euterpe, after the muse of lyric song) to Egypt, giving many interesting and accurate details of geography.

Herschel, Sir John (1792–1871) — Astronomer, only son of astronomer Sir William Herschel. Made a fellow of the Royal Society at twenty-one for a brilliant mathematical investigation. Author of books on mathematics and astronomy considered among the elevating influences of the century.

Horus — Prehistoric Egyptian sky god in the form of a falcon whose eyes were the sun and moon; also called the "Behdetite" in the form of a winged sun-disk. Later incorporated in the Osiris cycle. Identified by the Greeks with Apollo.

Howard-Vyse, Colonel (later Major General) Richard William (1784–1853) — Son of General Richard Vyse and grandson of Field Marshal Sir George Howard. Retired as Colonel of Second Life Guards, 1826. Equerry to the king of Hanover. Member of Parliament. Traveled to the Middle East in 1835, where he organized excavation of the pyramids in 1837, employing Caviglia and hundreds of other workers. Discovered original casing stones and found chambers above Davison's. Author of *Operations Carried on at the Pyramids of Gizeh in 1837.*

Hyksos — Asiatic kings who invaded Egypt and formed the Fifteenth and Sixteenth dynasties. They were chased out of Egypt by Ahmosis I who founded the Eighteenth Dynasty.

ibn-Batuta (ca. 1352)	Mohammedan traveler. Said the pyramids were built by Hermes, who is the same person as the biblical Enoch, to preserve the arts and sciences, and other scientific acquirements, during the flood. Said dream occurred to King Surid that the Pyramid would be opened on the north side, so he deposited a sum of money equal to the expense of excavation.
Imhotep (ca. 2800 B.C.)	King Zoser's architect, who is accredited with the building of the stepped pyramid of Saqqara, of limestone. He is reputed to have been an author, diplomat, architect, and physician.
Ka	Metaphysical part of human being. Lived only on the essence of foods and was satisfied with facsimiles of food and mock buildings which had only façades.
Lepsius, Karl Richard (1810–1884)	German Egyptologist. Led Prussian expedition to Egypt and Nubia. Published seventeen folio volumes of *Denkmäler,* mostly epigraphic material. Keeper of Egyptian collections of Berlin from 1873.
Lieder, Rudolph Theophilus (1797–1865)	German missionary. Member of the Egyptian Society of Cairo, 1836. Collected antiquities.
Lindsay, (Lord) Alexander William Crawford (afterwards 25th Earl of Crawford and 8th Earl of Balcarres) (1812–1880)	Traveler and writer on art. His *Letters from Egypt,* etc., contain particulars on Caviglia.
Lockyer, Sir Joseph Norman (1836–1920)	English astronomer, educated on the continent of Europe; knighted for his work in spectroscopy and for identifying helium in the sun. The author of several books on the astronomy of ancient peoples, he was the first to demonstrate convincingly how ancient Egyptian temples were used as solar and stellar observatories and almanacs.
Luxor	Part of the ancient site of Thebes. A huge temple dedicated to the god Amon was built in the reign of Amenhotep III, and altered by succeeding Pharaohs, especially by Rameses II, who had many colossal statues of himself erected on the grounds.
Mandeville, Sir John (fl. 1356)	Fabulous writer of traveler's guidebooks. Most of his data were available in contemporary travel books and encyclopedias. His "voyages" are believed to be the work of a notary in Belgium who never traveled abroad.
Manetho	Egyptian priest and annalist in the reign of Ptolemy I who wrote a history of Egypt in Greek, only fragments of which remain. His division of the kings of Egypt into thirty dynasties is still the basic structure underlying Egyptian history.
Mariette, (Pasha) Auguste (1821–1881)	French Egyptologist. Traveled to Egypt to collect Coptic manuscripts and engaged in excavations. Appointed Conservator of Egyptian Monuments by the Khedive and settled in Egypt, where he made numerous finds which became the nucleus of the Cairo Museum.
Maspero, Sir Gaston Camille Charles (1846–1916)	French Egyptologist of Italian origin. Professor of Egyptology at Collège de France. Succeeded Mariette as director of the Services des Antiquités. Wrote many scientific memoirs and a large number of popular books and reviews.
mastaba	An oblong masonry structure with sloping sides and a flat top, usually above a deep pit.

Menes (fl. 3400 B.C. [3500?])	First historic ruler of the First Dynasty of ancient Egypt, who is reputed to have united the southern and northern kingdoms and settled on a new capital on the Nile at the point of juncture at Memphis.
mensuration	The science of measurement.
meridian	A great circle passing through the poles of the celestial sphere and the zenith of a fixed point on earth.
Meroe	Village in the Sudan on the Nile north of Khartoum which still has ruins of temples and pyramids.
Middle Kingdom	Twelfth to Fourteenth dynasties, from 2000 to 1600 B.C. Follows first intermediate period of chaotic conditions. The capital was at Thebes.
Minutoli, Johann Heinrich Carl, Freiherr von (1772–1846)	Prussian officer of Italian origin. Collected large quantities of antiquities. Published *Mes souvenirs en Egypte.*
New Kingdom	Covers Eighteenth and Nineteenth dynasties, 1580–1350 and 1350–1200 B.C. The Hyksos invaders were crushed and a military state embarked on wide conquest from as far as Cush to the Euphrates.
nilometer	An instrument for measuring the height of the Nile.
Nubia	Ancient region, originally called Cush, extending from the Nile Valley near Aswan southward to the modern Khartoum, east to the Red Sea and west to the Libyan desert.
obelisk	A tapered four-sided pillar used for measuring shadow length, usually inscribed with hieroglyphs proclaiming the achievements of a Pharaoh.
omphalos	Navel, or a central point on the surface of the earth.
Pepi	Two pharaohs of the Sixth Dynasty.
Perring, John Shae (1813–1869)	British civil engineer. Assistant to manager of public works for Khedive Mohammed Ali. Assisted Colonel Howard-Vyse in survey and exploration of the pyramids. In 1839 wrote and drew pictures for a large folio, *The Pyramids of Gizeh from Actual Survey and Measurement on the Spot.*
Petrie, Sir (William Matthew) Flinders (1853–1942)	Egyptologist, son of William Petrie, a civil engineer, and Anne, daughter of Matthew Flinders, the explorer of Australia. Surveyed ancient British sites such as Stonehenge before making first scientific survey of Giza hill. Founded the British School of Archaeology in Egypt. Responsible for many excavations and numerous books. He is considered the father of modern scientific archeology.
ϕ (phi) proportion	See Golden Section.
π (pi)	The constant by which the diameter of any circle may be multiplied to give its circumference.
Picard, Jean (1620–1682)	French astronomer, noted for having made the first accurate modern measurement of a degree of the earth's meridian. His figures enabled Newton to calculate the force of gravitation. Occupied the chair of astronomy in the Collège de France in 1655. Largely responsible for the establishment of the Paris Observatory and the appearance of *Connaissance des temps,* the first two volumes of which he authored.
Pococke, Richard (1704–1765)	Traveler and divine, bishop of Ossory (1756–1765). Ascended the Nile as far as Philae. The manuscript journal of his travels is in the British Museum.

precession of the equinoxes	Each year at the spring equinox the constellation in the sky where the sun rises due east appears to have fallen back about twenty minutes. This phenomenon, or precession, is caused by a slow toplike wobble of the earth on its axis which takes about 26,000 years to cycle.
Proctor, Richard Anthony (1837–1888)	English astronomer and popular writer on scientific subjects. Founded the popular scientific magazine *Knowledge*. Lectured in the United States and Australia. Author of many books on science and astronomy. Developed the theory that the Great Pyramid had been designed and used as a great astronomical observatory while still a truncated body at the level of the King's Chamber.
Ptah	Called Hephaistos by the Greeks. Egyptian god of the city of Memphis, portrayed as a human figure in a tight mummy wrapping. Considered the creator of the world who produced visible phenomena through thought and the word. The protector of artisans. His high priest was the doyen of master craftsmen.
Pylon	A double tower with rectangular base pierced by central door to a temple. The temple of Karnak had ten pylons.
Pythagoras' theorem	The square of the hypotenuse of a right triangle is equal to the sum of the squares of the other two sides.
Ra	The sun, later deified. Creator of the world, was said to be swallowed at night by Nut and recreated fresh each day.
Reisner, George Andrew (1867–1942)	American Egyptologist (Ph.D., Harvard University, 1893). Director of the Hearst expedition to Egypt 1905–1907. Excavated for Harvard University for many years in Egypt, particularly at Giza. Professor of Egyptology at Harvard (1914–1942). Curator of Egyptian Department, Boston Museum of Fine Arts (1910–1942). Author of several books on archeological excavations.
Rhind, Henry Alexander (1833–1863)	Scottish lawyer and traveler. Owing to ill health was obliged to winter in Egypt. Excavated at Thebes and bequeathed collection to National Museum of Antiquities, Edinburgh. Noted for the Mathematical Papyrus (BM10057–8), which was sold to the British Museum, and is considered the oldest manuscript dealing with Egyptian mathematics.
right ascension	The arc along the celestial equator which separates a star from an arbitrary zero point; analogous to longitude around the stellar vault.
sacred triangles	Right triangles with sides in such proportions as 3–4–5 or $2–\sqrt{5}–3$, which were credited with magic or esthetic properties.
Saqqara	Situated 28 kilometers south of modern Cairo, just west of Memphis and south of Giza. Ancient burial site named after Sokar, the god of measure. Graves date from the First Dynasty. Pyramids attributed to the Fifth and Sixth dynasties. Site of the stepped pyramid built for King Zoser of the Third Dynasty by the architect Imhotep.
Schwaller de Lubicz, R. A. (?–1961)	Philosopher, archeologist, and author who spent twelve years at Luxor reconstructing the philosophical and theological system of the ancient Egyptians. Born in Alsace, he was granted the title Chevalier de Lubicz by O. W. de Lubicz Milosz for his help after World War I in obtaining independence for the Baltic States.
sextant	An instrument for precise measurement of angular distances to determine latitude and longitude.

sidereal year	The time it takes the earth to revolve around the sun so that an observer will see a given star reappear in the same position—about 20 minutes longer than the solar year.
Sneferu (ca. 2700 B.C.)	First king of the Fourth Dynasty. Father of Cheops. Built bent pyramid at Medûm.
solar parallax	The angle formed by the semidiameter of the earth as regarded from the sun, or 8.80″.
solar year	The time between two successive equinoxes 365 days, 5 hours, 8 minutes, 49.7 seconds 365 days, 5 hours, 48 minutes, 46 seconds
solstice	The two points—in summer and winter—when the sun is at its greatest declination north or south of the equator.
Sothic year	365 days, 6 hours—introduced in ancient Egypt to correct the civil calendar year of 365 days. A "Sothic cycle" began when civil and Sothic new year coincided.
Syene	Site of the modern Aswan. The southern limit of Egypt at the First Cataract of the Nile, close to the Tropic of Cancer. Nearby quarries supplied the hard granite monoliths for the King's Chamber in the Great Pyramid and for the tall Egyptian obelisks used for measuring shadows.
Taylor, John (1781–1864)	Devoted his early years to publishing in London, becoming editor of the *London* Magazine. An amateur astronomer and mathematician, he was also a student of Scripture and devoted much time to mastering Old English, Welsh, French, and Italian. His *The Great Pyramid: Why Was It Built & Who Built It?,* published in 1854, established the π proportion in the pyramid, but his theory, that the Great Pyramid had been built under divine guidance, caused his work to be disputed and he was given little recognition.
Thebes	Ancient city in upper Egypt renowned in antiquity for its hundred gates. Became prominent with the Eleventh Dynasty (c. 2160 B.C.) for the worship of Amon. Went into decline when the locus of power shifted to the Nile Delta. There is a nearby large necropolis where kings and nobles were entombed. It was sacked by the Assyrians in 661 B.C. The remains of the temples of Luxor and Karnak are still among the most impressive in the world.
theodolite	A telescopic instrument for precise measurement of horizontal angles, used in land surveying.
Thoth	Lunar god in form of Ibis, patron of scribes and calendars. The Hermes of the Greeks.
triangulation	By carefully measuring a base line and the angles formed by either end of it with a distant point, the distance of the point may be calculated by trigonometry.
vernier	A small moveable scale attached to a large scale for obtaining finer fractions of measurements.
ziggurat	The stepped-pyramid temples of Mesopotamia.

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APPENDIX

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PETER TOMPKINS

SECRETS OF THE GREAT PYRAMID

with an appendix by Livio Catullo Stecchini

© 1978 paperback

HARPER COLOPHON BOOKS
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To Henry B. Tompkins, whose avuncular support made possible a quarter century of cosmopolitan research; to my friends Alan C. Collins, John Newhouse and Carlo and Nicola Caracciolo, in whose hospitable houses this book was largely written; to my wife, who, though she would rather it had been a novel, was a constant help.

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CONTENTS

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To Geraldine Dent, of Hopewell, New Jersey, and to Edward O. Mitchell, of McLean, Virginia, I wish to express my gratitude for painstaking help in reproducing the pictures which adorn this volume; to Diagram Ltd. of London for the streamlined drawings which illustrate the text.

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For a careful checking of the mathematical properties incorporated in the Great Pyramid I am indebted to Philippe Dennery, author of *Mathematics for Physicists.* His mathematical analysis of the secret geometric structure of the Great Pyramid as discovered by the Danish engineer Tons Brunés, made it possible to resolve the problem of the geodetic and geographic functions of the pyramid.

Most grateful I am to Livio Catullo Stecchini, Professor of the History of Science (characterized by Professor Giorgio de Santillana of MIT as "a Copernicus of the twentieth century"), for permission to quote from numerous unpublished monographs, the fruit of thirty years research into the advanced science of geography, geodesy and astronomy developed by the ancient Egyptians and Sumerians, several of which appear for the first time in the appendix to this volume.

This is indeed a cumulative effort, and I hope that my successors in pyramidal quests will be as lively and entertaining as have been my predecessors.

I have taken the book's 350 illustrations from the most disparate Medieval, Renaissance, Romantic, and Modern sources, from the 400 engravers of Napoleon's 20-volume *Description de l'Egypte* to the most recent archeological journals.

I am indebted to the Royal Society of Edinburgh for the original plates of the first photographs ever taken inside the Great Pyramid, by Professor Piazzi Smyth in 1865.

In particular I wish to thank Manly P. Hall for permission to reproduce the illustrations on pages 4 and 257 from his *Encyclopedic Outline of Masonic, Hermetic, Qabalistic and Rosicrucian Symbolical Philosophy;* Mlle. Lucy Lamy for permission to reproduce from the works of R. A. Schwaller de Lubicz, published in Paris by Flammarion and Caractères; Charles E. Jeanneret-Gris, better known as Le Corbusier, for the illustrations on page 192, from his *The Modulor,* published by Harvard University Press; Albert Champdor for the illustration on page 259, from his *Le Livre des Morts,* published by Albin Michel; C. Funk-Hellet for illustrations from his *La Bible et la Grande Pyramide,* published by Vincent Fréal; David Davidson for several plates from his *The Great Pyramid: Its Divine Message,* published by Williams & Norgate; Morton Edgar for plates from his *The Great Pyramid, Its Scientific Features,* published by Bone & Hulley; Howard B. Rand for the intricate interior of the Pyramid on page 28, from his *The Challenge of the Great Pyramid,* published by Destiny Publishers; Ludwig Borchardt for line drawings from his various works listed in the bibliography; Georges Goyon for the illustrations on pages 252 and 254 from *Revue Archéologique;* Adam Rutherford for the photographs and diagrams appearing on pages 7, 66, 69, 104, 110, 116, and 248 derived from the third volume of his five volume *Pyramidology* published in Harpenden, Hertfordshire, by the Institute of Pyramidology; Leonard Cottrell for the portrait of Flinders Petrie from his book *The Mountains of Pharaoh,* published by J. Hale; and Sir Flinders Petrie for the illustrations on pages 98 and 99 from his *70 Years in Archeology,* published by S. Low, Marston in London. The cover and the extraordinary interiors of the Grand Gallery and the King's Chamber on pages 14 and 16 are from Ludwig Mayer's *Views of Egypt from the Original Drawings in the Possession of Sir Robert Ainsley During his Embassy in Constantinople,* published in London in 1804.

INTRODUCTION TO THE PAPERBACK EDITION

The astronomical, mathematical, and geodetic science of the ancient inhabitants of Egypt, their cosmology and theology, are only beginning to be appreciated.

The degree of prejudice that for the past few thousand years has obscured the physical and metaphysical wisdom of the ancients is beginning to dissolve, and their perennial wisdom may still be in time to save a planet rushing headlong to self-destruction.

When I began to write this book some twenty years ago, I suspected that the Great Pyramid might incorporate a secret or secrets, the revelation of which could lead to a better understanding of the cosmos and man's place in it.

I did not realize by half the depth of knowledge it incorporates. The veil is only parted, not removed. Dangerous as it is to venture into areas peripheral to accepted dogma, it is fortunate that even eight years after the original publication of this book, no one in or out of the academic world has faulted the basic premises; further scholarship has merely reinforced them.

In my narrative reconstruction of the discoveries made in and about the Great Pyramid I may have underplayed my own notions about the earth commensurate relation of ancient feet and cubits the base and apothem of the structure. Yet now that our figures for the dimensions of this planet have been refined by orbiting satellites, the results are that much closer to the figures mysteriously built into the so-called Pyramid of Cheops. And the Egyptian units are not only earth commensurate but cosmic—which makes it clearer why the Meso-American contemporaries of the Egyptians named their prime deity Hunab-Ku, sole dispenser of a movement and measure. It is measure which informs this universe: the same measure upon which all of modern science is dependent.

Wherefore I commend the appendix written by Livio Stecchini, one of the world's leading authorities on ancient mensuration.

Plato was not idle when he placed the apparently senseless dictum 'Αγεωμετρητος μηοεις εισιτω ("Those who don't know geometry stay away") over the doorway to his academy. As one reader of this volume, William Kelley, was quick to demonstrate, the hermetic meaning cryptically encoded in the dictum is that without geometry no one may enter into the secret of universal measure. The key to that geometry is encoded in the Pyramid.

INTRODUCTION

Does the Great Pyramid of Cheops enshrine a lost science? Was this last remaining of the Seven Wonders of the World, often described as the most sublime landmark in history, designed by mysterious architects who had a deeper knowledge of the secrets of this universe than those who followed them?

For centuries a debate has been waged between supporters of such a theory and its opponents, with eminent scientists and academicians lining up on either side. Though all agree that the Great Pyramid is at least four thousand years old, none can say for certain just when it was built, by whom, or why.

Till recently there was no proof that the inhabitants of Egypt of five thousand years ago were capable of the precise astronomical calculations and mathematical solutions required to locate, orient and build the pyramid where it stands.

It was attributed to chance that the foundations were almost perfectly oriented to true north, that its structure incorporated a value for π (the constant by which the diameter of a circle may be multiplied to give its true circumference) accurate to several decimals and in several distinct and unmistakable ways; that its main chamber incorporated the "sacred" 3–4–5 and 2–$\sqrt{5}$–3 triangles ($a^2 + b^2 = c^2$) which were to make Pythagoras famous, and which Plato in his *Timaeus* claimed as the building blocks of the cosmos. Chance was said to be responsible for the fact that the Pyramid's angles and slopes display an advanced understanding of trigonometric values, that its shape quite precisely incorporates the fundamental proportions of the "Golden Section," known today by the Greek letter φ (pronounced *phi*), revered equally by masters of the *cinquecento* and luminaries of modern architecture.

According to modern academicians the first rough use of π in Egypt was not till about 1700 B.C.—at least a millennium after the Pyramid; Pythagoras' theorem is attributed to the fifth century B.C.; and the development of trigonometry to Hipparchus in the second century before Christ. That is what the Egyptologists say, and that is what they put in their textbooks.

Now the whole subject has had to be reviewed.

Recent studies of ancient Egyptian hieroglyphs and the cuneiform mathematical tablets of the Babylonians and Sumerians have established that an advanced science did flourish in the Middle East at least three thousand years before Christ, and that Pythagoras, Eratosthenes, Hipparchus and other Greeks reputed to have originated mathematics on this planet merely picked up fragments of an ancient science evolved by remote and unknown predecessors.

The Great Pyramid, like most of the great temples of antiquity, was designed on the basis of a hermetic geometry known only to a restricted group of initiates, mere traces of which percolated to the Classical and Alexandrian Greeks.

These and other recent discoveries have made it possible to reanalyze the entire history of the Great Pyramid with a whole new set of references: the results are explosive. The common—and indeed authoritative—assumption that the Pyramid was just another tomb built to memorialize some vainglorious Pharaoh is proved to be false.

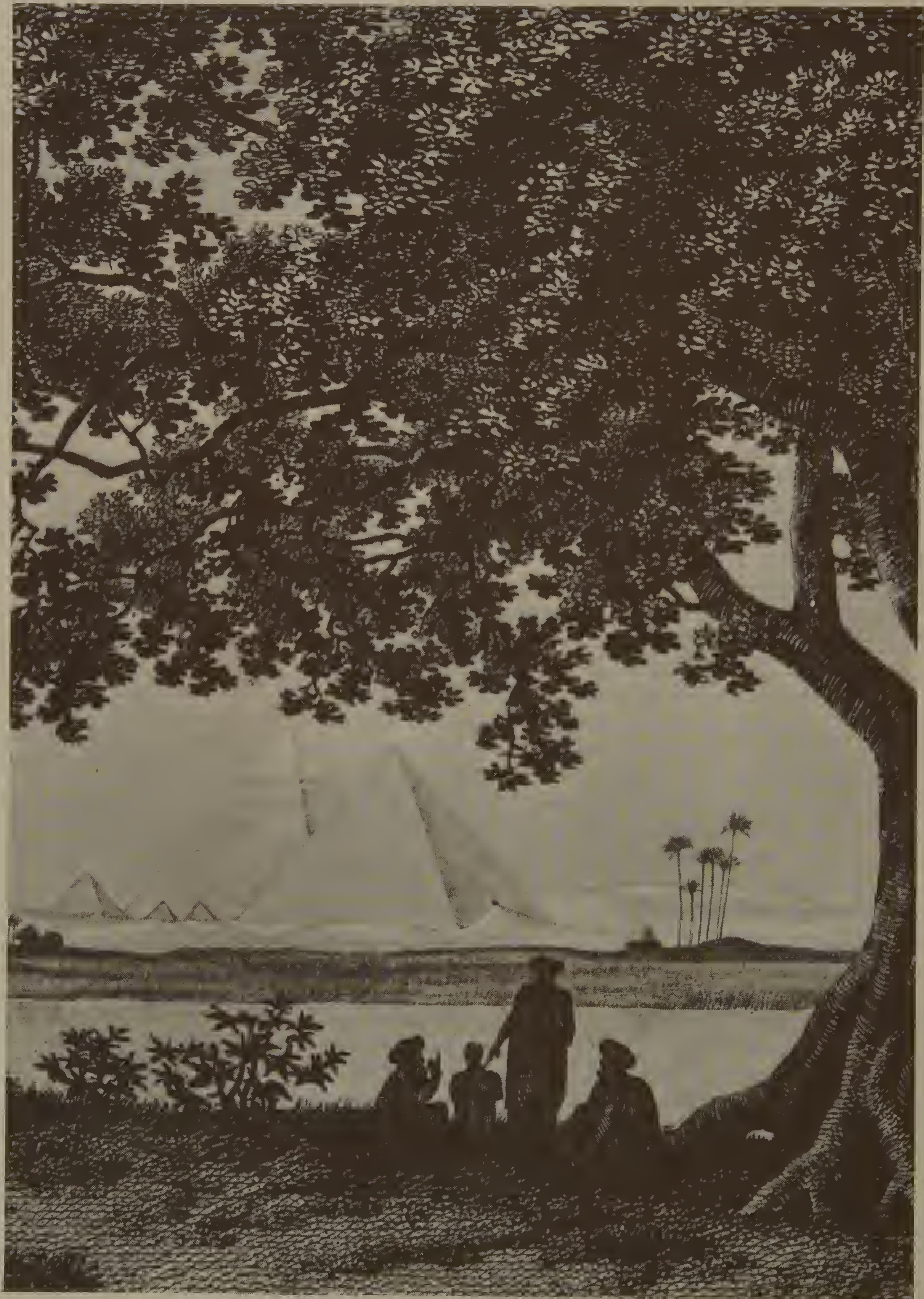
For a thousand years men from many occupations and many stations have labored to establish the true purpose of the Pyramid. Each in his own way has discovered some facet, each in its own way valid. Like Stonehenge and other megalithic calendars, the Pyramid has been shown to be an almanac by means of which the length of the year including its awkward .2422 fraction of a day could be measured as accurately as with a modern telescope. It has been shown to be a theodolite, or instrument for the surveyor, of great precision and simplicity, virtually indestructible. It is still a compass so finely oriented that modern compasses are adjusted to it, not vice versa.

It has also been established that the Great Pyramid is a carefully located geodetic marker, or fixed landmark, on which the geography of the ancient world was brilliantly constructed; that it served as a celestial observatory from which maps and tables of the stellar hemisphere could be accurately drawn; and that it incorporates in its sides and angles the means for creating a highly sophisticated map projection of the northern hemisphere. It is, in fact, a scale model of the hemisphere, correctly incorporating the geographical degrees of latitude and longitude.

The Pyramid may well be the repository of an ancient and possibly universal system of weights and measures, the model for the most sensible system of linear and temporal measurements available on earth, based on the polar axis of rotation, a system first postulated in modern times a century ago by the British astronomer Sir John Herschel, whose accuracy is now confirmed by the mensuration of orbiting satellites.

Whoever built the Great Pyramid, it is now quite clear, knew the precise circumference of the planet, and the length of the year to several decimals—data which were not rediscovered till the seventeenth century. Its architects may well have known the mean length of the earth's orbit round the sun, the specific density of the planet, the 26,000-year cycle of the equinoxes, the acceleration of gravity and the speed of light.

But to disentangle the authentic from the phony in what has been attributed to the builders of the Great Pyramid has required the technique of a Sherlock Holmes. To climax the story there is a mystery of detection to match the classic style of Sax Rohmer's Abu Hassan, complete with radiography by cosmic rays.



I. ANCIENT BACKGROUND

Ten miles west of the modern city of Cairo at the end of an acacia, tamarind and eucalyptus avenue stands a rocky plateau. A mile square, it dominates the luxuriant palm groves of the Nile Valley from a height of 130 feet. On this man-leveled plateau, called Giza* by the Arabs, stands the Great Pyramid of Cheops. To the west stretch the vast wastes of the Libyan desert.

The Pyramid's base covers 13 acres, or 7 midtown blocks of the city of New York. From this broad area, leveled to within a fraction of an inch, more than two-and-a-half *million* blocks of limestone and granite—weighing from 2 to 70 tons apiece—rise in 201 stepped tiers to the height of a modern forty-story building, etched against the cloudless blue of the Egyptian skies.

In terms of solid masonry, the structure contains more stone than all the cathedrals, churches and chapels built in England since the time of Christ; as a feat in masonry it was not to be matched till the construction of Boulder Dam. Modern engineers are astounded by both the enormity of the problems involved in the construction of the Pyramid and the optician's precision with which these problems were resolved. As originally designed, with its full mantle of polished limestone, the Pyramid must have been a dazzling sight. Unlike marble, which tends to become eroded with time and the weather, limestone becomes harder and more polished.

Near the Pyramid of Cheops stand two more pyramids, one, slightly smaller, attributed to Cheops' successor, Kephren, and another, smaller still, partly sheathed in red granite, attributed to Kephren's successor, Mykerinos. Together with six diminutive pyramids, supposedly built for Cheops' wives and daughters, they form what is known as the Giza complex. About a hundred more pyramidal structures of various sizes and in various stages of dilapidation follow the western bank of the Nile southward toward the Sudan, mostly within one degree of latitude, or 70 miles; but it is the Great Pyramid, unique in size and proportion, which is of paramount interest in this story.

The three large pyramids on the Giza plateau seen from across the Nile. The nearest of the three large pyramids is that of Cheops. Kephren's appears to be higher because it stands on higher ground. The third is that of Mykerinos. The two smallest pyramids are attributed to Cheops' wife and daughter.

* Most often spelt Giza, but transliterated by various authors as Djiseh or Jeeseh, the G is pronounced hard by the Egyptians and soft by other Arabs—as in *J* or *Dj*.

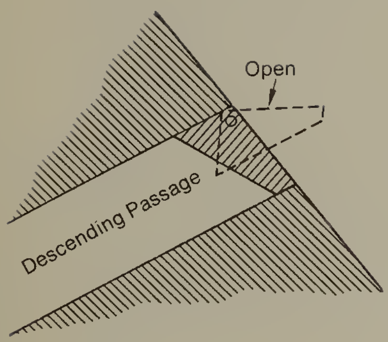
Reconstruction of a pyramid, showing the original polished limestone mantle which covered the entire structure.

What the Great Pyramid looked like when it was completed, or even for the first one or two millennia thereafter, is not recorded in history. No description of the Pyramid has survived in the Egyptian texts. Legends have it painted in various colors, marked with designs and inscribed with symbols. The thirteenth-century Arab historian, Abd-al-Latif, says the Pyramid was once inscribed with unintelligible characters in inscriptions so numerous they would fill ten thousand pages: his colleagues assumed them to be the graffiti of myriads of ancient tourists.

The first eyewitness descriptions from classical authors are pitifully sparse. Thales, the father of Greek geometry, who visited the Pyramid sometime in the sixth century B.C., is reputed to have astounded its Egyptian guardians with a correct computation of its height by measuring its shadow at the time of day when his own shadow was equal to his height. Unfortunately he left no detailed description of his visit.

The works of other classical authors known to have written about the Pyramid, such as Euhemerus, Duris of Samoa, Aristagoras, Antisthenes, Demetrius of Phaleron, Demoteles, Artemidorus of Ephesus, Dionysius of Halicarnassus, Alexander Polyhistor, Butoridas, and Apion are all lost, and survive only in fragmented quotation.

Herodotus, who saw the Pyramid about 440 B.C.—by which time it was as ancient to him as his period is to us—says that each of the structure's four perfectly triangular faces was still covered with a mantle of highly polished limestone, the joints so fine they could scarcely be seen. In his *History,* which contains the first comprehensive account of Egypt to have survived intact, Herodotus



Though no remains of a swivel door have been found at the Great Pyramid, Strabo's description fits the conditions; and a similar swivel door was found at the south pyramid of Dashur.

deals with other aspects of the Pyramid, but not all his information can be taken at face value.

Diodorus Siculus, the Greek historian who lived soon after the time of Christ, described the Great Pyramid's 22 acres of polished casing stones as being "complete and without the least decay." The Roman naturalist Pliny gives a report of natives gamboling up the polished sides to the delight of Roman tourists.

A man who may have had a lot to say about the Pyramids, in the forty-seven books of his *History,* was Strabo, the Pontine geographer who took a trip up the Nile in 24 B.C., but his history is lost: in the geographical appendix which survives he does little more than describe an entrance on the north face of the Great Pyramid made of a hinged stone which could be raised but which was indistinguishable from the surrounding masonry when it lay flush.

Strabo reports that this small opening gave onto a narrow and low passage, less than 4 feet by 4, which descended 374 feet into a damp, vermin-infested pit dug from the live bedrock 150 feet below the base of the Pyramid. That this pit was visited in Roman times was deduced from initials supposedly written with smoking torches on the rough ceilings by wealthy Greek and Roman tourists.

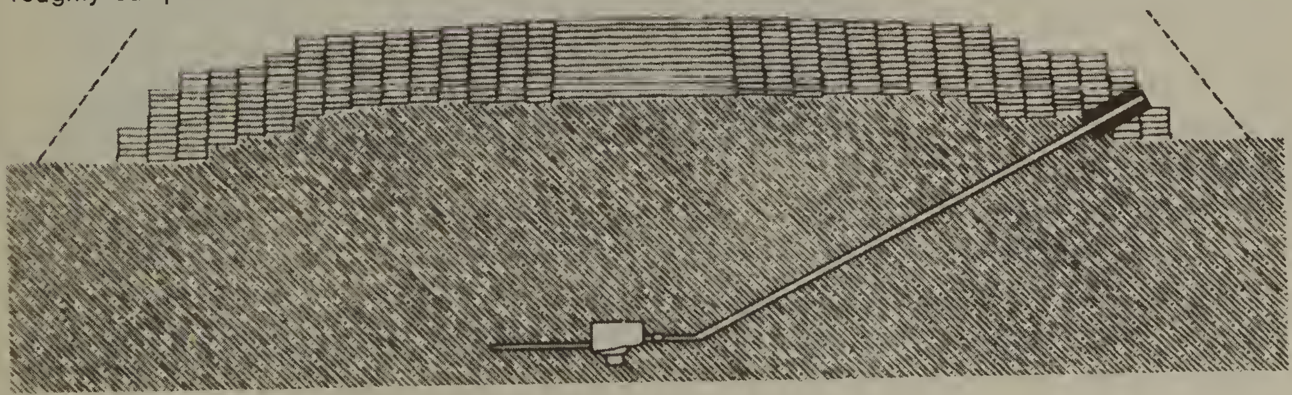
Sometime during the early centuries of the Christian era, the precise location of the movable door was lost. It was a period when information of all sorts began to grow scarce, when worldly learning came to be despised and denigrated. Christianized Egyptians were forbidden access to the ancient temples, which were either seized or razed by the Catholics; thousands of statues and inscriptions were disfigured; the hieroglyphs, whose meaning was already lost to most, became dead letters to the world to remain so for the next fifteen hundred years.

The great library of Alexandria, accidentally damaged by Julius Caesar and restored by Mark Anthony, was intentionally destroyed by a Christian mob on orders of the Christian emperor Theodosius in A.D. 389. All that was

From the original entrance a long passage descends Into the heart of the Great Pyramid at an angle of 26 1/2°, or a slope of about 1 in 2. The passage is 3 feet 5 inches wide and 3 feet 11 1/2 inches high.

For the first 130 feet down, the passage is built into the masonry with beautifully finished sides of white limestone, perfectly straight and smooth. Thereafter it is cut equally smoothly through the bedrock of limestone on which the Pyramid is founded.

At 345 feet from the entrance, the passage levels out for 25 feet, then enters a roughly cut pit.



ancient was pagan, and therefore sinful. Those interested in mathematics and astronomy were persecuted and put to death for their inquisitiveness. Even women weren't spared, as with the lovely Hypatia, who was seized by an angry mob (incited by the monks under the control of St. Cyril, then Bishop of Alexandria), dragged into a church, stripped naked, and scraped to death with oyster shells. Her crime was to have been the daughter of the celebrated Alexandrian mathematician Theon, to have edited her father's works, taught mathematics, and become a leading philosopher in her own right, renowned for her beauty, modesty and learning.*

As the Dark Ages continued, little or nothing more was heard of the Great Pyramid of Cheops.

* Though her writings perished with the burning of the library of Alexandria, Hypatia is known from contemporary writings to have produced a commentary on the *Arithmetic* of Diophantus, one on the *Astronomical Canon* of Ptolemy, and one on the *Comics* of Appolonius of Perga. Synesius, Bishop of Ptolemais requested her assistance in the construction of an astrolabe and a hydroscope.

II. MEDIEVAL EXPLORATION

The first dawn of a renaissance came with the Arabs. When the followers of Mohammed swept into power in the Near East in the seventh century and captured Alexandria in A.D. 640, they found no library of any importance, but a city of four thousand palaces, four thousand baths and four hundred theaters. Impressed by the opulence of the city and the size of the Christian fleet, they decided to emulate both.

The Mohammedans' delight in navigation engendered a need for geography, which required astronomy and mathematics. The search for such data was to lead them to the secrets of the Pyramid. To broaden their knowledge, the Arabs set about translating into Arabic all they could lay hands on of ancient Greek and Sanskrit material, ransacking monasteries for rare copies of Euclid, Galen, Plato, Aristotle, and the Hindu sages. In the midst of otherwise Dark Ages, Mohammed's religious successors, the caliphs of Baghdad, were soon the most enlightened as well as the most powerful potentates. Under caliph Harun Al-Rashid, whose feats were to be celebrated in the *Arabian Nights,* translators were paid in gold by the weight of each manuscript.

Harun's young son Abdullah Al Mamun, who came to the throne in A.D. 813, founded universities, patronized literature and science, and turned Baghdad—known as Dar-al-Salam, or City of Peace—into a seat of academic learning, with its own library and astronomical observatory.

Described by Gibbon as "a prince of rare learning who could assist with pleasure and modesty at the assemblies and disputations of the learned," young Al Mamun was responsible for the translation into Arabic of Ptolemy's great astronomical treatise, the *Almagest*. This work contained astronomical and geographical data, including the earliest star catalogue which has survived, all of which knowledge had been lost to the West for centuries but was of great value to the Arabs in their growing empire.

Claiming that Aristotle had appeared to him in a dream, Al Mamun commissioned seventy scholars to produce an "image of the earth" and the first "stellar map in the world of Islam." (Though they have since disappeared, these maps were consulted by the Arab historian Al Masudi in the first half of the tenth century.) To check Ptolemy's

In the *Arabian Nights* the Great Pyramid was reputed to have magical qualities and to contain extraordinary treasures. E. W. Lane's picture illustrates his nineteenth-century translation of *The Thousand and One Nights*.

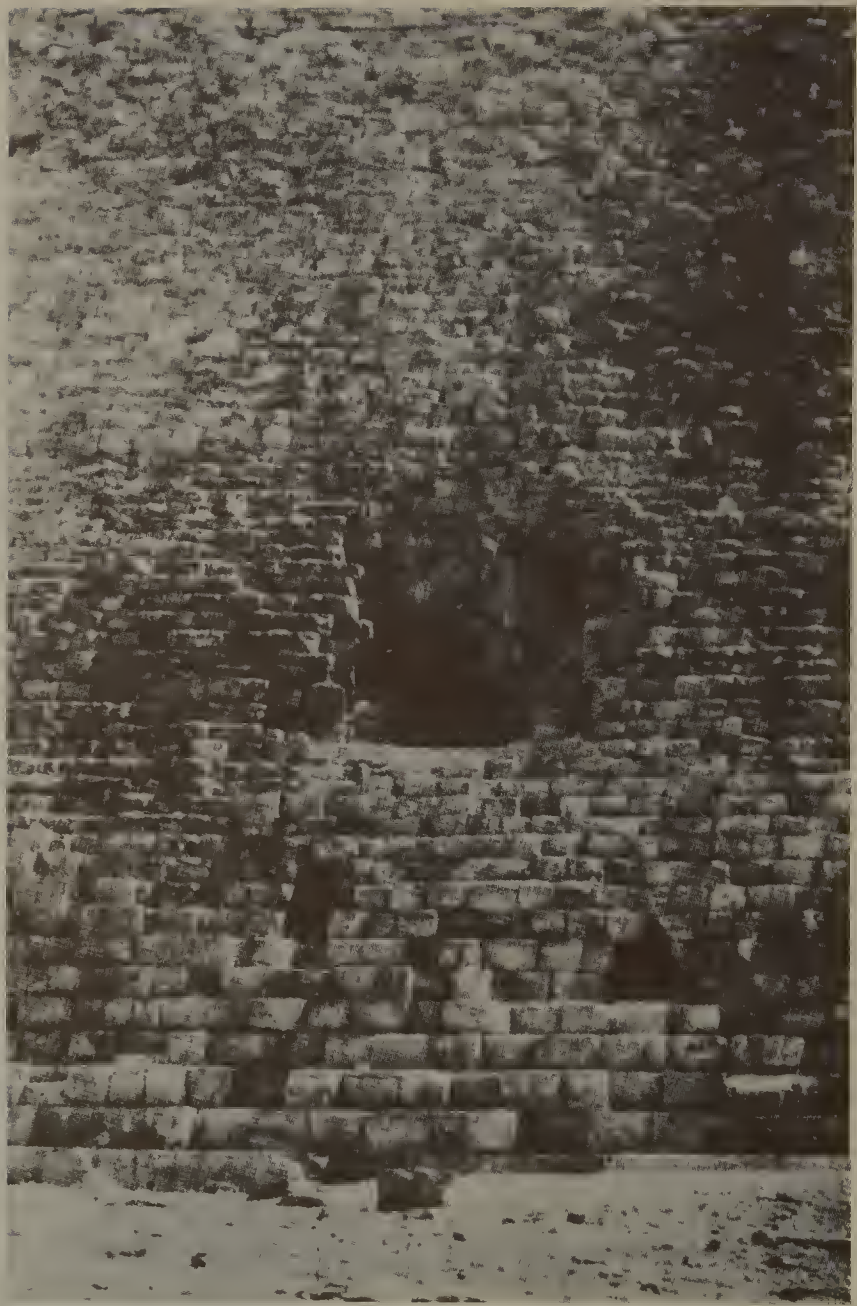
statement that the circumference of the earth was 18,000 miles, Al Mamun ordered his astronomers to measure the actual overland length of a degree of latitude across the adjacent plain of Palmyra, north of the Euphrates. From a central point the observers moved north and south till they noted by astronomical observation that the latitude had changed 1°; with wooden rods they measured across the sandy plain and obtained a degree of 56 2/3 Arabic miles, the equivalent of 64.39 English statute miles. This figure, which gave a circumference of 23,180 miles, was more precise than Ptolemy's, but the Arabs had no way of checking it: no one had yet circumnavigated the globe; indeed, most still argued that the world was flat!

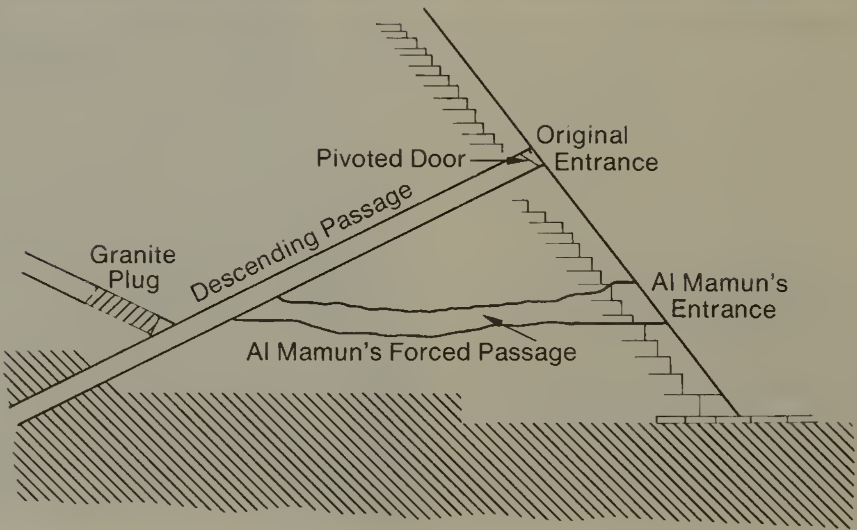
Al Mamun, who ran an up-to-date intelligence service under the direction of his postmaster-general employing as many as seventeen hundred old women as intelligence agents in Baghdad alone, was informed that the Great Pyramid was reputed to contain a secret chamber with maps and tables of the celestial and terrestrial spheres. Although they were said to have been made in the remote past, they were supposed to be of great accuracy. The chamber was also reported to contain vast treasures and such strange articles as "arms which would not rust" and "glass which might be bended and not break."

Arab historians, including one with the imposing name of Abu Abd Allah Mohammed ben Abdurakin Alkaisi, have recounted the tale of Al Mamun's attempts to enter the Pyramid. In 820 the young caliph collected a vast conglomeration of engineers, architects, builders and stonemasons to attack the Pyramid; for days they searched the steep polished surface of the northern slope for its secret entrance, but could find no trace of it.

Not to be thwarted, so the story goes, Al Mamun decided to burrow straight into the solid rock of the structure in the hope of running across some passage within the interior. Hammer and chisel would not dent the huge blocks of limestone, no matter how many blacksmiths stood ready to sharpen them; so a more primitive but effective system was used: fires were built close to the blocks of masonry, and when these became red hot they were doused with cold vinegar until they cracked. Battering rams knocked out the fragmented stone.

Al Mamun forced his way into the Pyramid to the west of the main axis of the northern face, at the level of the seventh course of masonry. He misjudged the level of the original entrance by starting ten courses too low, and too far to the west.




Original
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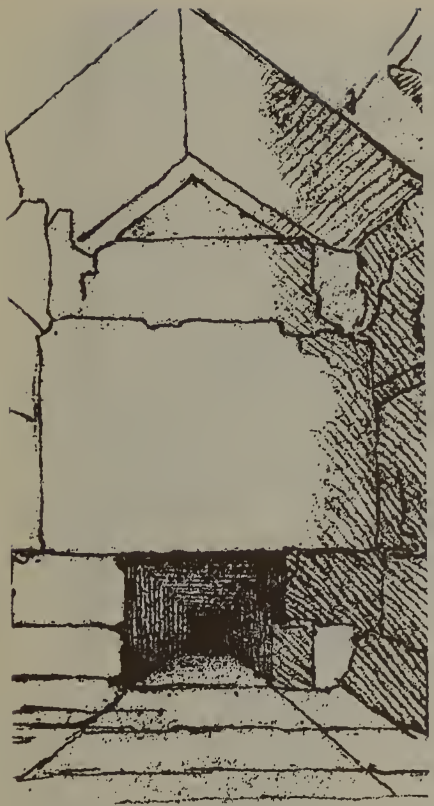
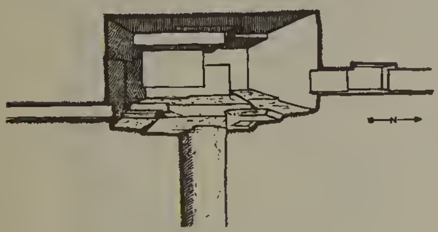


Entrance to Descending Passage.



The subterranean pit cut deep into the bedrock is almost 600 feet directly below the apex of the Pyramid. It is 31 feet in the east-west direction but only 27 feet north-south.

Though its ceiling is relatively smooth, its floor is cut in several rough levels, the lowest being 11 feet 6 inches from the ceiling.

In the south wall, opposite the entrance, is a low passage which runs another 53 feet southward before coming to a blind end.

In the center of the floor is a square hole, which was 12 feet deep in 1838, but was dug deeper by the English explorer Howard-Vyse in the vain hope of finding an outlet for a further hidden chamber.

For over 100 feet Al Mamun's men tunneled into the solid core of the Pyramid, excavating a narrow passage that became hotter, dustier and more constricted. Illumination by candle or flare consumed oxygen and poisoned the air.

Al Mamun was on the point of giving up when a workman heard a muffled sound of something heavy falling somewhere within the Pyramid, east of the tunnel. Renewing their efforts and altering the direction of the bore, the workers broke into a hollow way "exceeding dark, dreadful to look at, and difficult to pass." It was a passage 3 1/2 feet wide by 3 feet 11 inches high, which sloped at a steep angle of 26°. On the floor lay a large prismatic stone which had been dislodged from the ceiling of the passage.

Struggling up the passage on all fours, the Arabs discovered the original secret entrance about 90 feet to the north. It had been placed 49 feet above the base of the Pyramid, ten courses higher than Al Mamun had guessed, and 24 feet east of the main axis of the north face of the Pyramid.

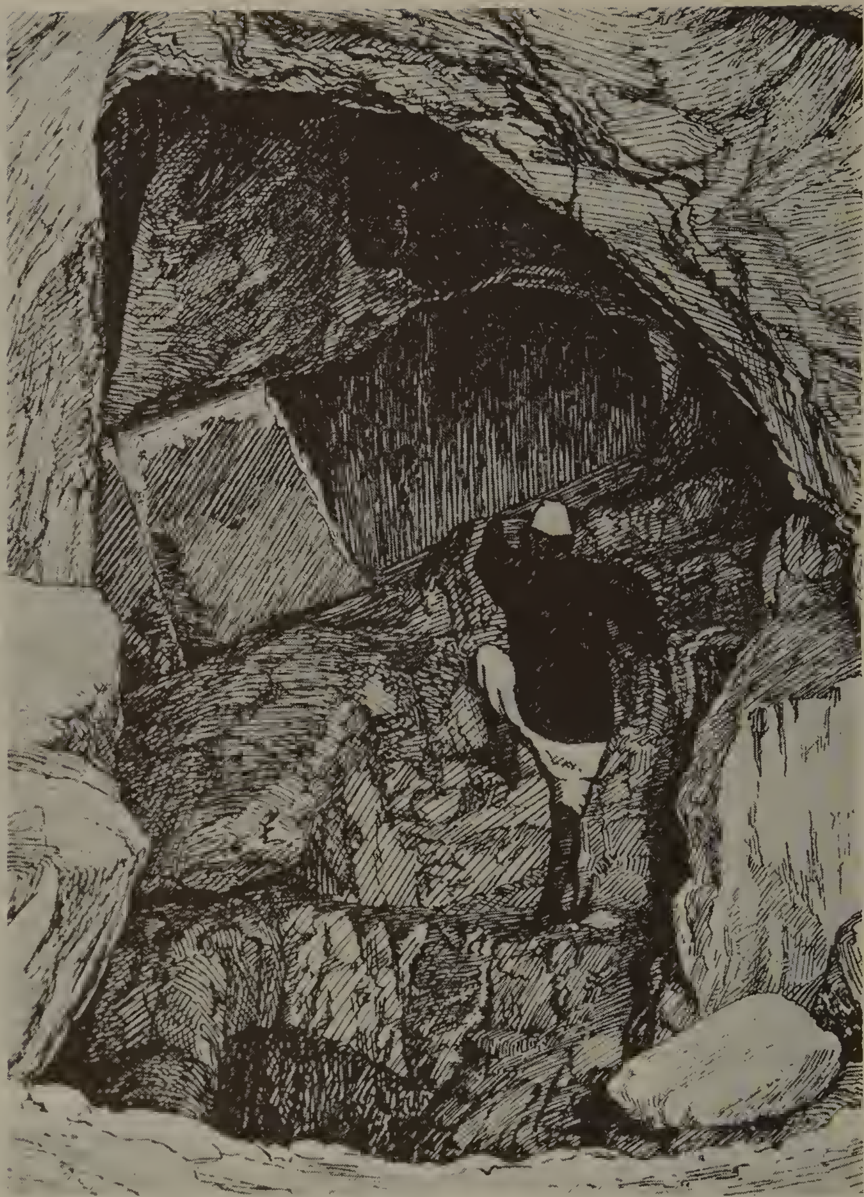
Retracing their steps, Al Mamun and his men groped down the low, slippery, Descending Passage, cut deep into the rock of the plateau. At the bottom they were disappointed to find nothing but the unfinished, roughly hewn chamber, or "pit," with an uneven floor, containing nothing but debris and dust. On the far side of it, an even narrower horizontal passage led 50 feet to a blank wall; in the floor a well shaft appeared to have been carved to a depth of 30 feet, leading nowhere.

From the torch marks on the ceiling, the Arabs deduced that the "pit" had been visited in classical times and that anything of interest it may have contained had long since been removed.

What now intrigued the Arabs was the large prismatic stone that had fallen from the ceiling of the Descending Passage. It had evidently covered the end of a large rectangular red-and-black granite plug which completely filled what looked like another passage sloping *up* into the body of the Pyramid. Of such a passage there had been no mention in the writings of Strabo or other classical authors; Al Mamun figured he might have stumbled onto a secret which had been kept since the original construction of the building.

The Arabs tried to chip or dislodge the granite plug, but it was tightly wedged, of indeterminate length, and it evidently weighed several tons. Spurred by the prospect of a new passage leading to some hidden treasure chamber, Al Mamun ordered his men to cut around the plug through

The granite plug in the ceiling, halfway down the descending passage, was of very hard quartz, mica and feldspar, which blunted the Arabs' chisels.



The Arabs dug a large cavity into the softer limestone blocks of the body of the Great Pyramid to the west of the Descending Passage. By means of this hole Al Mamun was able to circumvent the three impenetrable granite monoliths which barred his way to what appeared to be a passage leading upward into the Pyramid.

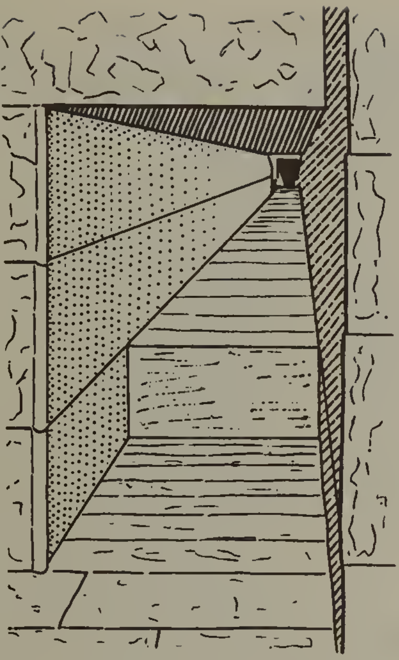
the softer limestone blocks of the surrounding walls. Even this turned out to be more of a job than expected. When the Arabs had bored beyond the first granite plug for over 6 feet, they encountered another granite plug, equally hard and equally tightly wedged. Beyond it lay yet a third. By now the Arabs had tunneled more than 16 feet. Beyond the third granite plug they came upon a passage filled with a limestone plug which could be cracked with chisels and removed piece by piece.

It is not recorded how many such plugs the Arabs encountered, but they may have had to clear a score or more before they could force their way into a narrow ascending passage, again less than 4 feet high and equally narrow. On their hands and knees, holding their torches low, Al Mamun and his men were obliged to scramble up 150 feet of dark, slippery passageway, at the same steep slope of 26°, before they could raise their heads and stand on a level spot.

In front of them stretched another low horizontal passage, no higher than the one they had painfully ascended.

Inching their way to the end of this passage, they found themselves in a rectangular limestone room with a rough floor and a gabled limestone roof. Because of the custom among the Arabs of placing their women in tombs with gabled ceilings (as opposed to flat ones for men), this room came to be known as the "Queen's Chamber."

The bare room, 18 feet long, and almost square, had an empty niche in the east wall large enough to have contained an overlifesize statue. Thinking the niche might conceal the entrance to a second chamber, the Arabs hacked their way into its solid masonry for another yard before giving up.



The first-level passage, at the top of the first long incline, is 127 feet long, 3 feet 9 inches high, and 3 feet 5 inches wide.
A sudden drop of 2 feet mysteriously appears in the passage.

Queen's Chamber, with niche, excavated by Arabs.

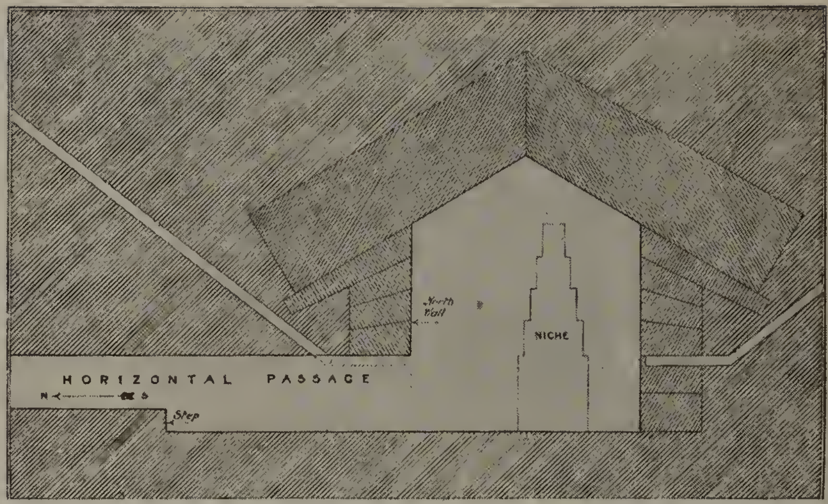
The name "Queen's Chamber" is considered a misnomer by Egyptologists, who claim that the Egyptians placed no queens in the pyramids of the Pharaohs.

The walls of the chamber are unblemished limestone blocks, beautifully finished, but early explorers found them mysteriously encrusted with salt as much as 1/2 inch thick.

Originally the niche was 3 feet 5 inches deep, but treasure seekers have hacked a passage through the back for several yards. The niche is just over 16 feet high. The sides have four corbeled courses, and are 61 3/4 inches (3 cubits) apart at the base and 20 1/4 inches (1 cubit) apart at the top.

The chamber, placed directly beneath the apex of the Pyramid, is almost square: 18 feet 10 inches from east to west and 17 feet 2 inches from north to south. It has a double-pitched ceiling, 20 feet 5 inches at its highest, formed by huge blocks of polished limestone at a slope of 30° 26′, which extend 10 feet beyond the supporting walls; there is no pressure, or arch thrust, at the apex, the center of gravity of each block being well behind the wall face.

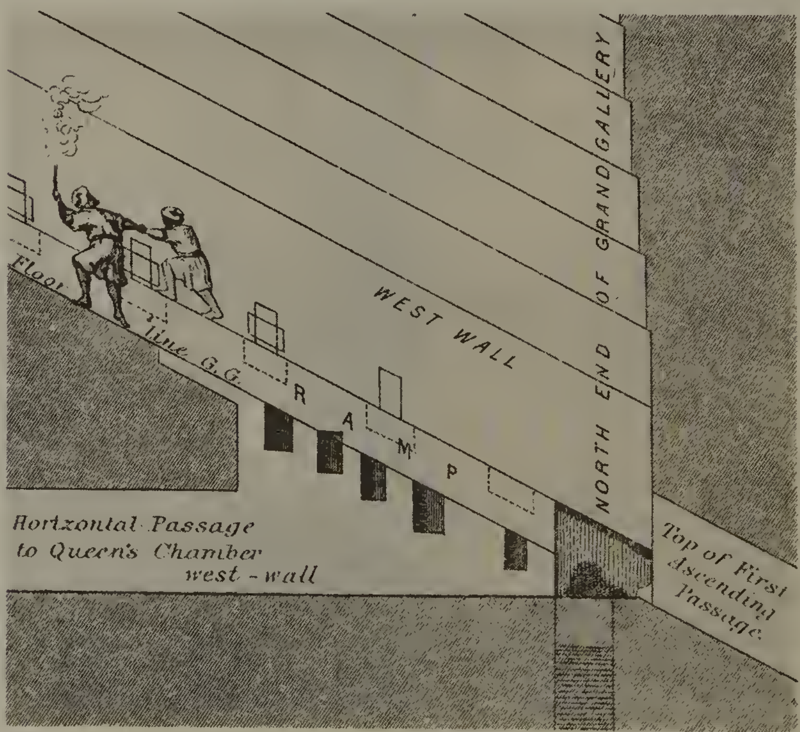
The floor of the chamber is of roughly dressed stones, and appears never to have been finished, as if another layer of polished stones were to be laid.



Retracing their steps to where they had left the low Ascending Passage, the Arabs raised their torches into an ominous void above them. In the side walls joist holes indicated that the floor of the Ascending Passage had once continued upwards, blocking and hiding the low passage to the Queen's Chamber.

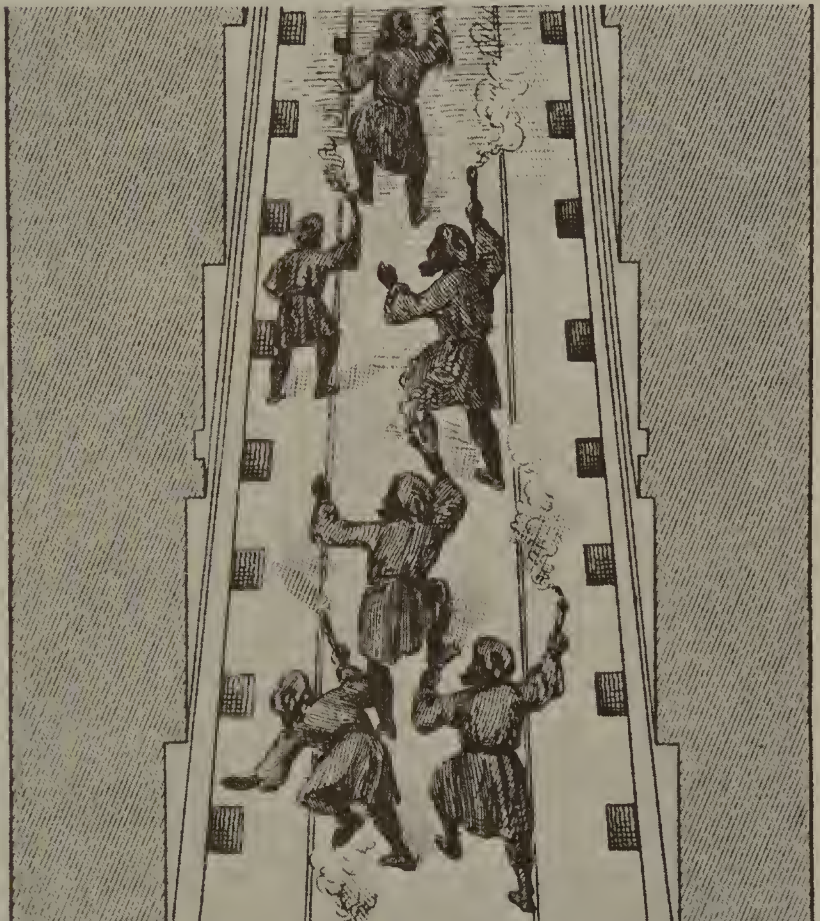
Climbing on each others' shoulders and raising their torches, the Arabs now saw that they were at the bottom of a narrow but grand gallery, about 28 feet high, which appeared to stretch upward at the same steep slope as the Ascending Passage into the black and mysterious heart of the Pyramid.

The center of this new passage was very slippery, but to either side of it were two narrow ramps slotted at regular intervals; they afforded a better foothold.



Holding their torches high, the Arabs proceeded to escalade these ramps. At the end of another 150-foot climb, they came upon a huge solid stone, raised 3 feet from the floor, which they had to clamber up in order to stand at the top of the gallery on a 6×8 foot platform.

Beyond this platform the floor continued level, but the

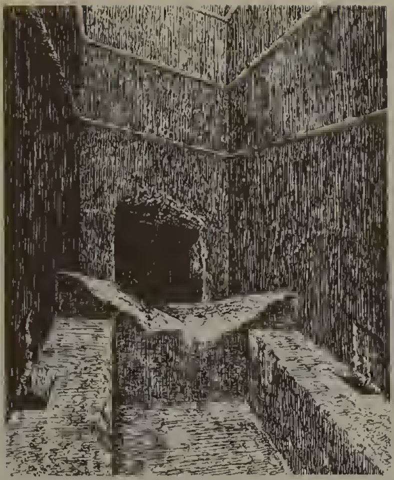


The overall length of the Grand Gallery, shown here, is 157 feet. It is inclined 26°, as is the Ascending Passage.

The walls are 28 feet high, rising vertically in seven courses of polished limestone, each corbeled 3 inches toward the center, making the gallery narrow from 62 inches at the base to 41 inches at the top. The first corbeling is 7 feet high.

On either side of the central 2-foot passage are two ramps 18 inches wide and 2 feet high; along the walls is a series of notches.

The gallery is considered an architectural masterpiece. Egyptologists have differed as to its function, and that of its ramps and notched holes.



At the top of the Grand Gallery lies a huge stone step, 6 feet wide, 3 feet high, which blocks the Ascending Passage and forms a platform 8 feet deep, now badly chipped and worn.

Beyond the Great Step there stretches another low, level passage 41 inches (or 2 cubits) square. A third of the way along this passage, it rises and widens into a sort of antechamber, the south, east and west walls of which are no longer of polished limestone but of polished red granite.

ceiling fell to a mere 41 inches, forming a sort of portcullis entrance to a small antechamber.

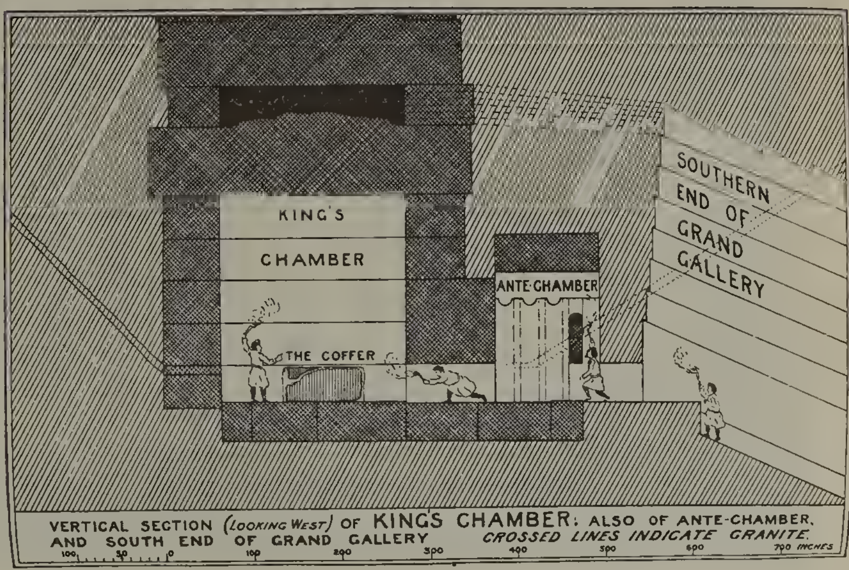
Past the portcullis, Al Mamun's men were again obliged to stoop along a short passage which led to yet another chamber.

Their torches revealed a great and well-proportioned room; the walls, floor and ceiling were all of beautifully wrought and polished red-granite blocks, squared and extremely finely jointed: "a right noble apartment, thirty-four feet long, seventeen broad, and nineteen high." Because of its flat ceiling, the Arabs named it the "King's Chamber."

Al Mamun's men frantically searched every cranny of the chamber but could find nothing of interest or value—there was no sign of any treasure, only a large lidless "sarcophagus" of highly polished, dark chocolate-colored granite.

Some Arabian authors have reported that Al Mamun found in the sarcophagus a stone statue in the shape of a man. They say that within the statue lay a body wearing a breastplate of gold set with precious stones, an invaluable sword on his chest, and a carbuncle ruby on his head the size of an egg, which shone as with the light of day. According to the storytellers the statue was inscribed with a mysterious writing that no one could decipher; but there is no historical evidence to support the tale.

To Al Mamun it appeared that either the vast mausoleum had been built about nothing but a single empty chest, or the whole place had previously been looted; though how and by whom it was hard to imagine, considering the enormous number of stone plugs the Arabs had been obliged to break up in order to make their entrance.



VERTICAL SECTION (LOOKING WEST) OF KINGS CHAMBER: ALSO OF ANTE-CHAMBER, AND SOUTH END OF GRAND GALLERY CROSSED LINES INDICATE GRANITE.

The sole item within the King's Chamber is a lidless coffer cut from a solid block of chocolate-colored granite, whose granules of feldspar, quartz and mica are even harder than those of the chamber walls. They were fabled to have come not from the Egyptian quarries up the Nile at Syene but from the mythical Atlantis or even from America.

Because the coffer is 6 feet 6 inches long, 2 feet 3 inches wide and 3 feet deep and could comfortably accommodate a human body, it has been called a sarcophagus and is believed by Egyptologists to have been the tomb of the Pharaoh Cheops.

A ridge along the top edge of the coffer indicates it may have once had a sliding lid, though no trace of the lid has been found.

As the Arabs removed 22 acres of 100-inch-thick pure-limestone covering from the Great Pyramid, vast mounds of chips and refuse built up as high as 50 feet around the base.

In a fury of disappointment, the Arabs ripped up part of the floor and hacked at the beautiful granite walls, even burrowing a short tunnel into a corner of the room, all to no avail.

Legend has it that to pacify his disappointed men Al Mamun had a treasure of gold secreted in the Pyramid at night, amounting to just the wages due his men, and palmed off the coincidence on the wisdom and prescience of Allah.

For another four centuries the great pile lay undisturbed on the desert's edge, its outer casing virtually intact, its geometric shadows lengthening and shortening with the revolutions of each year. An Arab historian who saw the Pyramid in the early thirteenth century compared it to a great female breast rising from the bosom of Egypt. He remarked that it was still perfect except for the entrance carved in it by Al Mamun.

Subsequently a series of earthquakes demolished large parts of northern Egypt, and the descendents of Al Mamun's workers wreaked their revenge on the treasureless Pyramid by stripping it of its precious limestone casing to rebuild their new capital city El Kaherah, "The Victorious." In the course of several generations they managed to remove the entire 22 acres of 100-inch-thick covering of the Pyramid, and even built two bridges especially to drag the heavier stones across the river on camel trains to Cairo for the construction of a series of mosques and palaces.

The Mosque of Sultun Hasan in Cairo, built in 1356 with limestone blocks removed from the covering of the Great Pyramid.

One of the more renowned of the several hundred minareted mosques in what came to be known as "Grand" Cairo was built in 1356 by Sultan Hasan almost entirely with stones removed from the Pyramid. Forty years later, in the reign of his successor Barluk, when the French Baron d'Anglure traveled to Egypt, he was able to see and report on the continued dismantling of casing stones by Arab stonemasons. D'Anglure was naïve enough to fall for the historical canard that the pyramids had been built as granaries by the biblical Joseph to store Pharaoh's grain in years of plenty; but his old French gives a vivid picture of the despoilers tumbling the massive blocks from the summit: ". . . *certain ouvriers massons qui à force desmuroient les grosses pierres taillés qui font la couverture de desdits greniers, et les laissoient devaller à val.*" ("Certain masons demolished the course of great casing stones which covered these granaries, and tumbled them into the valley.")

The stripping of the limestone left the core masonry exposed in a series of gradually ascending and receding steps to be weathered and worn by wind, sand and rain. Some of the underlying core blocks proved to be of pure limestone, others of nummulitic limestone containing large quantities of fossil shells resembling coins.

Around the stripped Pyramid, fragments of limestone and rubble were piled so high that they finally obliterated the entrance which Al Mamun had forced in the north face.

But the removal of the outer casing brought to light two huge transoms embedded in the masonry which formed a protective gable over the tiny gaping original entrance to the Descending Passage.

Only now, no one cared to reenter the Pyramid.

III. RENAISSANCE AND REVIVAL OF INTEREST

Superstition shrouded the ancient structure. It was said to be haunted by ghosts and to be alive with venomous vermin. According to the Arabs the Great Pyramid was haunted at noon and sunset by a naked woman with large teeth who seduced people into her power and then drove them insane.

When Rabbi Benjamin ben Jonah of Navarre, an adventurous twelfth-century traveler, reached the Giza plateau from Abyssinia he noted that "the Pyramids which are seen here are constructed by witchcraft."

Abd-al-Latif, who taught medicine as well as history in Baghdad, summoned the courage to enter the Great Pyramid shortly after Benjamin's visit but admitted that within its stifling interior he fainted from fear and came out more dead than alive.

The Pyramid's bad reputation spread so far afield that when the fabulous English explorer Sir John Mandeville is supposed to have visited Egypt in the fourteenth century, he is said to have complained he dared not enter the Pyramid because it was filled with serpents: but the serpents turned out to be as fabulous as his *Travels* which were produced by a notary in Liège who had never even left his native country.

Not till the Renaissance had swept away some of the cobwebs of medieval obscurantism, and revived man's interest in science, was there enough motive for Europeans to enter the Pyramid and rationally examine its interior.

In 1638 John Greaves, a 36-year-old mathematician and astronomer who had studied at Oxford and taught geometry in London, decided to set off for Egypt. His was no idle curiosity: like Al Mamun, he hoped to find in the Great Pyramid a datum that might help to establish the dimensions of the planet. Although the preceding century had spawned the great voyages of exploration, and Magellan's crew had circumnavigated the earth, the sciences of geography and astronomy were still so much in their infancy—to all appearances—that no one had improved on Ptolemy's or Al Mamun's geographical degree and hence no one knew the true circumference of the earth.

The Giza pyramids and Sphinx as depicted in 1610, showing European travelers.

A clue to a possible solution had been postulated by Girolamo Cardano, an astonishing Milanese physician and mathematician of the early sixteenth century and a close friend of Leonardo da Vinci's, who maintained that a body of exact science must have preexisted the Greeks. Cardano suspected that a degree of meridian (far more exact than that of Eratosthenes, Ptolemy or Al Mamum) must have been in existence hundreds if not thousands of years before the Alexandrians and that to find it one must search in Egypt. Pythagoras was said to have claimed that the measures of antiquity were derived from Egyptian standards, themselves copied from an invariable prototype taken from nature. It followed that the pyramids might have been built to record the dimensions of the earth and furnish an imperishable standard of linear measure.

Greaves had already traveled to Italy to measure its ancient buildings and statues in an attempt to establish the original standard of measure used by the Romans—which he concluded to be a foot somewhat shorter than a British foot by 28 thousandths.

John Greaves.

Statue of young Roman architect, Statilius Aper, in Vatican gardens, from which Greaves measured a Roman foot which was related to the circumference of the earth.

In the Vatican gardens Greaves found a statue commemorating a young architect of the first century A.D., T. Statilius Vol Aper, who had died in his twenty-third year. Portrayed in relief were Aper's architectural instruments, including a Roman foot. Greaves copied this foot and compared it to an English foot made of brass which he had divided in 2,000 parts. "I spent at least two hours," wrote

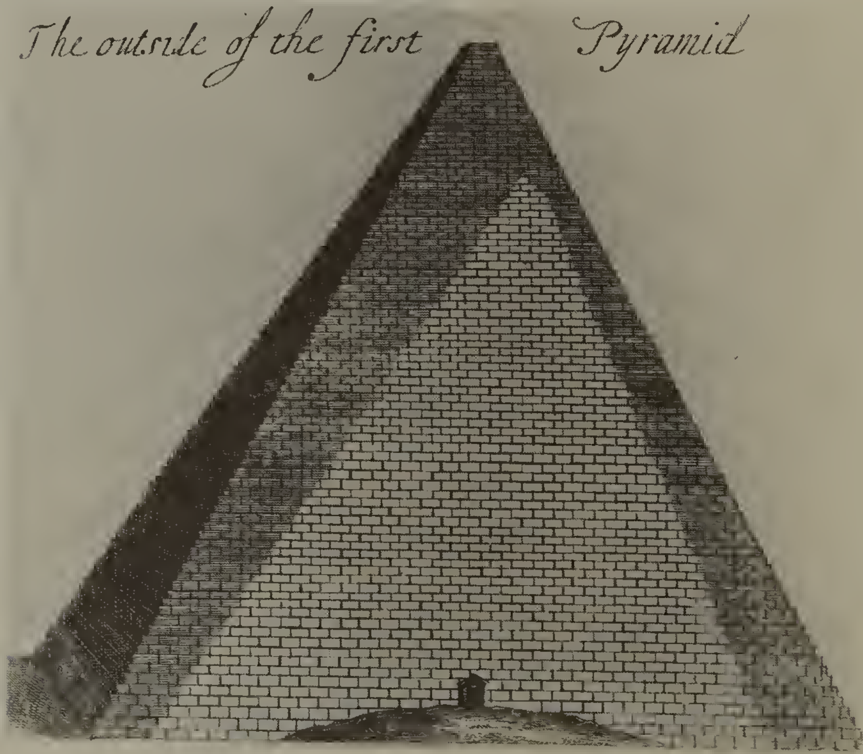
Greaves, explaining the diligence with which he performed the operation, "so often comparing the several divisions and digits of it respectively one with another, that I think more circumspection could not have been used."

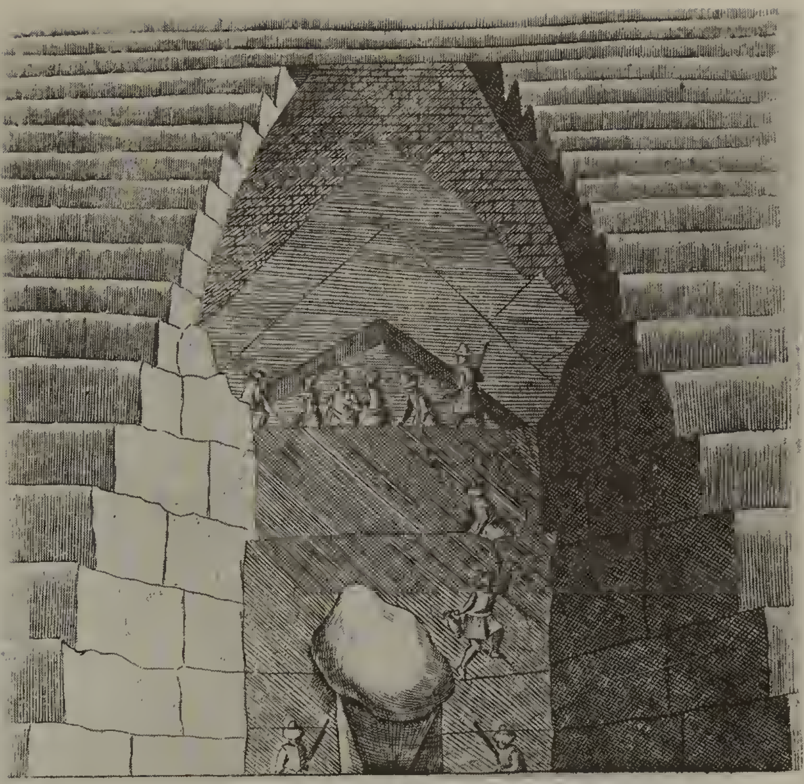
Greaves found that the Roman foot contained "1,944 such parts as the English foot contains 2,000." The interesting result of this measurement was the fact that it confirmed a Roman foot to be exactly 24/25ths of the Greek foot derived from the Parthenon—a foot of which there are 100 in the width and 225 in the length of the building.

Greaves's next problem was to establish the basic unit on which the Pyramid had been built—whether foot, pace, cubit (an arm's length), or palm.

To help defray his expenses, Greaves applied for the patronage and assistance of the magistrates of the City of London, but they turned him down. Luckily the Archbishop of Canterbury thought enough of Greaves, and was sufficiently interested in rare Arabic and Persian manuscripts which might be discovered in the East, to patronize him. Greaves was able to equip himself with instruments for measuring the inside and the outside of the Pyramid and for obtaining the declination and right ascension of the stars above it, and have enough money left over to spend a few weeks in Cairo.

Though a bookish mathematician and an ingrained antiquarian, Greaves was not without courage as an explorer. At the Pyramid he climbed onto the mound of rubbish 38 feet high which surrounded it and gingerly let himself into the Descending Passage, "creeping like a serpent," horrified to





Entrance to the Great Pyramid as depicted by John Greaves.

find himself in a storm of bats "so ugly and so large, exceeding a foot in length," such as he had never imagined.

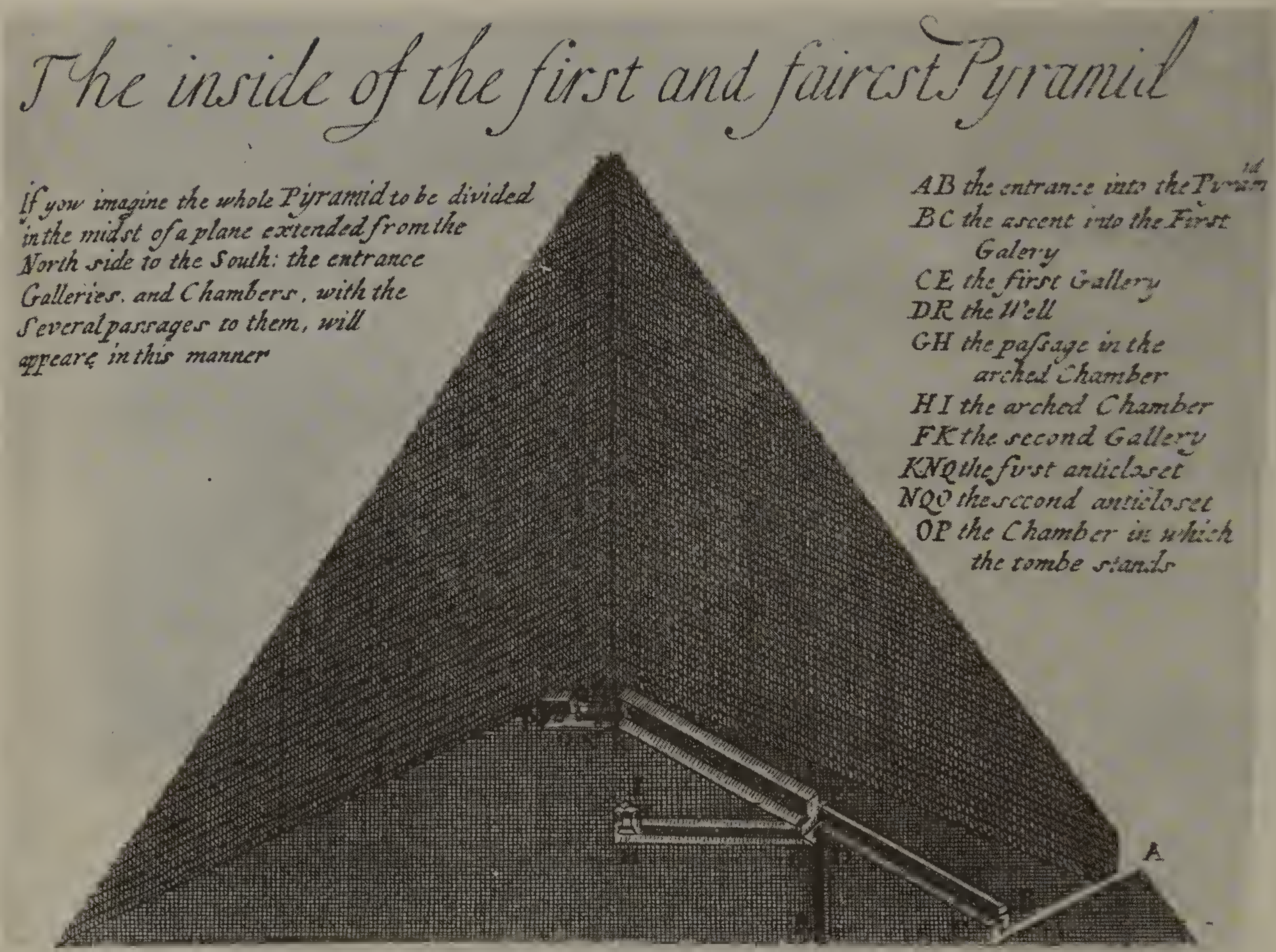
To scare off the bats and clear the air, Greaves resorted to firing his pistols; the explosions reverberated like cannon shots in the restricted passage of the Pyramid.

Working his way downward, Greaves reached the point where Al Mamun's original tunnel joined the Descending Passage, but was unable to proceed in a downward direction because of the debris left behind by Al Mamun's men when they had broken up the series of limestone plugs that had filled the upper passage.

Following in the Arabs' footsteps, Greaves climbed around the massive granite plugs and up into the low Ascending Passage. Having scrambled to the top, Greaves retraced Al Mamun's course along the short Horizontal Passage to the Queen's Chamber, where he found the stench of vermin so offensive he could not linger.

Everything Greaves came across was a puzzle to him. The steepness of the Grand Gallery seemed to preclude its having been designed as a chamber: the difficulty of scaling its polished slope made it impractical as a stairway. Also, it was accessible only through the preceding very low passage.

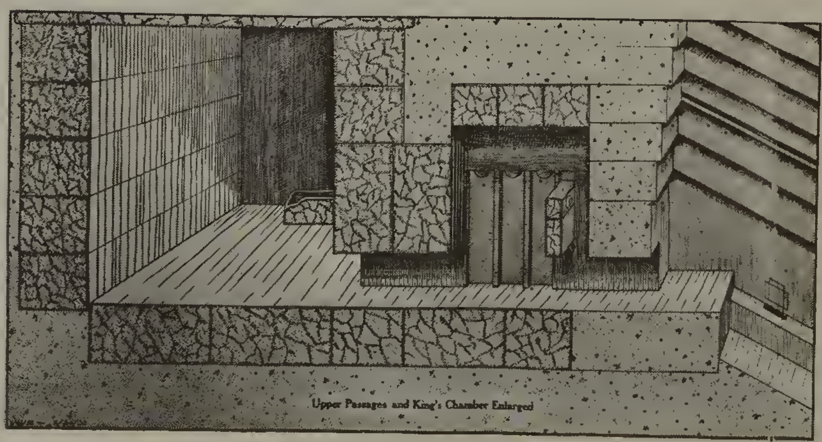
He admitted nevertheless that the Pyramid was "a very stately piece of work, and not inferior, either in respect of the curiosity of art or richness of materials, to the most sumptuous and magnificent buildings." He noted that it was built of polished limestone "very evenly cut in spacious



squares or tables"; and he found that the "coagmentation or knitting" of the joints was so close it was scarcely discernible with the naked eye.

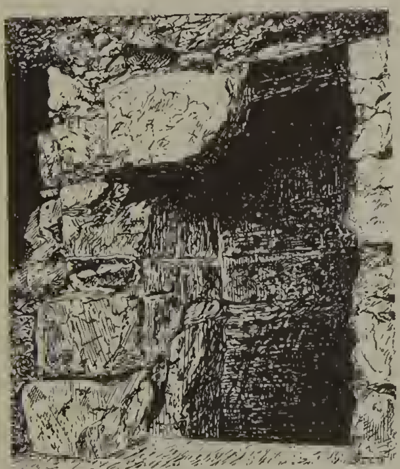
Making his way to the King's Chamber, Greaves was puzzled that so incredibly imposing a structure as the Pyramid should be built around a single chamber with a single empty coffer. He could see no apparent reason for its portcullis entrance or for the complexity of its antechamber where the walls changed mysteriously from limestone to granite. But being a scientist by nature, Greaves set to collecting and noting data about the building.

How the King's Chamber and its Antechamber with its portcullis are entirely cased by granite blocks within the limestone body of the Pyramid.



Entrance to the "well."

In the west wall of the Grand Gallery, not far from the north wall, a small part of the ramp is missing, allowing entry into a shallow pit. At the bottom of this pit a short passage leads westward to an opening in the floor which becomes a shaft.
This shaft descends through the nucleus masonry of the Pyramid and penetrates a rocky core which was left by the builders as an anchor for the Pyramid *above* the level of the foundation pavement.
A grotto opens off the shaft and the shaft passes through several natural fissures in the bedrock.
For many centuries the shaft's terminus was a mystery, as was its purpose.



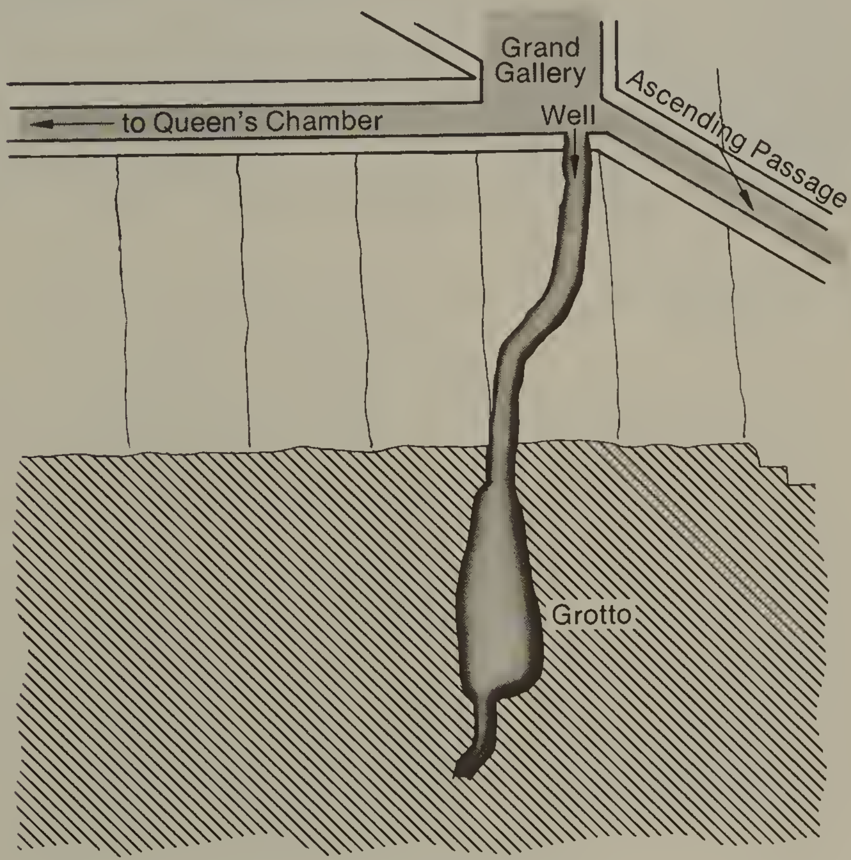
Shaft entrance to the grotto.

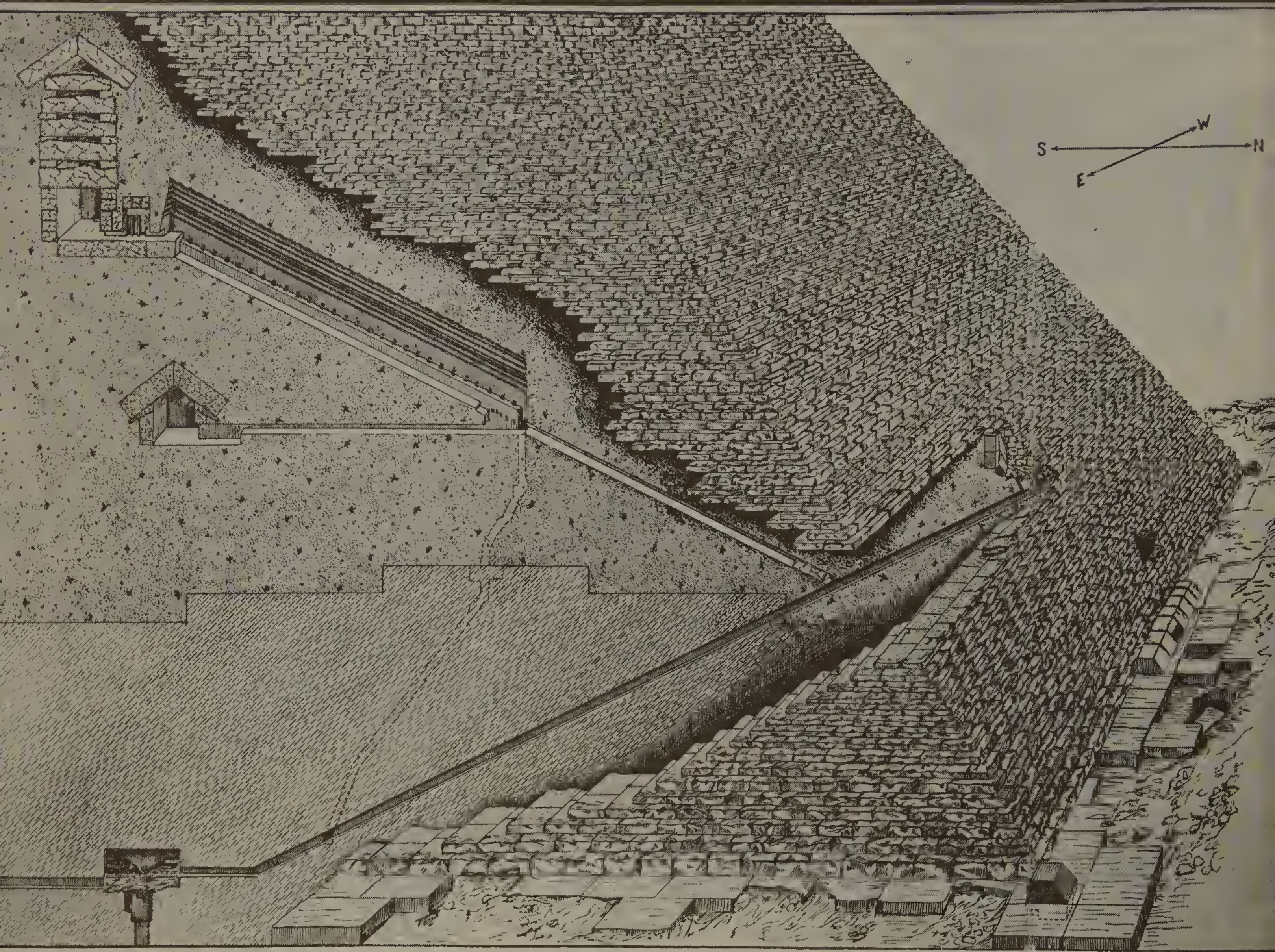
In London Greaves had furnished himself with a special 10-foot measuring rod based on a standard English foot deposited in Guild Hall, finely divided into 10,000 equal parts. With great care he measured the length, breadth and width of the King's Chamber, commenting that "the structure of it hath been the labour of an exquisite hand." He counted its tiers of granite, measured their length and breadth, and did likewise to the empty coffer, "even to the thousandth part of a foot," finding it to be 6.488 English feet.

Picking his way back to the foot of the Grand Gallery, Greaves made a new and startling discovery. From the ramp at one side, a stone block had been forcibly removed and a passage appeared to have been dug straight down into the bowels of the Pyramid.

The aperture was a little over 3 feet wide; but as notches had been carved opposite one another on the sides of this "well," Greaves lowered himself into it and descended about 60 feet, to where the shaft had been enlarged into a small chamber, or "grotto." Below him the shaft continued into the murky darkness, but the air was so foul, and the bats so thick, that Greaves decided to climb back up the way he had entered, puzzled by this strange feature of the Pyramid.

That the well shaft was not bottomless he established by dropping a lighted flare which continued to flicker from its depths.





Chambers and passages in the Great Pyramid.

Outside, Greaves climbed to the top of the Pyramid. From this high point he could admire the minarets of Cairo, the range of Mokattam hills across the Nile, and the silhouettes of the pyramids of Abusir, Saqqara and Dashur to the south.

On his way down Greaves was the first to make a reasonable count of the Pyramid's visible tiers of chiseled blocks, which he figured to be 207, estimating the total height of the structure to be 481 feet, or 499 with the missing capstone. This was within a dozen feet of being correct.

As a length for the base, Greaves estimated 693 feet, which was short of the mark by some 70 feet: but the base was so littered with rubbish that he had no way of telling where the first tier might rise from the hidden base.

Back in England Greaves was rewarded for his efforts at the Pyramid by being appointed Savilian Professor of

Pyramidographia:

OR, A

DESCRIPTION

OF THE

PYRAMIDS

IN

ÆGYPT.

By JOHN GREAVES, *Profeſſor of Aſtronomy in the Univerſity of* Oxford.

Romanorum Fabricæ & antiqua opera (cum veniâ id dictum ſit) nihil accedunt ad Pyramidum ſplendorem, & ſuperbiam.
Bellon. lib. II. Obſerv. cap. 42.

Astronomy at Oxford. All the facts and figures Greaves had accumulated he meticulously wrote up in a scholarly booklet entitled *Pyramidographia.*

His conclusions led to a very lively discussion—with as much con as pro—in which even the celebrated Dr. William Harvey, discoverer of the circulation of blood, took part. Harvey was surprised that Greaves had not described, or apparently even discovered, any conduits by means of which the central chambers in the Pyramid could be ventilated from the exterior. According to Harvey such conduits were bound to have existed, or the air in the King's Chamber would have become extremely foul—"Seeing we never breathe the same air twice, but still new air is required to a new inspiration (the succus alibilis of it being spent in every expiration)." Harvey's surmise turned out to be true, but was not established for another two generations.

Greaves had indeed noted "two inlets or spaces, in the south and north sides of the chamber, just opposite from one another," but attributed the blackness within them to their being receptacles for burning lamps.

Before returning to England, Greaves had left his instruments, including the special 10-foot rod, to a young Venetian whom he had met in Egypt and who had accompanied him to the Pyramid, Tito Livio Burattini, who who was as anxious as Greaves to find out not only the exact measurements of the Pyramid, but the unit—whether cubit, foot or palm—on which it had originally been designed.

Burattini's trip to Egypt had been subsidized by the Jesuit Father Athanasius Kircher of Cracow, Poland, who had moved to Rome and entered into correspondence with Galileo Galilei on the subject of a universal standard of measure.

At that time Galileo was living in seclusion near Florence, having been tried and imprisoned by the Inquisition for supporting the Copernican belief that the earth and the planets revolved round the sun, and the equally heretical conceit that the earth and the sun spun on their own axes.

As a young man Galileo had timed the oscillations of a lamp swinging in the Duomo of Pisa by means of his pulse beats and found the time for each swing to be the same, no matter what the amplitude of the oscillation, thus discovering what is known as the isochronism of the pendulum.

Developing Galileo's idea, Burattini had tried to obtain a universal standard of measure by using the length of a pendulum that would vibrate exactly 3600 times in one hour, or once every second, but the gold-ball pendulum he devised proved impractical because it was found that its swing varied with temperature, location, and altitude above sea level.

Burattini lingered four years in Egypt taking careful measurements with Greaves's instruments, and he sent reports of the results to Father Kircher by letter, which was lucky for the scientific world: on Burattini's journey through the Balkans back to his adopted Poland he was set upon by bandits and deprived of not only his cash but all his notes on the Pyramid which he intended to have printed as a book in Italy.

There remained the data which he had sent to Father Kircher; but it was from Greaves's data that Sir Isaac Newton deduced that the Great Pyramid had been built on the basis of two different cubits, one of which he called "profane" and the other which he called "sacred." From Greaves's and Burattini's measurements of the King's

Sir Isaac Newton is described by Giorgio de Santillana, of MIT, as "the last of the magicians, the last of the Babylonians and Sumerians, the last great mind which looked on the visible world with the same eyes as those who began to build our intellectual world rather less than 10,000 years ago."

Chamber, Newton computed that a cubit of 20.63 British inches produced a room with an even length of cubits: 20 × 10. This cubit Newton called the "profane," or Memphis, cubit; whereas a longer, more arcane cubit appeared to measure about 25 British inches.

This longer, or "sacred," cubit Newton derived from the Jewish historian Josephus's description of the circumference of the pillars of the Temple at Jerusalem. Newton estimated this cubit to be between 24.80 and 25.02 English inches, but believed the figure could be refined through further measurement of the Great Pyramid and other ancient buildings.

All of this Newton wrote up in a small and now hard-to-find paper called *A Dissertation upon the Sacred Cubit of the Jews and the Cubits of several Nations: in which, from the Dimensions of the Greatest Pyramid, as taken by Mr. John Greaves, the ancient Cubit of Memphis is determined.*

Newton's preoccupation with establishing the cubit of the ancient Egyptians was no idle curiosity, nor just a desire to find a universal standard of measure; his general theory of gravitation, which he had not yet announced, was dependent on an accurate knowledge of the circumference of the earth. All he had to go on were the old figures of Eratosthenes and his followers, and on their figures his theory did not work out accurately.

By establishing the cubit of the ancient Egyptians, Newton hoped to find the exact length of their stadium, reputed by classical authors to bear a relation to a geographical degree, and this he believed to be somehow enshrined in the proportions of the Great Pyramid.

Unfortunately Greaves's and Burattini's measurements of the *base* of the Pyramid were incorrect because of the accumulated debris, and though Newton's figure for the cubit was very close to perfect, the false measurements of the base failed to give him the answer he was searching.

To resolve Newton's problem, Burattini suggested taking the actual measure of two or three degrees of latitude across the flat countryside of Poland; but the operation proved too costly. Unfortunately, neither Newton nor Burattini knew that in 1635 Richard Norwood, author of *Sea-Man's Practice,* had made an observation of the sun at noon at York using a sextant more than 5 feet in radius, and a similar observation in London near the Tower; the distance between the two points was 9149 chains, and he thus obtained a figure of 69.5 English statute miles for 1° of latitude. This figure would have solved Newton's problem, but because of the political unrest in Cromwellian England he did not hear of it; so he put away his theory of gravitation for several more years, or until the French astronomer Jean Picard repeated Norwood's feat with rather more fanfare.

In 1671 Picard measured a degree of latitude between Amiens and Malvoisine. His method was to measure a base line at Amiens very meticulously with wooden rods, then measure the angles formed by this base line with a point on the horizon and deduce its distance by trigonometry. Selecting a series of points on hilltops easily distinguished with a telescope and measuring only the angles between their sides, he was able to string out a series of thirteen large triangles across the countryside and obtain a very accurate degree of 69.1 English statute miles.

On the basis of this computation Newton was able to announce his general theory of gravitation—that all bodies in the universe attract each other in proportion to the product of their mass and inversely as the square of their distance apart—and so launch a new era of physics.

As the English poet Alfred Noyes summed up the event:

> . . . Newton withheld his hope
> Until that day when light was brought from France,
> New light, new hope, in one small glistening fact . . .
> Picard in France—all glory to her name—
> Had measured earth's diameter once more
> With exquisite precision . . .

But all this Anglo-Gallic dalliance was short-lived because an argument developed between Newton and a French family of astronomers, map makers, and surveyors called Cassini. Newton figured that the centrifugal force of the globe spinning on its north-south axis would cause the earth to bulge at the equator and be slightly flattened at the poles.

In his *Principia* Newton estimated that this would have the effect of making a degree of latitude longer nearer the poles and shorter nearer the equator.

The theory was heatedly opposed by the Cassinis, who had extended Picard's triangulation survey north to Dunkirk and south to Perpignan on the Spanish border, and maintained that the earth was elongated like an egg, as depicted in Ptolemaic Egypt: that the degree of latitude was *shorter* north of Paris.

To settle the argument the French Academy of Sciences sent out two expeditions, one to Lapland to measure an actual degree near the Arctic Circle and another to Peru to measure a degree near the equator.

After 18 months of being frozen in winter and devoured by mosquitoes in summer, the expedition to Lapland returned with a figure that showed a degree of latitude was *longer* near the flattened Pole. The Peruvian expedition suffered

The Great Sphinx lies about twelve hundred feet southeast of the Pyramid of Cheops near the valley building of Kephren. Carved from a single sandstone knoll, the colossus is 240 feet long, 66 feet high, and 13 feet 8 inches at its widest.
The headdress and the cobra on the forehead are said to have been symbols of royalty; the features are thought to resemble those of Kephren.
At one time the Sphinx may have been coated with plaster and painted in various colors.
A rational explanation of the mystery of the Sphinx was produced by the British astronomer Sir Norman Lockyer, who said that its being half lion, half virgin symbolizes the junction of the constellations Leo and Virgo which occurred at a summer solstice in the fourth millennium B.C.

even worse conditions, measuring from mountaintop to mountaintop in the Andean highlands, but after ten years of misery, came back with a similar conclusion that the degree was shorter at the equator, vindicating Newton: the Peruvian degree measured 56,734 French *toises*, the Paris degree was 226 *toises* longer, and the Lapland degree 362 *toises* longer still.*

Cassini, who very sensibly proposed the adoption of a geodetic foot representing 1/6000th part of a terrestrial minute of arc, would have been astounded had he known that just such a foot had been in existence for several millennia and that the Sphinx, which could be used as a geodetic marker to indicate the equinox, also once had an obelisk between its paws whose shadow could be used to compute not only the correct circumference of the earth but the variance in the degree of latitude.

But in all this geodetic enterprise the Pyramid's geodetic values were forgotten; its secrets remained as enigmatic as those of its neighbor the Sphinx, which by this time was almost obliterated in the accumulation of wind-blown sand from the Libyan desert.

* The *toise*, or double arm's length, was the standard of measure used by the French before the development of the meter.

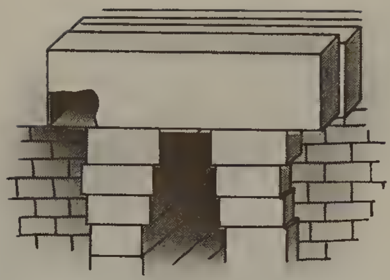
IV. THE AGE OF ENLIGHTENMENT

Travel to the Giza plateau became a dangerous undertaking in the eighteenth century. Though Egypt was still nominally under the suzerainty of the Ottoman Turks, the traveler was likely to be robbed or killed by gangs of bandit Arabs unless protected by a bodyguard of friendly Janissaries such as had accompanied Greaves.

Not until the time of the American Revolution was any further discovery of importance made at the Pyramid. In 1765, Nathaniel Davison, who was later British Consul General in Algeria, was able to spend a vacation in Egypt in the company of Edward Wortley Montagu, former British ambassador to the Sublime Porte, and carefully explore the Pyramid.

More intrepid than Greaves, Davison lowered a lamp into the "well," tied a rope round his waist, and had himself carefully lowered into its ominous darkness, about a hundred feet farther than Greaves, only to find the bottom blocked with sand and rubbish. To Davison it appeared strange that anyone should go to such an enormous amount of effort to dig a shaft almost 200 feet into the heart of the Pyramid and simply come to a dead end. But there was nothing more he could do. It was extremely close and filthy at the bottom of the "well," and his candle soon burnt up what little air was available. Also, an immense number of huge bats made it difficult for Davison to keep his candle alight; so he laboriously made his way back to the surface.

Abandoning this quest, Davison set about finding any other secret features within the interior of the Pyramid. At the top of the Grand Gallery he noted that his voice was answered in a curious way by repeated echoes which appeared to resonate from somewhere above him.



Davison's hole at the top of the Grand Gallery.

Placing a candle at the end of two long canes, Davison was able to spot a small rectangular hole about 2 feet wide at the very top of the Grand Gallery, where its wall joined the ceiling.

To reach this hole was a precarious ordeal: the walls of the gallery were polished and slippery; the perch upon which he had to place his ladder was extremely small and stood high above a yawning drop of 150 feet, all the way down the Grand Gallery. Nevertheless Davison managed to raise seven short ladders till the topmost reached the small rectangular hole.

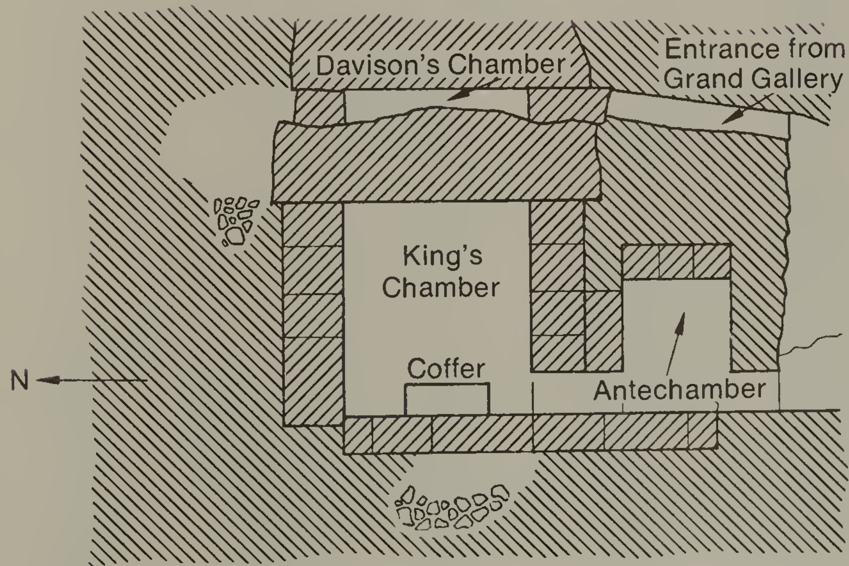
Davison climbed this rickety echeloning with difficulty. At the top he found that he was prevented from entering the 2-foot hole by some 16 inches of bat dung, which had accumulated through the centuries.

Masking his face with a kerchief, Davison managed to wedge himself into the stifling passage and crawl 25 feet to a chamber not high enough to stand in, but every bit as wide and as long as the King's Chamber below it.

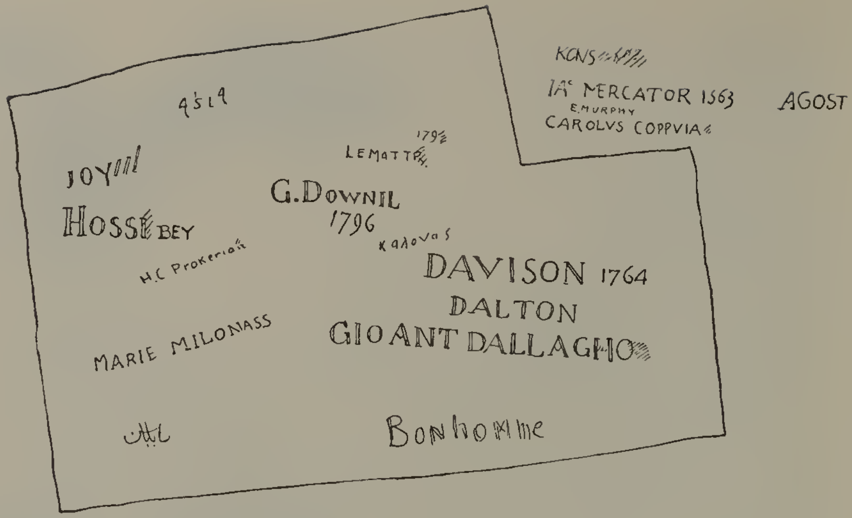
Beneath the bat dung Davison was able to make out a floor consisting of the tops of nine rough-hewn monolithic granite slabs, each weighing up to 70 tons, or as much as a modern railway engine. The under sides of these slabs formed the ceiling of the King's Chamber. To Davison's amazement, the low flat ceiling of the chamber was also constructed of another similar row of granite monoliths.

Otherwise, Davison could find nothing of either historical or architectural interest: no treasure, no inscription, no sign of any further passage. His sole reward was to carve his

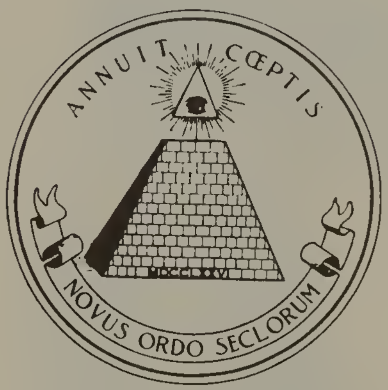
Three distinct types of Egyptian bats as depicted in the eighteenth century. The bats found by Greaves in the Great Pyramid were over a foot long, with an even greater wingspread. Of the more than a thousand known varieties of these curious nocturnal mammals the "flying foxes" of Australia have a wing-spread of up to 5 feet.



Davison's Chamber above the King's Chamber.



Davison's and other graffiti in the Great Pyramid, including that of Mercator, the Flemish cartographer.



Reverse of the seal of the United States of America. According to Manly P. Hall, an expert on Masonic lore, not only were many of the founders of the U.S. government Masons, but they received aid from a secret and august body existing in Europe, which helped them to establish the United States for "a peculiar and particular purpose known only to the initiated few." The Great Seal, says Hall, was the signature of this exalted body, and the unfinished pyramid on its reverse side "is a trestleboard setting forth symbolically the task to the accomplishment of which the U.S. Government was dedicated from the day of its inception." The eagle was apparently intended to represent a phoenix, or symbol of the immortality of the human soul. Great currency has been given to the pyramid and phoenix symbols by placing them upon a one dollar bill.

graffito on the wall and to have the newly discovered chamber named Davison's Chamber in his honor.

When the American Revolution was followed by the French, and Napoleon set out to spread his political doctrines of Free Masonry, interest was rekindled in the Pyramid.

The American revolutionaries had already gone so far as to adopt the ancient Masonic symbol of the Pyramid for the reverse of the Great Seal of the United States.

In their own revolutionary housecleaning, the French outlawed the biblical seven-day week and reverted to the decades of the ancient Egyptians. The *sans-culottes* replaced the old holidays with feast days celebrating Nature and the Supreme Being, the Human Race, the Martyrs of Liberty, Truth, Justice, Paternal Tenderness, Conjugal Faith and even Misfortune. To replace the archaic *toise* made up of six *pied de roi,* the new academicians remeasured the arc from Dunkirk to Perpignan and adopted as a decimal unit the meter, which they computed to be exactly one ten-millionth of the Paris meridian from pole to equator.

On the last day of the month of Floreal in the IXth year of the revolution—our May 19, 1798—General Bonaparte, a sallow little man of 29, set sail from Toulon with a force of 35,000 soldiers crammed into 328 vessels, to conquer Egypt as a steppingstone to India and world domination. Bored by the company of his fellow officers, Napoleon spent most of his time with an extraordinary collection of erudite French civilians classified as "savants." He had brought them along because they were reputed to have acquired a profound knowledge of Egyptian antiquities despite the fact that no one had yet deciphered Egyptian hieroglyphics, so that very little was known of Egypt's remote antiquity.

These savants, a hundred and seventy-five of whom were scattered throughout the fleet, were treated with something less than respect by Napoleon's lower ranks, who were convinced that the "graybeards" had been brought along solely to help locate and dig up hidden treasure. Once the learned gentlemen had landed in Egypt, where their function was to "civilize the natives," they were issued no rations or billets, and whenever the French came under attack from the Mameluke forces of Murad Bey, Napoleon's soldiers would form their famous squares and shout "savants and asses to the center."

Not that the savants ran any real risk. When the French reached the Great Pyramid and were attacked by 10,000 Mameluke horsemen armed with glittering yagatans under the command of Murad himself, in a brilliant green turban astride a snow-white charger, the slaughter consisted entirely of the intrepid Mamelukes. Renowned for having withstood the hordes of Genghis Khan, they were no match for the French sharpshooters and cannoneers.

In two hours two thousand Mamelukes were killed for two score Frenchmen.

Mameluke Beys and their horsemen were mostly converted Christian slaves like the Janissaries and Pages of the Sublime Porte, trained to police, tax, and control Egypt under the nominal suzerainty of the Ottoman Sultan.

In 1811 the Mamelukes were destroyed in one of the foulest but most successful ambushes in history. May 1 they were invited to a feast by Mohammed Ali, the Greek-born adventurer who governed Egypt for the Turks. Dressed in their finery, on richly caparisoned horses, 420 Mameluke Beys arrived at the citadel. Once they were crowded into the narrow street, Mohammed Ali's Albanian mercenaries opened fire from rooftops and windows with rifle and cannon. The Mamelukes screamed, their horses neighed, the street ran with blood. In half an hour all the Mamelukes were dead with the exception of Amir-bey whose horse is reputed to have leapt from the battlements and carried him safely to Syria.

Bonaparte's general staff arriving at the Great Pyramid.

Napoleon Bonaparte before the Battle of the Pyramids.

Murad Bey, whose Mameluke forces were defeated.

July 12, 1798, in the shadow of the pyramids of Giza, some 25,000 Frenchmen, demoralized, hungry, and sleepy from a ten-hour march, were ordered by Napoleon to face what he overestimated to be 78,000 Egyptians, including 12,000 mounted Mamelukes in multicolored turbans and gold-embroidered caftans that floated like gauze. The French formed into squares, ten soldiers deep, their cannons (and savants) in the center. With remarkable discipline the French held their fire till Murad Bey's cavalry were upon them. The Mamelukes outdid themselves in bravery, slashing through the barrels of the Frenchmen's rifles with their scimitars, but in vain. In two hours the squares were surrounded by corpses, the Battle of the Pyramids was over, and Napoleon was master of Egypt. As the flames from the Egyptian fleet illumined Cairo's minarets, Napoleon's men feasted on hoards of captured sweetmeats and looted the gold-laden bodies of the Mamelukes, dumping them into the Nile to float seaward the news of the Egyptian defeat.

The discoveries of the savants within the Pyramid were not sensational, mostly because of the hindrance of bats, which had greatly increased since the time of Davison.

Edmé-François Jomard, one of the younger but more astute of the savants, described the painful process of moving through the passages bent double, seared by the heat of the torches, stifled by lack of air, and sweating profusely from the effort.

Colonel Jean Marie Joseph Coutelle, a military member of the expedition, made another exploration of the well, but complained of being attacked by clouds of infuriated bats, "who scratched with their claws and stifled with the acrid stench of their bodies."

Discharging their pistols at the top of the Grand Gallery, the French were astonished at the repeated echo which sounded like thunder moving away into the distance.

In Davison's Chamber the accumulation of bat dung had risen to 28 centimeters. The savants retired without further contribution to the problem of the Pyramid's interior.

Outside, the savants were more successful. Jomard dogtrotted round the Pyramid, appalled by the amount of sand and debris which had accumulated on its flanks.

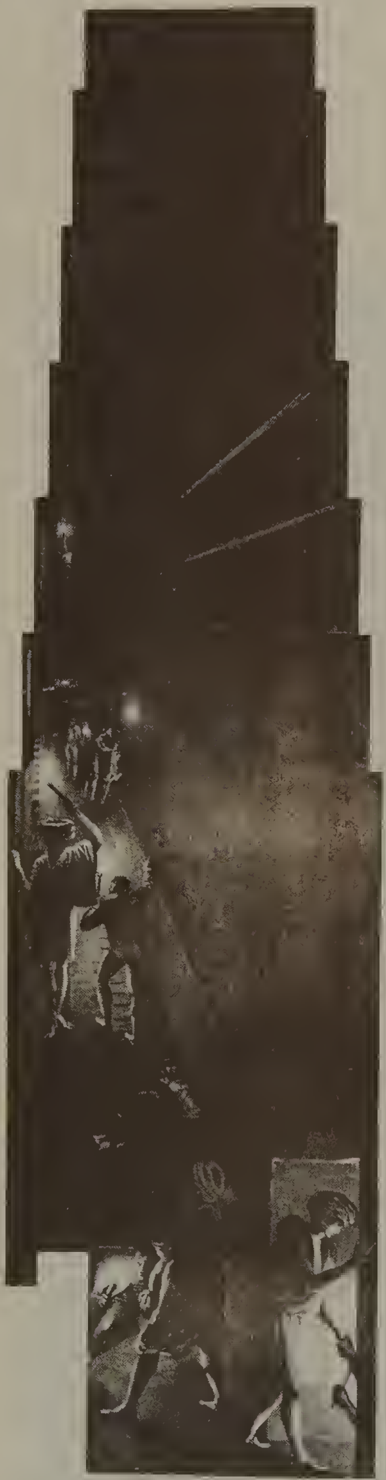
With the help of 150 Ottoman Turks, the French were able to clear the northeast and northwest corners of the building and make an important discovery.

They found the "esplanade" on which the Pyramid had originally been established, as well as two shallow rectangular "encastrements," or sockets, 10 feet by 12, hollowed some 20 inches into the base rock, quite level with each other, where the original cornerstones had once been laid.

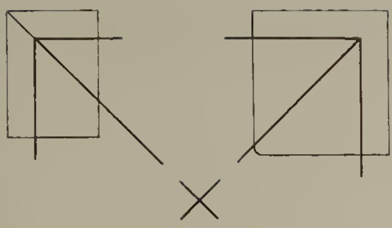
These gave the savants two firm points from which to measure the base of the Pyramid. Though the huge mounds of debris all along the north face of the structure still impeded their efforts, Jomard was able to make a series of measurements up and down and around. These gave a length for the base of 230.902 meters, or 757.5 English feet. The French now needed to know the height.

Jomard took almost an hour to climb the Pyramid, stopping on the way for breath. Once he reached the summit, his imagination was exalted by the view of the green Delta to the north, the black strip of fertile earth along the Nile, the wavelike dunes to the west. Arab villages looked like anthills on the horizon; men at the base of the Pyramid were barely distinguishable.

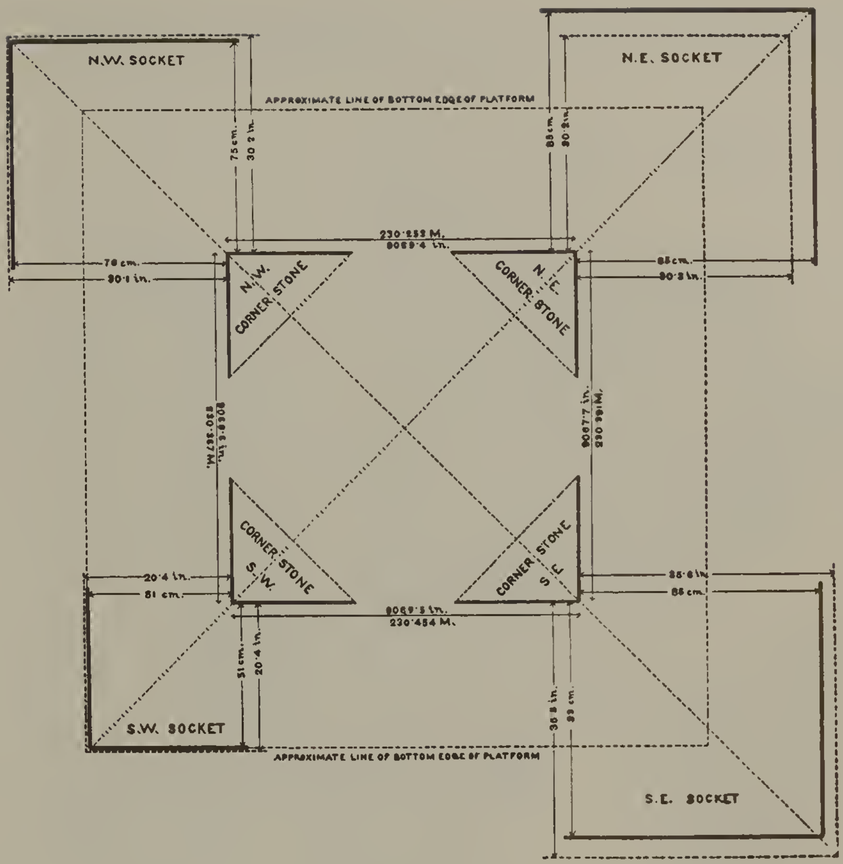
With a slingshot Jomard tried to hurl a stone far enough to clear the base, but in vain. Not even the Arabs had been able to shoot an arrow from the summit that would clear the footing.

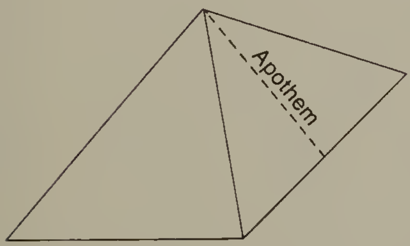


Jomard, Coutelle and Le Père exploring the Grand Gallery.



The positions of the sockets.





To obtain a height of the Pyramid, Jomard measured down each step, for a total of 144 meters, or 481 feet. By elemental trigonometry this gave him an angle for the slope of 51° 19′ 14″ and an apothem of 184.722 meters.

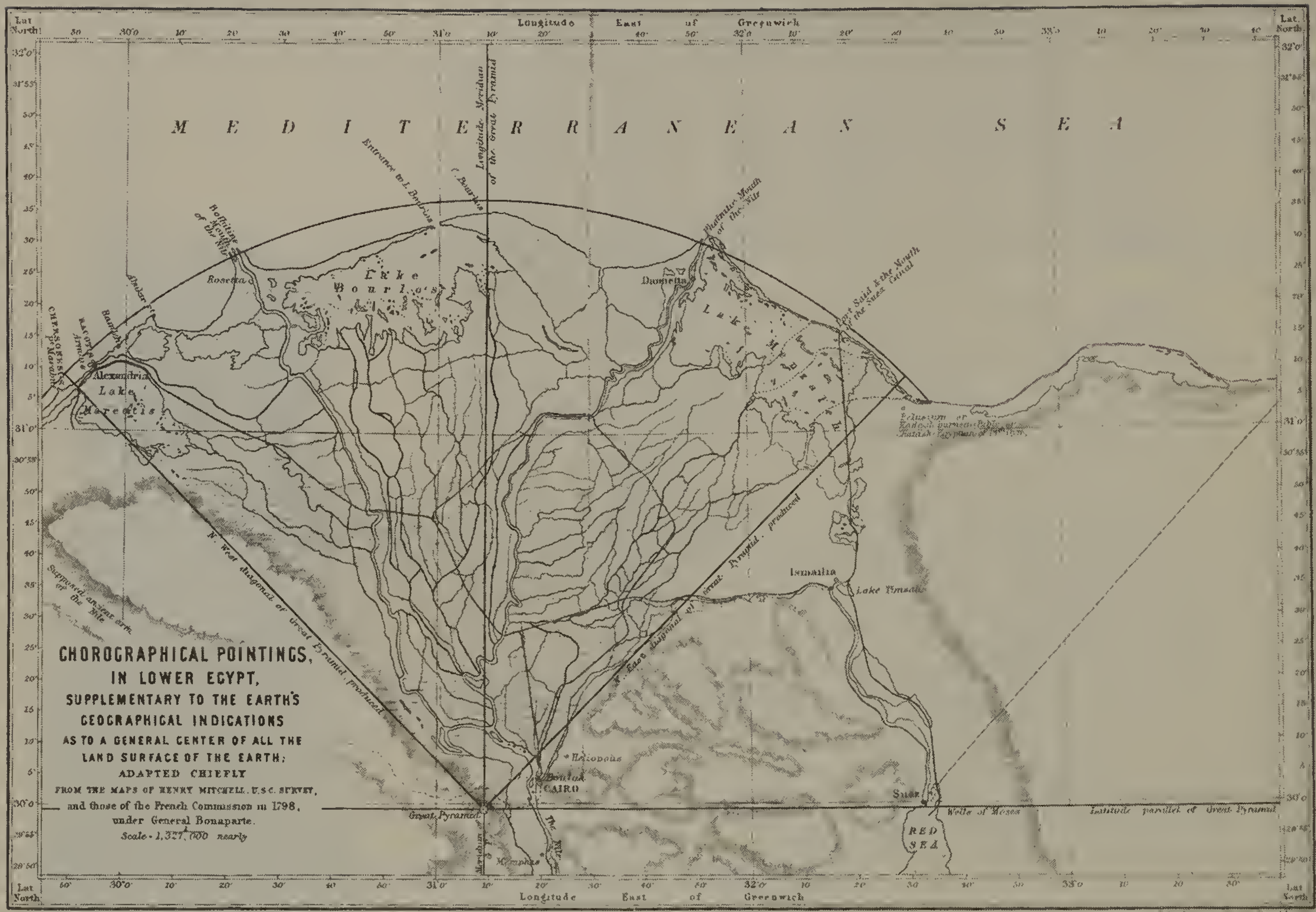
The apothem is the slant height of the Pyramid, or line from apex to center of each base, down which a raindrop would run as the shortest distance to the ground.

Because the outer casing was entirely missing there was no way to know just how thick it had been: so the measure for the apothem had to be an estimate; but the figure of 184.722 meters was to open up a whole new vista for Jomard, who was a very well-read young man.

Jomard remembered that according to Diodorus Siculus and Strabo, the apothem of the Pyramid was supposed to be one stadium long. He also knew that an Olympic stadium of 600 Greek feet—from which our modern stadium is derived—was a basic unit of land measure in the ancient world, one which was said to be related to the size of the earth.

Searching further through the trunks full of classics which the savants had brought to Egypt, Jomard found that the stadium of the Alexandrine Greeks (of Eratosthenes and Hipparchus) had been the equivalent of 185.5 meters—which was within a meter of what he had found for the apothem.

To reinforce the point, Jomard discovered that the



Bonaparte's surveyors found that the Pyramid was accurately oriented to the four cardinal points of the compass and therefore used the meridian running through its apex as the base line for their measurements.

Having mapped Lower Egypt, they were surprised to find that this meridian neatly cut the Delta region into two equal portions, and were even more surprised when they found that the diagonals drawn through the Pyramid, at right angles to each other, completely enclosed the entire Delta.

Evidently a structure which could serve as such a perfect geodetic benchmark could not have been located at random, and without considerable proficiency in astronomy, as well as a developed understanding of the configuration of the planet.

distance between the Egyptian localities as measured by Napoleon's surveyors also coincided with the classical distances between these localities computed in stadia, if the stadium was taken to be 185 meters.

Finally, Jomard learnt from his perusal of the classics that a stadium of 600 feet was considered to be 1/600 of a geographical degree.

Jomard calculated that a geographical degree at the mean latitude of Egypt was 110,827.68 meters. Dividing this figure by 600 resulted in a measure of 184.712 meters. This was within 10 centimeters of his value for the apothem.*

Could the Egyptians, Jomard wondered, have been capable of working out their basic units of measure—such as the stadium, the cubit, and the foot—from the size of the earth and then built this knowledge into the Pyramid?

To reinforce this exciting hypothesis Jomard found that several Greek authors reported that the perimeter of the base

* At Syene the degree of longitude is 110,791.11. At Alexandria it is 110,892.66. The mean for the whole planet is 111,111.9. Jomard took the mean for Egypt.

of the Pyramid was intended to measure half a minute of longitude. In other words, 480 times the base of the Pyramid was equal to a geographical degree.

Jomard took the 110,827-meter degree and divided it by 480. The result was 230.8 meters, or again within 10 centimeters of his measured length of the base.

To find the length of the cubit that would fit these measures, Jomard again consulted the classics. According to Herodotus 400 cubits made a stadium of 600 ft. Jomard divided the apothem of the Pyramid by 400 and obtained a cubit of .4618 meter. To his surprise this turned out to be the common cubit of the modern Egyptians.

According to other Greek sources the base of the Pyramid was said to be 500 cubits. Multiplying his .4618 meter cubit by 500, Jomard got 230.90 meters—which was just what he had measured for the base.

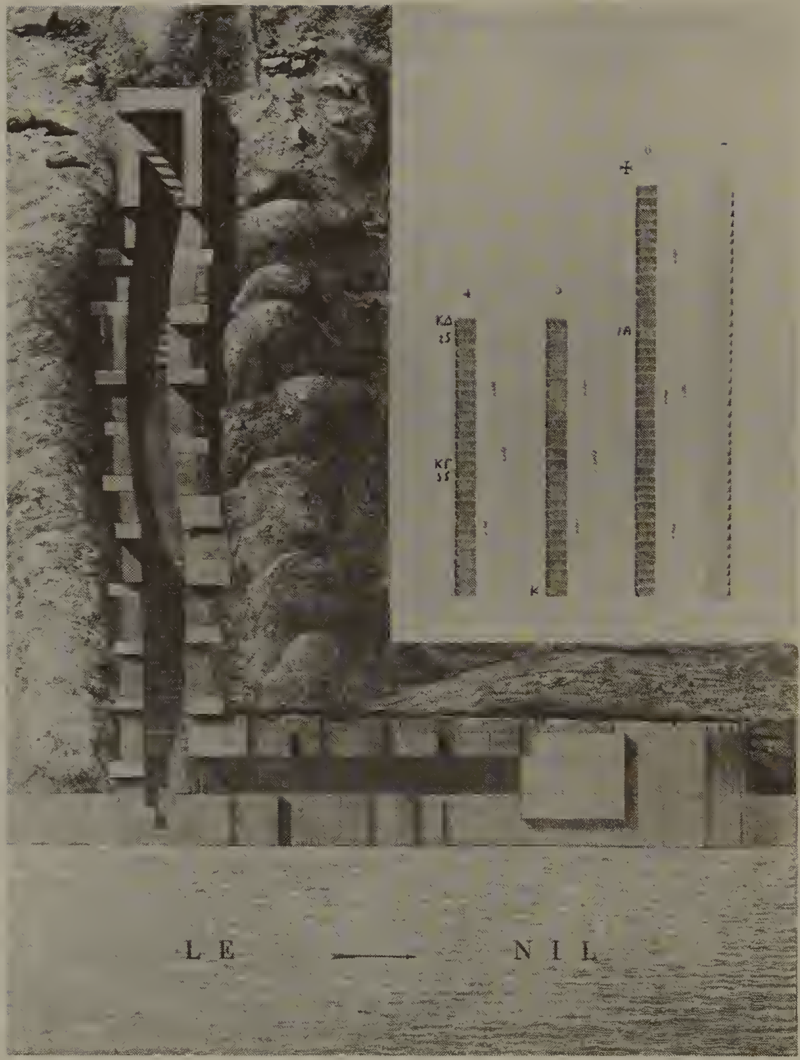
Jomard's theory was impressive to his colleagues; but when Gratien Le Père and Colonel Coutelle *re*-measured the base of the Pyramid, they found it to be 2 meters longer. They also *re*-measured the height with a specially designed instrument, step by step, and the results showed Jomard's angle of incline to have been too low, and his apothem consequently too short.

In vain Jomard argued that he had found an even more surprising coincidence in that the four-hundredth part of his base of the Pyramid gave a figure of .5773 meter, which was exactly the length of a longer modern Egyptian cubit called the *pyk belady*.

Jomard's colleagues insisted there was no evidence in any other ancient Egyptian building of the use of such odd cubits and that the only adequate cubit they had found was the one marked on the nilometer of Elephantine, which was nearly the same as the "royal" cubit of Memphis of .524 meter, or 20.63 inches, which Newton had derived from the dimensions of the King's Chamber.

Unperturbed, Jomard continued his observations. It seemed to him that from the bottom of the Descending Passage, the ancients might have been able to see the transit across the meridian of some circumpolar star, and thus have previously established true north and correctly oriented the building. Because of the length and narrowness of the passage, he said, they might even have been able to see such a star by daylight. His colleagues argued that the trap door would have prevented any such observation.

Jomard suggested that the King's Chamber, with its empty sarcophagus, might not necessarily have been a tomb but a metric monument, designed to embody, and perpetuate, a system of measures.



Nilometer discovered by the French at Elephantine, near Syene, used by the Egyptians for measuring the rise of the Nile at flood time, and marked in cubits very close to the royal cubit of Memphis.

To the end, Jomard remained convinced that the builders of the Pyramid had the necessary astronomical know-how to measure a geographical degree and thus the true circumference of the earth, and had developed an advanced science of geography and geodesy which they had immortalized in the geometry of the Great Pyramid.

Jomard pointed out that Herodotus, Plato, Diodorus and many others had all named Egypt as the birthplace of geometry, that Solon as well as Plato had come to Egypt to study geometry, and that Pythagoras had learnt from the Egyptians his theorems of geometry, his art of calculation, and his doctrine of metempsychosis.

Jomard's classically indoctrinated colleagues could not stomach the idea that their cherished Greeks might not be the founders of geometry; so the pursuit was dropped.

One last boost to Jomard's theory was given by one of Napoleon's favorite generals, Louis Charles Antoine Desaix: on his way up the Nile to conquer Upper Egypt, the 29-year-old general found a gorgeous temple near Thebes half

Edmé-François Jomard.

buried in the sand. On its ceiling was a circular zodiac. Because the zodiac clearly depicted the skies over Egypt and showed the recognizable constellations in quite different positions, the savants deduced that it must have represented the skies many centuries in the past and that the ancient Egyptians must have been acquainted with the zodiacal constellations in remote antiquity.

Unfortunately, an inscription also found in the temple appeared to date it from Ptolemaic times, shortly before our era; so another of Jomard's balloons was pricked.

Meanwhile Napoleon, whose logistical mind enabled him to figure that the Great Pyramid and its Giza neighbors contained enough stone to build a wall 3 meters high and one meter thick all around France, had become attracted by the arcane qualities of the King's Chamber.

On the twenty-fifth of Thermidor (the Revolutionaries' August 12, 1799) the General-in-Chief visited the Pyramid with the Imam Muhammed as his guide; at a certain point Bonaparte asked to be left alone in the King's Chamber,

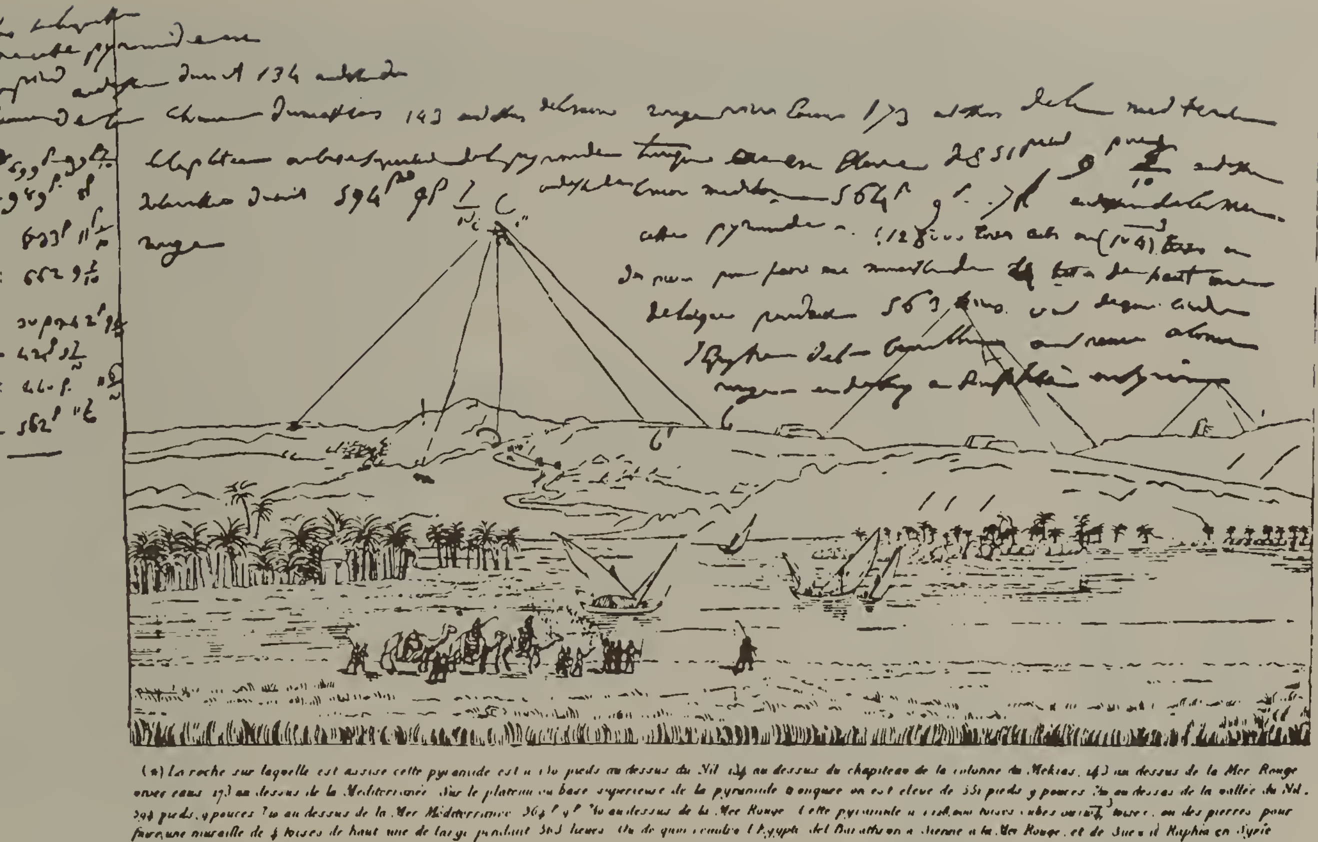
Napoleon in the King's Chamber.

as Alexander the Great was reported to have done before him.

Coming out, the general is said to have been very pale and impressed. When an aide asked him in a jocular tone if he had witnessed anything mysterious, Bonaparte replied abruptly that he had no comment, adding in a gentler voice that he never wanted the incident mentioned again.

Many years later, when he was emperor, Napoleon continued to refuse to speak of this strange occurrence in the Pyramid, merely hinting that he had received some presage of his destiny. At St. Helena, just before the end, he seems to have been on the point of confiding to Las Cases, but instead shook his head, saying, "No. What's the use. You'd never believe me."

When military and political priorities obliged Napoleon to pull out of Egypt, he abandoned his savants to be captured by the British. Chivalrously treated as civilians, they were allowed to return to France with their notes and drawings. By the time they got home Napoleon had gained sufficient power as First Consul to order them to produce a truly monumental work on all they had discovered about the sites, buildings, inscriptions, life, language and manners of the ancient and modern Egyptians. With the help of an army of painters, typographers and four hundred engravers, the study was completed and published over a period of 25 years



Napoleon's notes on his sketch of the Pyramid.

with the title, *Description de l'Egypte ou Recueil des observations et des recherches qui ont été faites en Egypte pendant l'expédition de l'armée française.*

The work ran to nine folio volumes of text and twelve of plates, and was described as "the most immortal conception and glorious performance of a book ever realized by man." Jomard contributed to it brilliantly, but his perspicacious thesis received little credit.

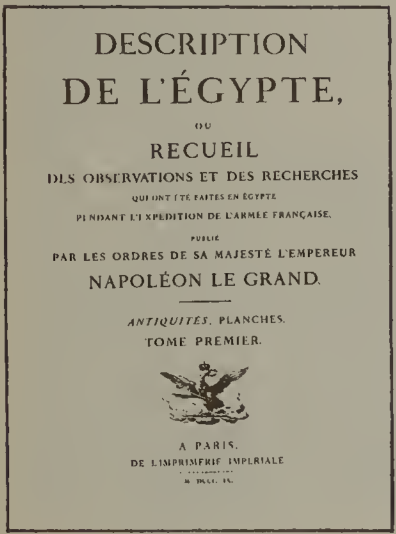
The savants were scooped by the wily Baron Vivant Denon, who brought out two volumes of the etchings he had made during the campaign in Egypt. His *Voyage dans la basse et la haute Egypte* became an instant best seller, stunning Europe with incredible sights of an unknown world of Egypt both ancient and modern, and launching a great vogue for the style known as *Empire.*

Denon's publication and the *Description de l'Egypte* which followed it piecemeal were to turn what had been a French military disaster into a cultural triumph. They also shattered once and for all the figment that before the Homeric Greeks there had been nothing but primitive barbarism.

Scientifically the most sensational discovery made by the French in Egypt proved to be a 3-foot diorite slab engraved with hieroglyphics found by a Captain Bouchard in a branch of the Delta near Rosetta. Hijacked by the British, the

SALAHIEH
EL ARICH
GAZA
NAZARETH
ABOUKIR
N

Frontispiece for the twenty-one volume *Description de l'Egypte,* bearing Napoleon's imperial crown, and showing a composite picture of the principal monuments described by the French.


DESCRIPTION

DE L'ÉGYPTE,

OU

RECUEIL

DES OBSERVATIONS ET DES RECHERCHES

QUI ONT ÉTÉ FAITES EN ÉGYPTE

PENDANT L'EXPÉDITION DE L'ARMÉE FRANÇAISE,

PUBLIÉ

PAR LES ORDRES DE SA MAJESTÉ L'EMPEREUR

NAPOLÉON LE GRAND.

ANTIQUITÉS, PLANCHES.

TOME PREMIER.

A PARIS.

DE L'IMPRIMERIE IMPÉRIALE

Dominique Vivant Denon accompanied Napoleon on his expedition to Egypt and produced a series of drawings and etchings of the land of the Pharaohs which revealed a whole new world to an amazed Europe.

Born an aristocrat and renowned mostly for a series of pornographic etchings, Denon managed to ingratiate himself with the revolutionaries and escape execution. Hypnotically attractive to women, Denon was befriended by such notables as Madame de Pompadour and Catherine II of Russia. He was introduced to Napoleon by his wife Josephine.

In Egypt Denon would ride ahead of the French columns, sometimes under fire, to catch the vivid scenes of action. Sketching directly from the saddle, in which he had been for as many as sixteen hours, his eyelids ripped by the windblown sand, and seeing through a veil of blood, Denon managed to reproduce the most evocative scenes of Egypt, ancient and modern, full of verve and an exquisite sense of composition.

Brought up to think that Greek architecture of the best period was *the* standard of beauty, he was seized by the extraordinary beauty of the Egyptian works "with no extraneous ornaments or superfluity of lines." His two-volume illustrated description of Bonaparte's campaign in Egypt was an instant bestseller in Europe.

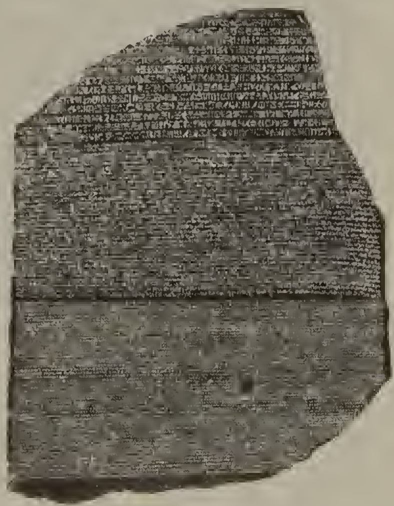
Denon was made a baron by his emperor and became superintendent of the Louvre and director of the Beaux Arts.

Nubians drawn by Denon in 1799.

Denon making a sketch in Upper Egypt.

Napoleon reviewing the French troops at Rosetta.

J. F. Champollion.



The Rosetta Stone, found in 1799, was ordered by Napoleon to be placed in the French Institute in Cairo. By an article of the treaty of capitulation it was surrendered to the British in 1801. Major General Turner sailed with it to Portsmouth in 1802 and deposited it with the Society of Antiquarians in London who turned it over to the British Museum.

A plaster of paris cast of its inscription in hieroglyphs, demotic Egyptian, and Greek, enabled Champollion to decipher the hieroglyphic language of the ancient Egyptians and formulate a system for their grammar; this made it possible for archeologists and Egyptologists to read the millennial inscriptions found throughout Egypt.

trophy ended up in the Egyptian Gallery of the British Museum. It lay there undeciphered for twenty years, until another young Frenchman, Jean-François Champollion, was to crack the mystery of its ancient hieroglyphs and throw the first real light on several millennia of Egypt's mysterious past.

As Napoleon had somewhat pompously remarked when elected a member of the National Institute, "the only true conquests are those gained by knowledge over ignorance."

V. EXPLORING WITH CHISEL AND GUNPOWDER

After Wellington's victory at Waterloo, the efforts of the French savants at the Pyramid were forgotten and the sockets they had cleaned were covered once more with the sands of the desert.

It remained for an obscure Italian to make the next impressive discovery within the Pyramid. While Napoleon was languishing on St. Helena, an exophthalmic Genoese merchant, Captain G. B. Caviglia, arrived in Egypt as the master of a Maltese vessel flying the British flag. Seized by the mystery of the Great Pyramid, he gave up the sea and settled down to exploring the Pyramid and its neighbors on the Giza plateau, financing himself by helping rich Europeans scavenge the surrounding tombs to assuage their taste for original Egyptian antiquities—a taste which ran to anything from scarab rings to thousand-ton obelisks.

Described by a contemporary as an "enthusiastic devotee at the shrine of antiquarian learning, who sacrificed country, home, friends and fortune for the indulgence of the refined though eccentric taste of exploring the hidden mysteries of the Pyramids and Tombs of Egypt," Caviglia cleared out the bat excrement from Davison's Chamber and set up housekeeping within it, turning "the gloomy recess into a residential apartment"—though how this was accomplished under a 3-foot ceiling is not explained.

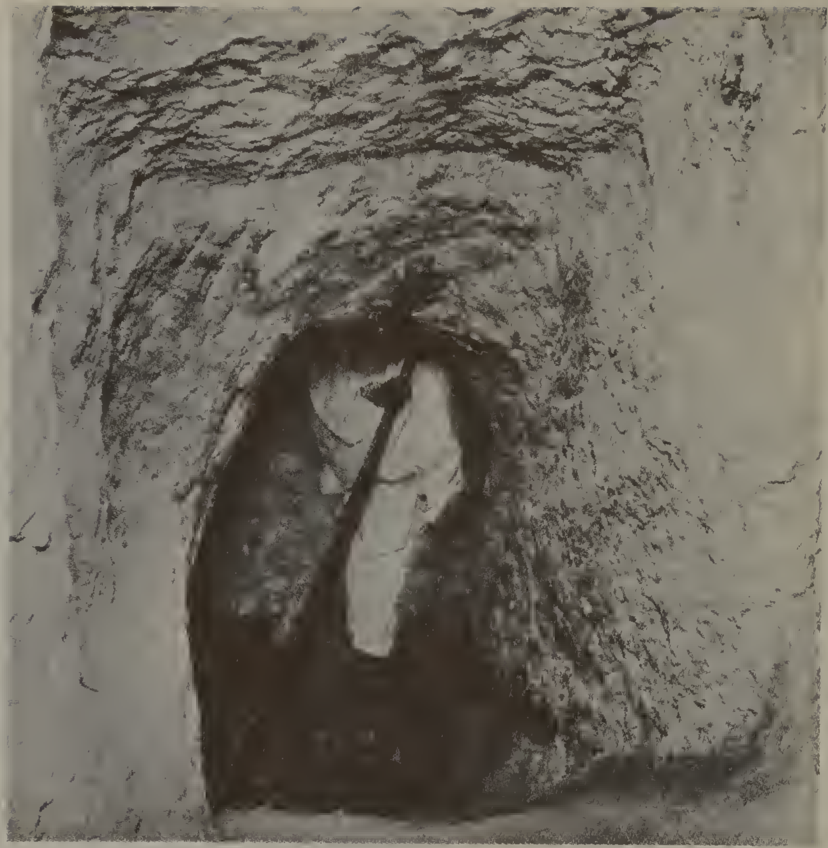
Alexander William Crawford (later Lord Lindsay), who encountered Caviglia in Cairo, found the Italian to be a deeply religious man, well versed in the Bible, which he constantly quoted, but also a man with some pretty strange ideas about what he would find in the Pyramid. To England Crawford wrote: "Caviglia told me that he had pushed his studies in magic, animal magnetism, etc., to an extent which nearly killed him . . . to the very verge, he said, of what is forbidden man to know, and it was only the purity of his intentions which saved him."

Caviglia was convinced that if he dug into the Pyramid he would eventually encounter a secret room. To find it he hired a gang of Arab workmen to dig a tunnel leading off from Davison's Chamber. But no matter how far they dug, they found nothing but solid masonry.

Caviglia cleared the sand from the base of the Sphinx and revealed the footing for a missing obelisk between its paws.

At last Caviglia was obliged to give up the job; to console himself he set about analyzing the mystery of the "well." Lowering himself down the shaft, Caviglia got as far as 125 feet below the grotto only to find, as Davison had before him, that the bottom was completely stopped, and that the air was so scarce his candle spluttered, making it difficult for him to breathe.

However, as the bottom appeared to be mostly sand and loose rocks, Caviglia was determined to unplug it and see where it led. For a while he managed to impress a gang of Arabs into raising basketfuls of the sand all the way up to the top of the well; but the shaft was so tight, the air so fetid with bat dung, and the dust so suffocating, that the Arabs began to faint and refused to work further. Caviglia attempted to clear the air at the bottom of the well by burning chunks of sulfur, but it was still impossible to breathe that far down for any length of time, and the Arabs would not resume their digging.

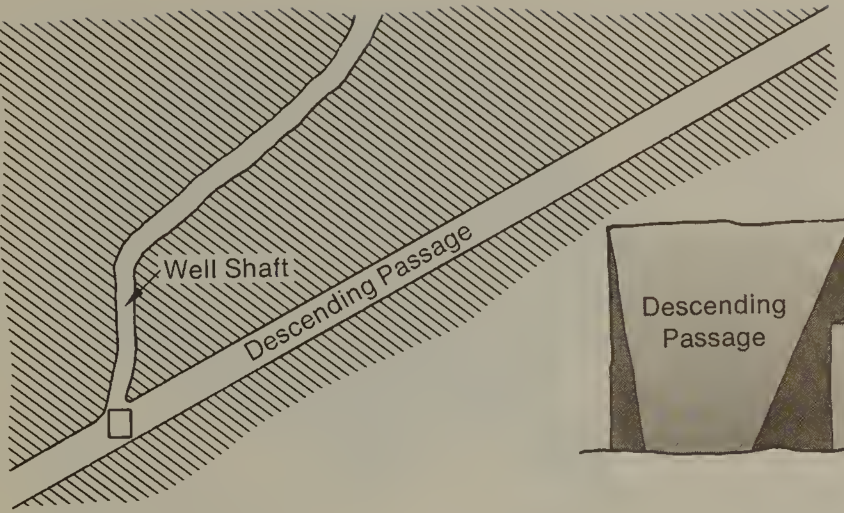


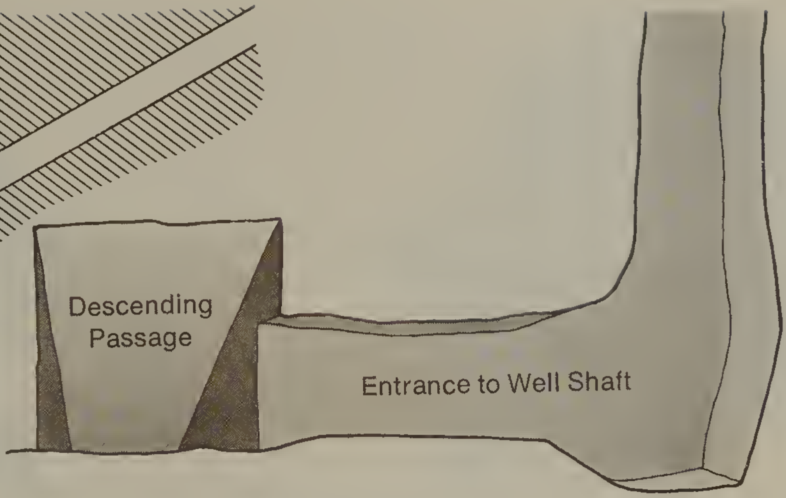
Lower end of the well shaft.

Caviglia decided to attack the problem from a different angle. He would attempt to clear the main Descending Passage to the subterranean pit which had been filled since Al Mamun's time with the refuse of the plugs they had broken out of the Ascending Passage. Caviglia had the refuse carried up and out of the Pyramid, and was able to push his way on hands and knees down the passage for 150 feet; then the air became so impure and the heat so great that he started to spit up blood. Still, he would not give up. At the end of another 50 feet he made a discovery which seemed to indicate he might be on the right track. On the west side of the passage he found a low doorway leading into a hole. As the Arabs began to dig upward into this hole, Caviglia noted a strong smell of sulfur. It occurred to him that he might have hit upon the solution to his previous problem: the smell of sulfur might be coming from the bottom of the well, which must therefore be very close.

Digging harder, the Arab workmen dislodged some loose earth. A pile of dust and rubbish fell onto them, including a basket and ropes which had been left at the bottom of the well. There was also a sudden gush of air up the tunnel, and those in the passage were able to breathe with ease. Caviglia had discovered the end of the well. But a greater mystery remained. Why had it been dug there, when, and by whom?

As Caviglia set about resolving this mystery, another





Where the well joins the Descending Passage.

strange figure joined in the Pyramid research, one quite the opposite of the romantic, uncommunicative Caviglia. Richard Howard-Vyse, a British Guards officer, at first collaborated heartily with Caviglia, but they soon grew angry at each other and came to a heated parting.

Colonel Howard-Vyse, son of General Richard Vyse and grandson of the Earl of Stafford, was a martinet with little humor who had been equerry to the Duke of Cumberland (later first king of Hanover) and had stood unsuccessfully for Parliament in the borough of Windsor. He has been described as thoroughgoing and as artless as Wellington, under whom he served.

Colonel (afterward General) Howard-Vyse in 1830.

A trial to his family, who were pleased to have him away from the county seat in Buckinghamshire, even if it cost them some of the family patrimony, Howard-Vyse was to spend over 10,000 pounds sterling on exploration of the Pyramid site.

Howard-Vyse first saw the pyramids on a moonlit ride from across the Nile at Turah in November of 1836, during a trip to Egypt as "a fashionable amusement seeker." In his own words he was attracted by "the remote antiquity and uncertainty of their origin, and . . . the peculiarity of their mysterious construction." He was curious about "the purpose for which the passages and chambers already discovered were originally intended, but in much greater degree respecting any other passage or apartments which might reasonably be supposed to exist in the enormous structures."

Impressed by Caviglia's theories about the mysterious and hermetic purposes for which the Great Pyramid had originally been constructed, Howard-Vyse hired the services of a professional civil engineer, John Shae Perring, who had been an assistant to Mohammed Ali, the khedive of Egypt. Perring was to take measurements of all the pyramids and tombs which had thus far been discovered on the Giza plateau, as well as many of those farther south.

In his *La Pyramide de Cheops ât-elle livré son secret* Fernand Ihek says that the shape of the Great Pyramid was such that it enabled bodies (either animal or vegetable) to become naturally mummified when placed within the King's Chamber. He says the end result was a desiccation or dehydration of the body with no sign of putrefaction. Experiments revealed that an uncleaned trout became mummified in thirteen days, a radish in fifteen days, and the heart of a sheep in forty days.

Ancient Egyptians removed the brain and entrails of a body to be mummified without scarring it by pulling the brain out through the nose and the viscera through the anal aperture.

The body was then soaked in brine for a month; aromatic plugs, often perfumed with onion, were placed in the nostrils and other orifices.

According to Manly P. Hall, there is every reason to suppose that originally only those who had received some grade of hermetic initiation were mummified; for "it is certain that, in the eyes of the Egyptians, mummification effectually prevented reincarnation."

Reincarnation was considered necessary to imperfect souls, or those who had failed to pass the tests of initiation. "The body of the Initiate," says Hall, "was preserved after death as a species of Talisman or material basis for the manifestation of the soul upon earth." When the body of a "god-like" Pharaoh was mummified it could serve as a medium through which survivors could communicate and plead their cause with "the beyond." At first only Pharaohs appear to have been mummified; later it was done to persons of royal rank, and to anyone who could afford it; eventually even animals were mummified.

Howard-Vyse set up his headquarters in an empty tomb near the Great Pyramid and was soon employing a larger number of workmen than anyone since the time of Al Mamun, often as many as seven hundred, using Captain Caviglia as superintendent of works.

All went well till the colonel chose to take an extended tour up the Nile to inspect a further series of pyramids. When he returned he was outraged to find that Captain Caviglia had almost entirely neglected the Great Pyramid and was using the men hired by Howard-Vyse to search for mummies and little green idols in the neighboring burial pits.*

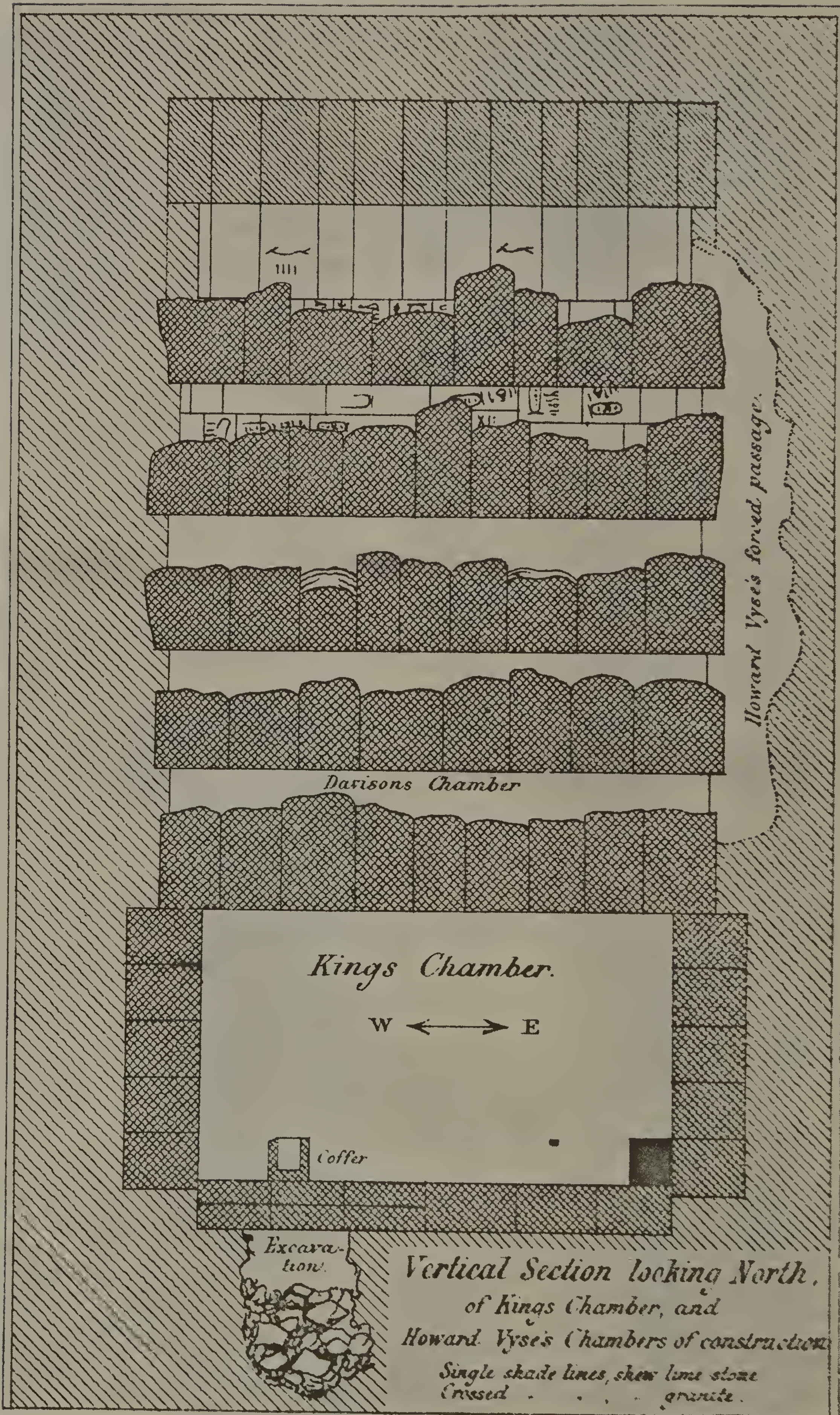
Caviglia became equally outraged at the colonel's reprimands, and gesticulated abusively declaring that "he alone had the head to conduct excavations and to understand the value of 'curios' and *'anticos,'* the colonel having nothing but money."

When the colonel asked for the return of his money, Caviglia disdainfully appeared at breakfast in the colonel's tent and threw on the table the money wrapped in an old stocking.

It was the end of Caviglia's exploring in Egypt. He retired to Paris, where he was sporadically supported by another great scavenger of antiquities, the former British ambassador to the Sublime Porte, Lord Elgin.

Howard-Vyse took over Caviglia's duties. In the words of a Victorian lady admirer, the colonel "sat down before the Great Pyramid as a fortress to be besieged, and through winter and spring and the burning summer of Egypt, long after all travelers had left the country, became the sole director of operations, clerk of the works and paymaster of his hundreds of workmen, day after day, month after month, until they had wrought out his own ideas of pyramidical exploration to the full. For not only was he one of those men who was never known to turn back after having put his hand to the plow, but he was a religiously [*sic*] minded man, a devout Christian, who felt that he was in this case called to a certain work for the Master, and though in the first instance he had distrusted himself in a new field of labor

* Mummy flesh was in great demand in Europe during the sixteenth and seventeenth centuries as a medicinal; it was a common drug to be found in all apothecaries. Mistaken for Persian *moma,* or pitch, which was used to heal cuts and bruises, mummy flesh was believed to make fractures unite in a few minutes and to be good for all kinds of internal ailments. When mummies became scarce traders used the bodies of executed Christians, or the bodies removed from hospitals, many of which had died of loathsome diseases. The bodies were stuffed with bitumen, wrapped in bandages and baked.



Vertical Section looking North,
of Kings Chamber, and
Howard Vyse's Chambers of construction.
Single shade lines, shew lime stone
Crossed . . . . granite.

so that he had thought it better to use the purchased help of the Italian professional, yet when that failed he became a most admirable example to all kinds of men, rich and poor alike, of giving himself to the work, putting his own shoulder to the wheel, and never quitting it until the end was gained, during all the time, too, preserving the utmost urbanity, but dealing out the strictest justice in a manner that made a most honorable and lasting impression on the tawny Arabs around him."

In the Queen's Chamber Colonel Howard-Vyse had relays of men work day and night digging up the floor in front of the niche, but all they found was an old basket: so they refilled the hole.

In Davison's Chamber they found a crack in the ceiling through which they could run a reed about 3 feet long. Believing this to be an indication of a similar chamber above, Howard-Vyse had the workmen chisel their way into the granite over their heads. But the stone was too hard, and again the Arabs could not stand the heat in the restricted space of Davison's low-ceilinged chamber.

Special quarrymen were imported from the Mokattam hills across the valley. When even they could not manage the job, the colonel resorted to gunpowder to blast his way upward. To handle the charges he found a workman called Daued who lived mostly on hashish and alcohol. Daued successfully set off the blasts—a job that was particularly dangerous as the splintered granite flew about like shrapnel.

When the dust subsided Howard-Vyse found that they had indeed broken through to another chamber, which he chauvinistically named after Wellington. Its floor was the top of the eight monolithic blocks of granite which formed the rough-hewn ceiling of Davison's Chamber, each block weighing over 50 tons. About a yard above them lay another flat ceiling made of eight blocks of granite.

The new chamber had a strange effect on those who entered; it turned them black. Instead of bat dung, the floor was covered with a thin black powder which when analyzed turned out to be exuviae, or the cast-off shells and skins of insects. Of living insects there were none to be found.

Convinced that the monoliths of the ceiling were in turn the floor of a third chamber, Howard-Vyse ordered the blasting resumed. The colonel's excavations above the King's Chamber became more and more difficult as they rose vertically to a height of 40 feet and took three and a half months to accomplish.

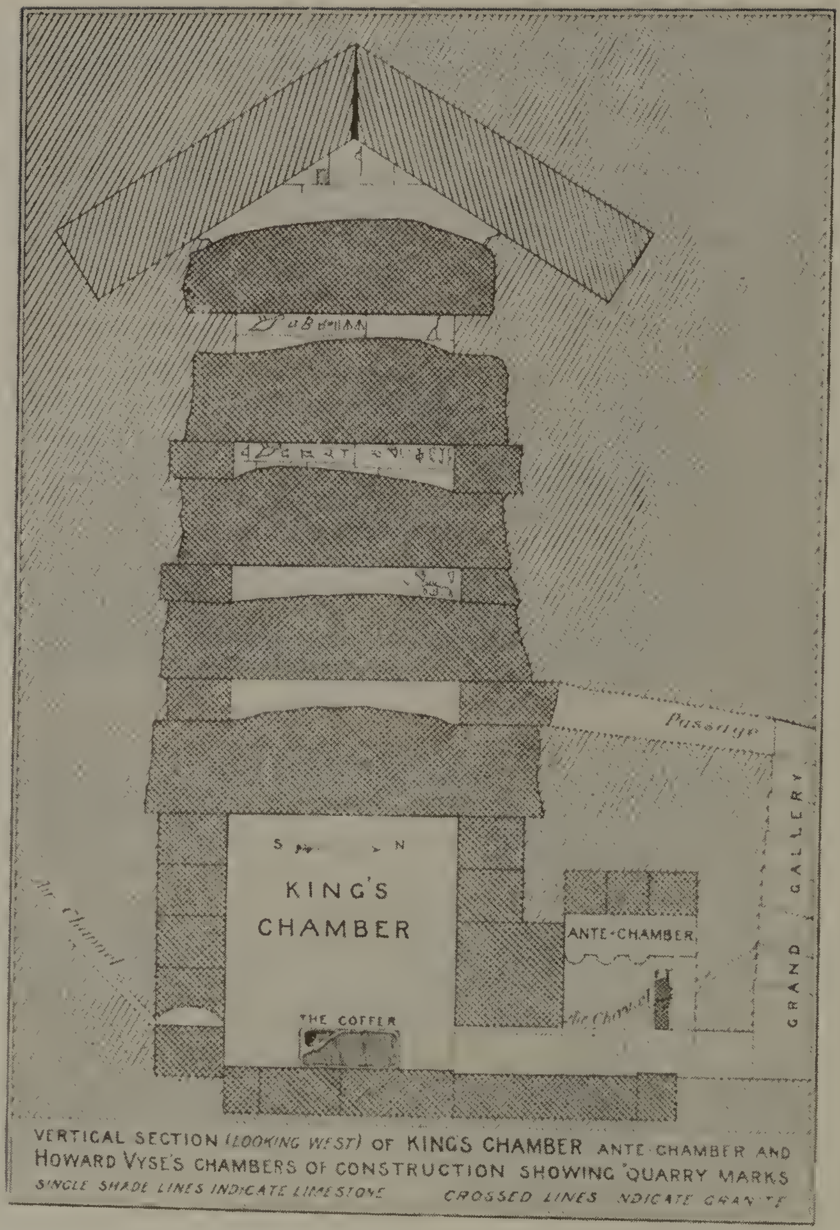
One by one, three more chambers were found above the two already discovered, the uppermost being gabled with huge blocks of sloping limestone. These chambers

Construction chambers above the King's Chamber.

As some of the quarry marks found in the chambers are hieroglyphs signifying "year 17," Egyptologists deduced that the building had reached that stage in the seventeenth year of the king's reign. Most of the marks were roughly daubed in red paint and appeared upside down, indicating they were quarry marks and not decorations.

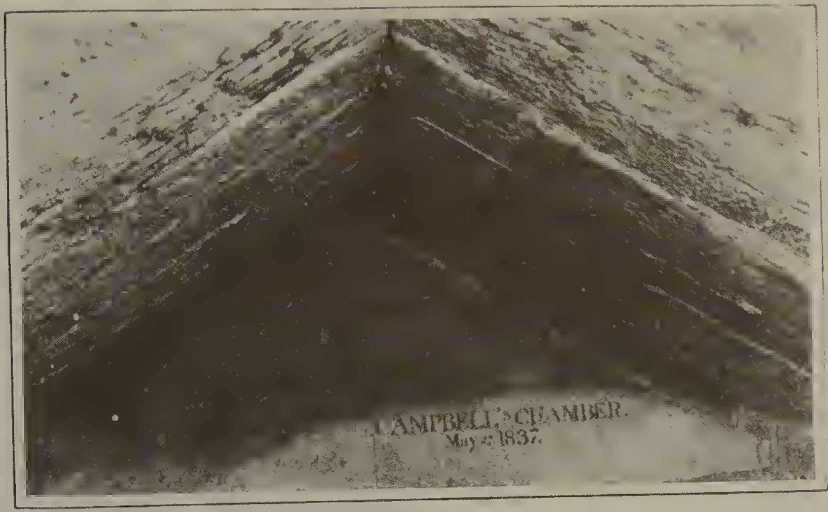
Similar marks, mostly red, but occasionally black, were also found on the first five or six courses of the Pyramid, behind the casing blocks.

Howard-Vyse sent copies of the crayon marks to Samuel Birch of the British Museum who identified one of the ovals as belonging to King Suphis, or Shofo, or Khufu.



Sectional drawing of the King's Chamber, looking west, showing all four chambers discovered by Howard-Vyse.

Lady Arbuthnot's Chamber, discovered by Howard-Vyse.



Ceiling construction above Campbell's Chamber.

Howard-Vyse named in turn for Admiral Nelson, for Lady Ann Arbuthnot, wife of Lt. General Sir Robert Arbuthnot, who happened to visit the Pyramid shortly after the room was discovered, and for Colonel Campbell, Her Brittanic Majesty's Consul in Cairo.

The most interesting discovery was not so much the chambers themselves but some red-paint cartouches daubed on the inner walls of the upper chambers. Thanks to the Rosetta Stone and Champollion's successors, one of these cartouches was recognized by Egyptologists as belonging to Khufu, believed to be the second Pharaoh of the Fourth Dynasty, called Cheops by the Greeks, whose reign was thought to have occurred in the third millennium before our era.

There was, of course, no way to prove that this Khufu was indeed the Cheops who had reigned in Egypt. But the fact that similar cartouches had been found in the quarries of the Wadi Magharah hills, from which much of the stone for the Pyramid was derived, added weight to the assumption.

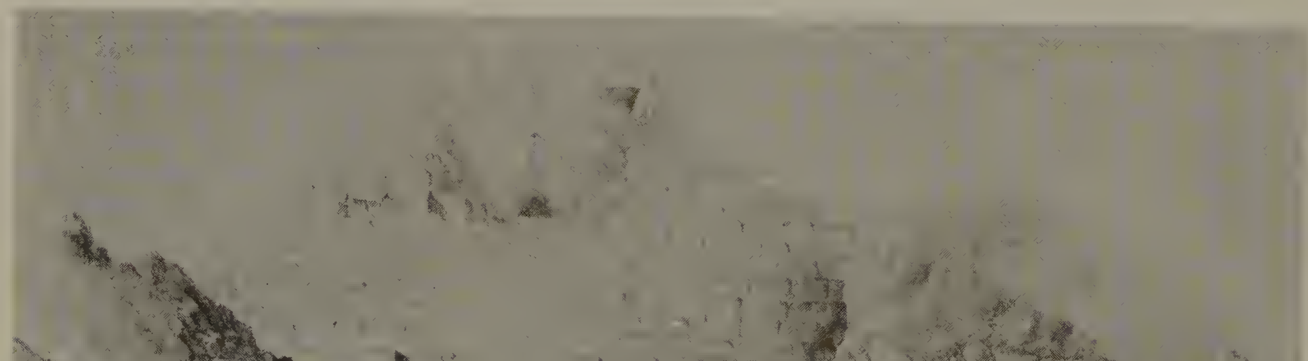
One thing seemed clear. Whoever had daubed the cartouches on the inner walls of the upper chambers must have done so *before* the chamber was sealed and the Pyramid completed; there appeared to be no entrance or exit other than the one blasted by the colonel.

Doubt still lingered that there might have been a far earlier king with a similar cartouche, quite unknown to Egyptologists; but until further evidence could be adduced, it seemed hard to go against the theory of the Pyramid having been built in the reign of the historic Cheops, as reported by Herodotus and other classic authors.

As for the reason for the five superimposed chambers, it was the conclusion of Howard-Vyse, and many who came after him, that they had been designed to relieve the flat

Air vent in the north wall of the King's Chamber.

Casing stones and pavement as exposed by Howard-Vyse. Both entrances can be seen, Al Mamun's on the sixth course, and the original entrance ten courses higher.



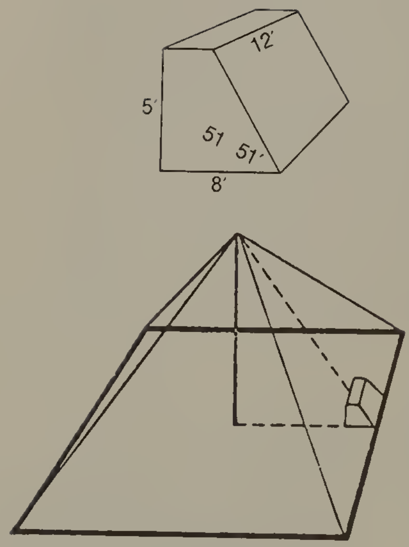
ceiling of the King's Chamber from the pressure of the 200 more feet of solid masonry piled above it.

Another remarkable discovery made by the colonel in the walls of the King's Chamber was to vindicate the hypothesis of Dr. Harvey. Greaves had found the two 9-inch-wide openings in the side walls of the King's Chamber, but it was not till Mr. Hill, one of Howard-Vyse's assistants, who ran a hotel in Cairo, climbed high up on the outer surface of the Pyramid and found two similar outlets that it was established they were connected for over 200 feet right through the solid masonry to the holes in the King's Chamber. The colonel's engineer, Perring, was nearly decapitated when a stone dislodged by Hill came crashing all the way down one of these conduits.

When the conduit was cleared, an immediate rush of cool air entered the King's Chamber. Thus ventilated, the temperature of this chamber in the center of the Pyramid was to remain at an even and pleasant 68 degrees, irrespective of the weather or season outside, a prehistoric system of air conditioning. This added substance to Jomard's theory that the chamber might have been the repository for weights and measures which require an even temperature and constant barometric pressure, such as the Paris observatory for measurements of standards 85 feet below ground.

Even more sensational for those who were bent on unraveling the secrets of the Pyramid was the next discovery of Howard-Vyse. Ever since the Middle Ages, when the Arabs had despoiled the outer casing, the whole perimeter of the base of the Pyramid had been heaped high with fragments of limestone, and sand and debris, often in piles as high as 50 feet. The two northern corners uncovered several years earlier by the French had already been buried again. This time Howard-Vyse decided to clear away a patch of debris in the center of the north façade to see if he could get down to the very base and bedrock of the Pyramid. In doing so, he was to make a great discovery: two of the original polished-limestone casing stones on the lowest level of the Pyramid were still in the spot where they had been originally placed.

This ended the argument about the casing; it silenced forever those who had continued to consider it a fiction that the whole of the Pyramid had once been covered with a fine mantle of limestone. The original limestone was there, and so finely carved that it was now possible to correctly measure the angle of the slope on which the Pyramid had originally been constructed. The blocks, 5 feet high, 12 feet long, and 8 wide, showed an angle of about 51° 51′, a little sharper than the one estimated by the French.



Relation of the casing stones to the slope of the Pyramid.

The base circuit of the Pyramid rests on a platform of finely finished limestone blocks which project beyond the end of the casing stones for an average of 2 feet on the south, east and west sides, and are still in place some 33 feet from the north edge.

This platform is so finely leveled that the official survey of the Egyptian government found it does not exceed 7/8 inch from dead level, and this variation may be due to subsidence.

At present it is not possible to say how far the platform extends under the building; but where the platform stones have been removed, the bed-rock is found to have been cut and leveled to receive each individual stone, sometimes as deep as 2 inches.

On the north side the platform stones have been deliberately laid at irregular angles, each corner being carefully cut out to receive the next irregularly angled stone.

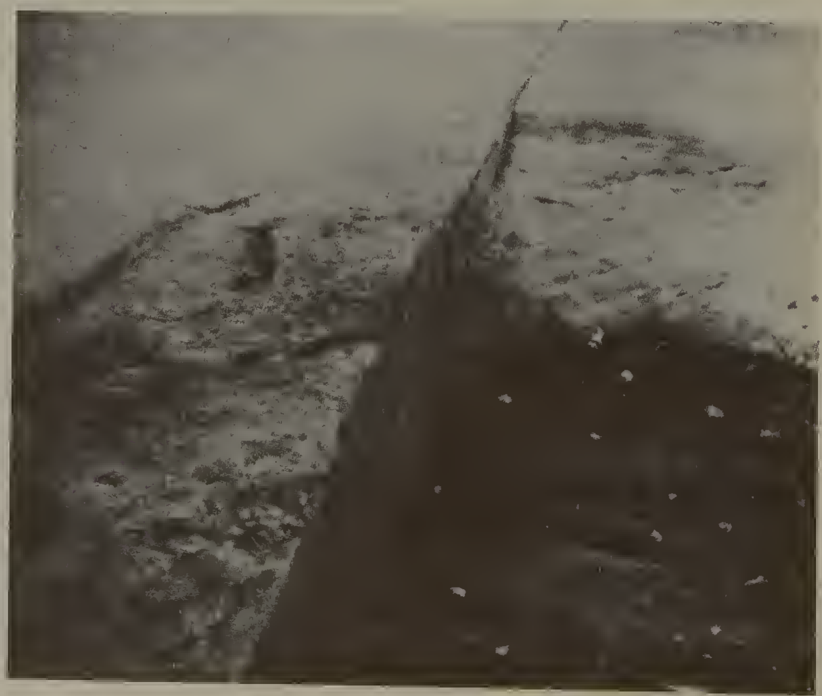
Hewn to the correct angle and polished to a uniform surface, they were quite perfect, in the words of Howard-Vyse, "in a sloping plane as correct and true almost as modern work by optical instrument makers. The joints were scarcely perceptible, not wider than the thickness of silver paper."

The colonel also managed to uncover part of the original pavement on which the building rested, and which appeared to stretch away to the north. "It was well laid and beautifully finished," noted Howard-Vyse, "but beneath the edifice it was worked with even greater exactness, and to the most perfect level."

Though the reason for this astounding accuracy on the northern side was not to become apparent for some years, Howard-Vyse summed up his discoveries thus: "I consider the workmanship displayed in the King's Chamber, in the pavement and the casing stones, is perfectly unrivaled."

The colonel had the casing stones quickly covered up pending permission to take them to the British Museum, but he was not able to prevent the infuriated local Moslems from uncovering them again and smashing the fine edges with hammers, jealous that Christians might obtain and dispose of something of value in their country.

With the angle of 51° 51′ of the casing stones and the base length of 763.62 feet measured by the Frenchmen Coutelle and Le Père, it was now possible to obtain by trigonometry a new dimension of the Pyramid. Its perpendicular height to where the missing capstone was presumed to have come to a point was figured to be 485.5 feet, or 147.9 meters, above the center of the base.



Stone sarcophagus found by Howard-Vyse in the pyramid of Mykerinos, which was lost at sea en route to the British Museum.

In 1840 Colonel Howard-Vyse sailed for England with his accumulated notes. Back home, at his own expense, or his family's, he produced two elegant volumes crammed with detailed but patronizingly Victorian descriptions of his exploits in Egypt, called *Operations Carried on at the Pyramids of Gizeh in 1837*. The book had the merit of including quotations from the works of 71 Europeans and 32 Asiatic authors who had written about the Pyramid from the fifth century B.C. to the nineteenth century.

The colonel's assistant John Perring also produced a handsome volume with some lovely copperplate etchings, *The Pyramids of Gizeh from Actual Survey and Measurement on the Spot*.

Unfortunately, Howard-Vyse was to lose his best trophy, the sarcophagus of Mykerinos, which he had found in the subterranean chamber of the Third Pyramid; the ship carrying it foundered in a storm off the coast of Spain and was sunk in deep water.

But the general measurements taken by Howard-Vyse and Perring were to open a whole new phase in the study of the Great Pyramid, now to be ennobled by the appellative "pyramidology."

VI. FIRST SCIENTIFIC THEORIES

A poet and essayist who had never set eyes on the Pyramid was to take the measurements of Howard-Vyse and those of the French savants and draw from them a set of conclusions, the most far-reaching thus far about the origin and purpose of the Pyramid.

John Taylor, the son of a London bookseller, whose regular job was editing the *London Observer,* already in his fifties when Howard-Vyse returned from Egypt, was to spend the next thirty years collecting and comparing accounts of travelers who had visited the Pyramid.

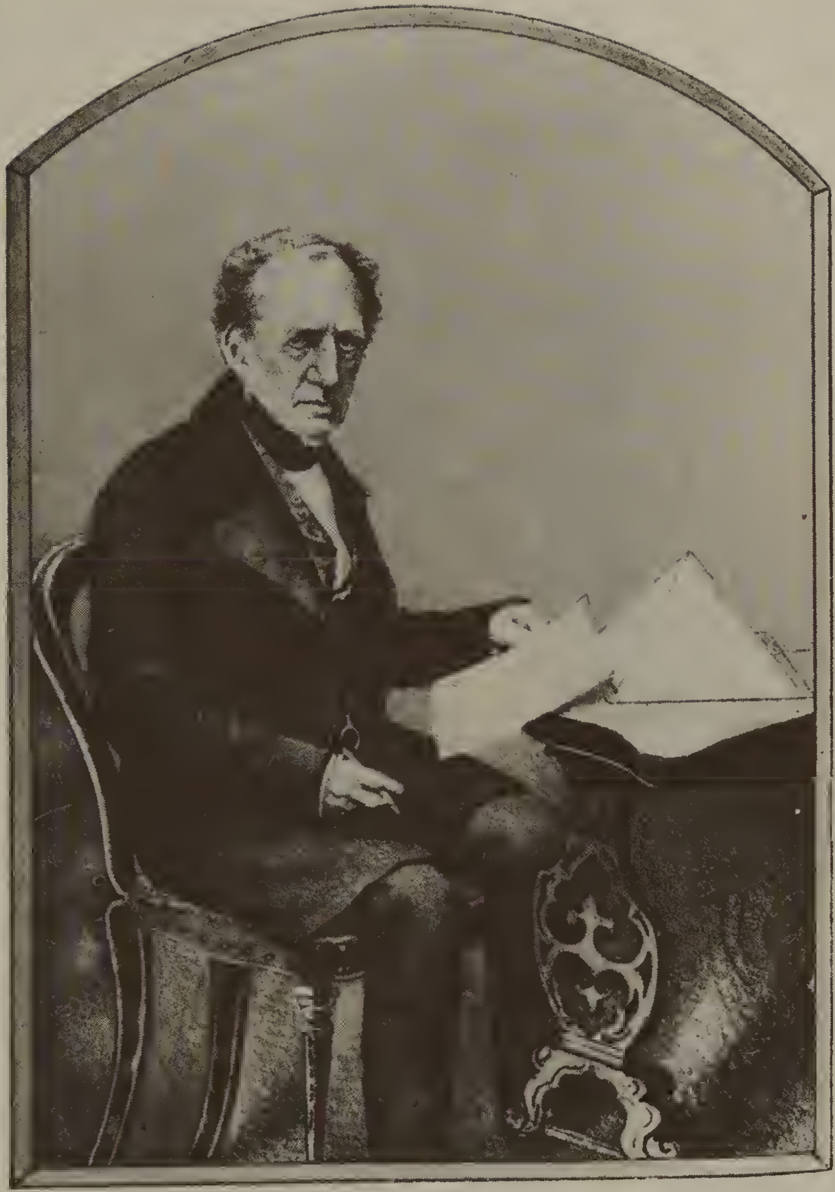
A gifted mathematician and amateur astronomer, Taylor made models to scale of the Pyramid and began to analyze the results from a mathematician's point of view. To account for the discrepancies in the length of the base reported by successive travelers—which increased progressively from the 693 feet of Greaves to the 763.62 feet of the French —it occurred to Taylor that as each measurer had arrived on the scene, more sand and rubble had been cleared from the base. Each had measured accurately, but at a constantly deeper layer of masonry.

Taylor set about drawing and redrawing every feature of the Pyramid on the basis of the measurements reported by Howard-Vyse, so as to see what geometrical or mathematical formulas might be derived from the structure.

Taylor was puzzled as to why the builders of the Pyramid should have chosen the particular angle of 51° 51′ for the Pyramid's faces instead of the regular equilateral triangle of 60°.

Analyzing Herodotus' report of what the Egyptian priests had told him about the surface of each face of the Pyramid, Taylor concluded they had been designed to be equal in area to the square of the Pyramid's height. If so, this meant the building was of a particular if not unique geometric construction; no other pyramid has these proportions.

Taylor then discovered that if he divided the perimeter of the Pyramid by twice its height, it gave him a quotient of 3.144, remarkably close to the value of π, which is computed as 3.14159+. In other words, the height of the Pyramid appeared to be in relation to the perimeter of its base as the radius of a circle is to its circumference.



John Taylor.

This seemed to Taylor far too extraordinary to attribute to chance, and he deduced that the Pyramid might have been specifically intended by its builders to incorporate the incommensurable value of π. If so, this was a demonstration of the advanced knowledge of the builders.* Still today the oldest known document which indicates that the Egyp-

* Not till the sixth century was π correctly worked out to the fourth decimal point by the Hindu sage Arya-Bhata. It took another thousand years before the Dutchman Pierre Metius calculated π to six decimals by means of the fraction 355/113. In 1593 François Viete carried the computation to eleven figures, and a generation later Rudolph Van Ceulin, just before he died, took π to 127 figures by postulating a circle with 36,893,488,147,419,103,232 sides. In 1813 the English mathematician William Shanks developed π to 707 decimals. Modern computers have carried the operation to 10,000 points of decimal, but with no solution to this apparently incommensurable number.

tians had a knowledge of the value of π is the Rhind Papyrus, dated about 1700 B.C., and therefore much later than the Pyramid. Found in the wrappings of a mummy in 1855 by a young Scottish archeologist, Henry Alexander Rhind, the rare papyrus is now in the British Museum. It gives a very rough value for π of 3.16.

Searching for a reason for such a π proportion in the Pyramid, Taylor concluded that the perimeter might have been intended to represent the circumference of the earth at the equator while the height represented the distance from the earth's center to the pole.

Perhaps Jomard had been right: perhaps the ancient designers *had* measured the length of a geographical degree, multiplied it by 360° for the circumference of the globe, and by the π relation had deduced the polar radius of the earth, immortalizing their knowledge by making the circumference to scale with the perimeter and the radius to scale with the height of the Pyramid.

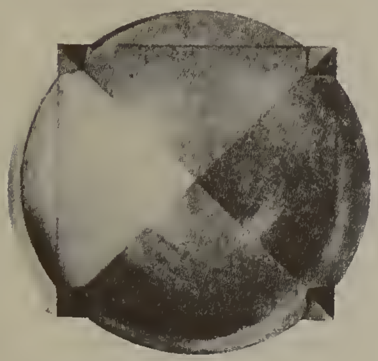
Taylor underlined his thesis: "It was *to make a record of the measure of the Earth* that it was built." He then elaborated: "They knew the Earth was a sphere; and by observing the motion of the heavenly bodies over the earth's surface, had ascertained its circumference, and were desirous of leaving behind them a record of the circumference as correct and imperishable as it was possible for them to construct."

But it was evident to Taylor that the builders of the Pyramid could not have used for their calculations such a unit as the British foot, which fitted neither the height nor the base exactly; he therefore looked for a unit that would retain the π proportion and fit the Pyramid in whole numbers.

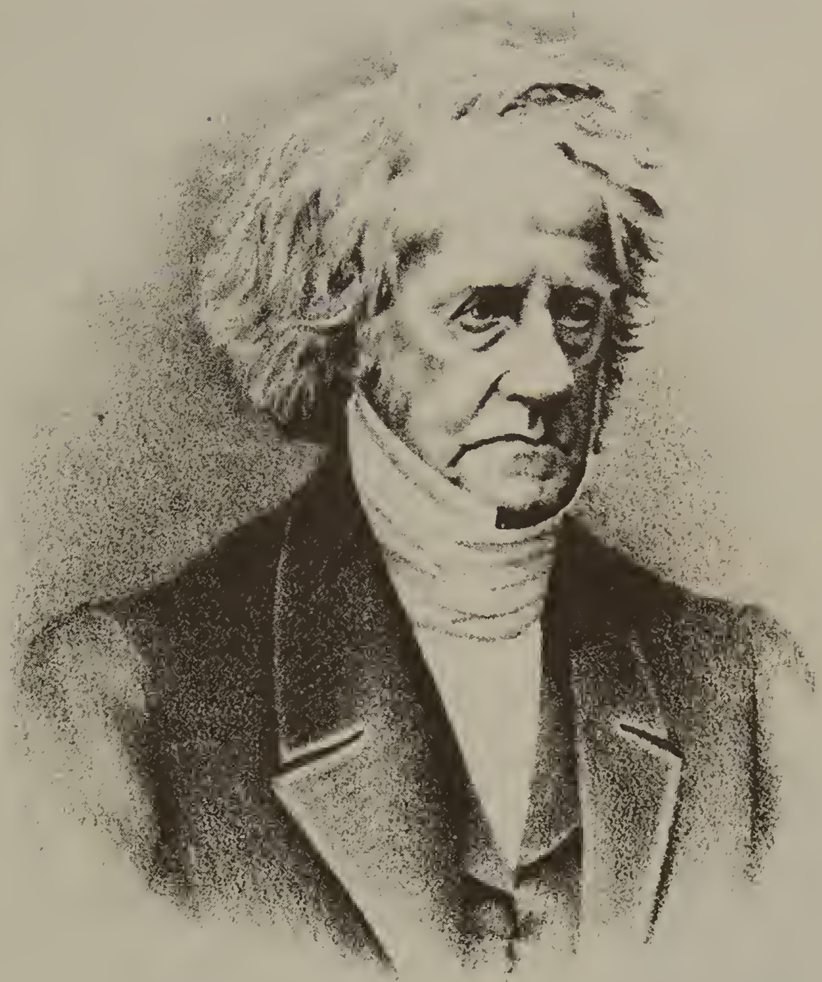
When he came to 366:116.5 he was struck by the similarity of 366 to the number of days in the year and wondered if the Egyptians might have intentionally divided the perimeter of the Pyramid into units of the solar year.

He then noticed that if he converted the perimeter into inches, it came to very nearly 100 times 366. Also he was surprised to see that if he divided the base by 25 inches, he obtained the same 366 result. Could the ancient Egyptians have used a unit so close to the British inch? And a cubit of 25 such inches?

By coincidence, Sir John Herschel, one of Britain's most eminent astronomers at the beginning of the nineteenth century, had just postulated a unit half a human hair's breadth longer than a British inch as the only sensible earth-commensurable unit, or unit based on the actual size of the earth.



Relation of a hemisphere to the Pyramid.



Sir John F. W. Herschel.

Herschel criticized the French meter derived from a curved meridian of the earth as being erratic and variable from country to country because the earth is not a true sphere, and each meridian of longitude would therefore be different. (What's more the French had erred, and produced a meter that was .0002 too short.)

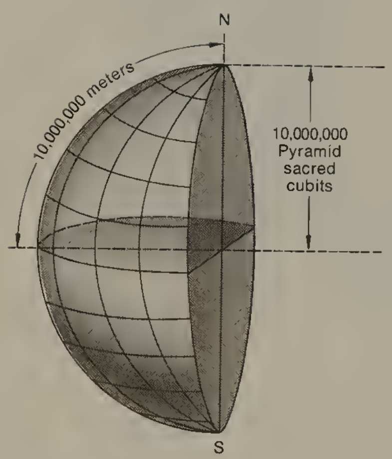
According to Herschel the only really reliable basis for a standard of measure was the polar axis of the earth—the straight line from pole to pole—which a recent British Ordnance Survey had fixed at 7898.78 miles (by taking the mean of all the available meridians measured). This translated into 500,500,000 British inches, or an even five hundred million inches if the British inch were half a human hair's breadth longer.

Herschel suggested that the regular British inch—which was officially computed as the length of three grains of barley taken from the middle ear and placed end to end—be arbitrarily lengthened by a mere one-thousandth part in order to obtain a truly scientific, earth-commensurable unit exactly one fifty-millionth part of the polar axis of the earth.

Fifty such inches, said Herschel, would make a yard that was exactly one ten-millionth of the polar axis, and half that measure, or 25 inches, would make a very useful cubit.

By coincidence these were the cubit and the inch which Taylor had found to fit the Great Pyramid in multiples of 366.*

Another unexpected piece of evidence astounded Taylor. He discovered that recent maps produced by the British Ordnance, the largest and most expensive yet undertaken, had been done on a scale of 1:2500. This scale turned out to bear no relation to the standard British mile of 5280 feet, which had varied through the ages, but almost miraculously fitted the "sacred" cubit as postulated by Newton, as well as the British acre, one side of which was equal to 100 cubits of 25 inches. It appeared that the British inch must have been an ancient unit of measure which had lost a thousandth part as it was handed down from generation to generation.†



To Taylor the inference was clear: the ancient Egyptians must have had a system of measurements based on the true spherical dimensions of the planet, which used a unit which was within a thousandth part of being equal to a British inch.

Fired by what he considered a stunning discovery, Taylor launched into a monumental study of the cubits, feet, spans, inches and stadia, not only of the ancient Egyptians, but of the Babylonians, Hebrews, Greeks and Romans. He found that all kinds of cubits had been used in the past, some of which appeared to have mathematical relations to each other. He also analyzed the ancient measures of cubic capacity along with the modern gallons, firkins, kilderkins,

* That this figuring was not arbitrary was confirmed by the International Geophysical Year 1957–58 geodetic research with orbiting vehicles, which obtained a figure of 3949.89 miles for the polar radius of the earth. Divided by 10,000,000 British inches, this gives 25.02614284, or the length of Taylor's and Newton's "sacred cubit" correct to the third point of decimal.

† Corroborative evidence for Taylor's conclusion was recently produced by Algernon E. Berriman in his *Historical Metrology,* published by E. P. Dutton in New York in 1953. "The English acre," writes Berriman, who is an engineer and an architect, "is the most intriguing of ancient measures because it is virtually equal to a hypothetical geodetic acre defined as one myriad-millionth of the square on the terrestrial radius." Berriman noted that the geodetic acre could also be defined as measuring one myriad square cubits of a hypothetical cubit equal to one ten-millionth of the terrestrial radius. Berriman gave a value to this cubit of 25.064 inches, saying "its former existence is as plausible (or as incredible) as a cubit derived from the sexagesimal division of the Earth's circumference." Berriman also noted that the slightly larger Scottish and Irish acres are related to each other and to the basic English acre as a square to an inscribed circle.

hogsheads, butts, barrels, gills, pecks, faggots, and chaldrons—all in the hope of finding an ancient unit of measure that could be used as a standard, and from which others could have been derived or corrupted.

Pursuing Jomard's theory that the King's Chamber and its sarcophagus might have been designed not so much as a tomb as to monumentalize a system of weights and measure, Taylor was amazed to find that the cubic capacity of the granite coffer was almost precisely four times what the British farmer still used as a standard measure for grain: the *quarter,* or eight bushels.

From all his studies, Taylor concluded that the proportions of the Pyramid had definitely been intended to incorporate geometric and astronomical laws simply and easily expressed, and that its purpose had been to preserve and pass on this knowledge to future generations.

However, as there was nothing in Taylor's philosophy to indicate the existence in such remote antiquity of any civilization which could have had a knowledge of the true shape of the planet, its actual size, and its motion in the solar system; and as the conceit was not then current that this planet might have been visited by superior beings from some other part of the universe, Taylor was hard put to explain the sources of science he found incorporated in the Pyramid. More than a scholar and a mathematician, Taylor was also a profoundly religious man, thoroughly steeped in the Old Testament which he believed to be literally true. To Taylor the creation of Adam had occurred in 4000 B.C. and the Flood in 2400 B.C. It seemed to him hard to believe that in a mere 300 years man could have redeveloped to the point of building so complex a structure as the Great Pyramid. Taylor could come to but one conclusion: whoever had built the Pyramid must have done so under the direct influence of Divine Revelation as Noah had built the Ark. In his own words: "It is probable that to some human beings in the earliest ages of society, a degree of intellectual power was given by the Creator, which raised them far above the level of those succeeding inhabitants of the earth."

Taylor even ventured the hypothesis that the builders of the Pyramid were of "the *chosen race* in the line of, though preceding Abraham; so early indeed as to be closer to Noah than to Abraham."

Because of the close similarity of the British inch to the "Pyramid inch," his idea was to give impetus to the theory that the British were related to the Lost Tribes of Israel, "which during their captivity and wanderings preserved a knowledge of the wisdom of the Egyptians."

As might have been expected, Taylor, who had been known as a benign and dignified old gentleman, had a hard time convincing his quiet Victorian contemporaries of such wild and revolutionary theories, especially as they were just then being rocked by Darwin's theory of the descent of man.

A paper on the Pyramid which he presented to the prestigious Royal Society was rejected with the suggestion that such a paper might be more appropriate for the Society of Antiquarians.

Growing older and more infirm, Taylor was afraid he would die without developing any audience for his theories which by 1859 he had formulated into a volume entitled *The Great Pyramid: Why Was It Built & Who Built It?*

Nearing his death, he had the luck to find the support of an eminent academician with the reputation of having an excellent and sober mathematical mind: Professor Charles Piazzi Smyth, the Astronomer Royal of Scotland.

VII. FIRST CONFIRMATION OF SCIENTIFIC THEORIES

Piazzi Smyth, who was born in Naples to Admiral William Henry Smyth (and named for his godfather, the renowned Sicilian astronomer, Father Giuseppe Piazzi, discoverer of the first known asteroid), was enough of a mathematician not to mock at Taylor's reasoning. Carefully studying Taylor's figures, Piazzi Smyth decided to support them with a paper which he presented to the Royal Society of Edinburgh, of which he had become a member because of his important contribution to the new science of spectroscopy.

It was Smyth's conclusion that the sacred cubit used by the builders of the Great Pyramid was the same length (25.025 British inches) as the one used by Moses to construct the tabernacle and by Noah when he built his Ark, and because the twenty-fifth part of this cubit was within a thousandth part of being the same as a British inch, Smyth also concluded that the British had inherited this "sacred" inch down through the ages.*

Smyth's fellow academicians treated him no better than they had treated Taylor.

During the last few weeks of Taylor's life, there was an animated correspondence between Smyth and Taylor. When Taylor died in 1864 Piazzi Smyth decided that the only way definitely to confirm or refute Taylor's theories about the π relation, and the Pyramid cubit, would be to go to Egypt and carefully measure the Pyramid.

In "utmost straits for funds," Smyth asked his fellows of the Royal Society in London for help; though the Society

* Attributing to Newton the original discovery of the presence of the sacred cubit in the Pyramid, Smyth wrote: "How thankful should we be that it pleased God to raise up the spirit of Newton amongst us; and enable him to make one of the most important discoveries of his riper years—though the opposition of the Church of England has caused it to remain unread almost to the present day—that while there undoubtedly was in ancient times a cubit of 20.7 inches nearly . . . and which Newton calls "the profane cubit" there was another which he equally unhesitatingly speaks of as the *sacred* cubit, decidedly longer."

C. Piazzi Smyth, Astronomer Royal for Scotland.

was "in receipt of a large annual grant from the government for the assistance of precisely such special efforts in science, it not only gave nothing to my semi-pauperized expedition, but actually sent back part of that year's grant to the government on the plea that there was nothing going on that needed it."

That same December, Piazzi Smyth and his wife—then in their early forties—set sail for Egypt with a vast number of boxes containing scientific instruments more accurate than any yet taken to the Pyramid, and with stores and equipment enough for several months.

Despite a series of mishaps, and the almost ruinous expense of everything in Egypt—which was in the midst of a cotton boom engendered by the American Civil War—the Smyths eventually arrived in Cairo, where they were obliged to hang around waiting for permits and local supplies. In his diary Smyth morosely entered exotic descriptions of "the abominations of the worst city in the world," where the food reeked of garlic, lard and African macaroni, the air was fetid from mounds of desiccated human excrement, where he was infested with flies by day and mosquitoes by night, and woken up by a predawn cacophany of howling cats and dogs which roused the pigs which roused the geese and turkeys "just before the disk of the sun comes up like a ball of liquid fire."

Poignantly he described little girls "diving between the hind feet of colossal camels to pick up its hideous droppings, pat them into nicely shaped cakes . . . to make high-scented ammonia-filled fuel for the cooks . . . of the resplendent city."

Smyth was so well received by Ismail Pasha (who a few years later was to commission Verdi's opera *Aïda* which opened in Cairo in 1871) that he tried to buttonhole the viceroy into providing men and funds to remove the great mounds of debris around the base of the Pyramid, to have a 3-inch hole carved through the center of the granite plugs in the Ascending Passage (so as to ascertain its true meridian), to have the ventilating ducts to the King's Chamber cleared, and to sink a shaft through the hole in the pit down to the level of the Nile.

The pasha shook his head, promising to provide twenty men for two weeks to clean and wash the main chambers of the Pyramid so that Piazzi Smyth might take some measurements. The pasha also kindly agreed to provide the Smyths with donkeys and a camel train to bear them and their luggage to the Great Pyramid.

Leaving "the purse-proud modern Muslim city with its tulip-clothed individuals struggling for wealth," the Piazzi

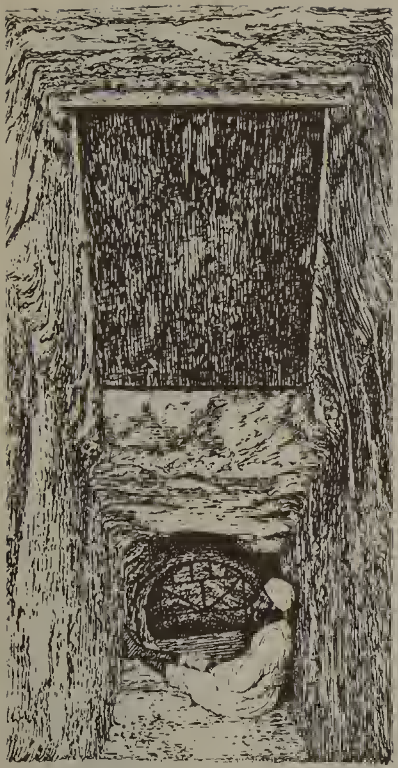
Traveling from Cairo to the Great Pyramid in the mid-nineteenth century.

Sandstorm in the desert.

Smyths set off for the Pyramid. On the way they stopped to eat buns "from Mrs. Smyth's commissary" and refresh themselves with Nile water "muddy and opaque as milk with suspended clay" but celebrated, says Smyth, for its health-giving qualities, the best cure for "the windy melancholy arising from the shorter ribs."

The pyramids, tinted by the golden rays of the setting sun "embalmed in the intense azure of the western heaven," appeared to grow no larger as the caravan approached. Only in the immediate vicinity did they suddenly tower so completely as "to take possession of the mind."

Looking up at the vast stepped sides toward the "dizzy apex 480 feet above in perpendicular height, the mind slowly and almost painfully began to realize the enormous size of the mountainous buildings."



Descending Passage blocked by Arab guides below the level of the granite plug.

As a place to live within reach of the Pyramid, the Smyths selected an abandoned tomb in the eastern cliff of the Giza hill which had previously been used as a storeroom by Howard-Vyse. It proved to be an agreeable residence: the solid rock was the best possible protection against the midday heat, and the orientation of the cave protected it from the sandstorms and the clouds of multicolored locusts that otherwise made life in the desert a misery.

To assist Smyth in his measurements, and to help with the general chores, he found a whiskered Arab called Ali Gabri who had carried baskets for Colonel Howard-Vyse a generation earlier.

At twilight Professor and Mrs. Smyth sat on campstools and watched with amazement as flock after flock of bats flew out of the Pyramid, "for almost twenty minutes without any cessation," to be pounced on by hawks or owls.

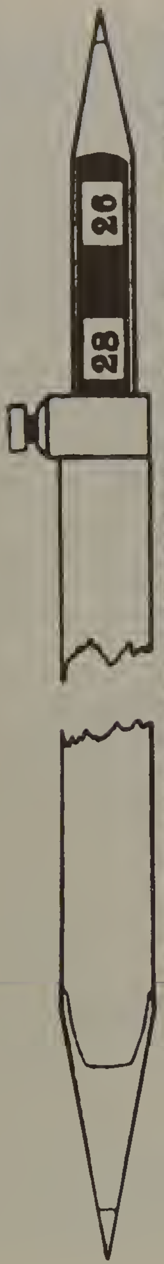
Several days were wasted while Ali Gabri impressed a gang of Arabs to clean the chambers of the Great Pyramid, but at last, in late January, the day came for Smyth to enter what he called "the largest building in the world by the smallest of all doorways."

As Smyth picked his way down the Descending Passage, partly on his seat and partly on hands and knees, he was relieved to find that shallow notches had been dug by Howard-Vyse every 2 or 3 feet so as to keep from slipping on the steep incline. However, each step raised a cloud of fine white dust that made it almost impossible to breathe. To his distress, Smyth also found that the passage leading down to the "pit," which had been cleared by Caviglia, was once more blocked with sand and stones, and barred by a grill just below Al Mamun's hole to the Ascending Passage.

It was explained to Smyth that it cost the Arab guides too much time and candle grease to accompany tourists all the way down to the "pit" before making the long climb back up to the King's Chamber, so they had blocked the passage and informed gullible tourists there was nothing but sand beyond the barrier.

Bent on finding proof that the Great Pyramid had been built on units of his "sacred cubit," Smyth had brought from England a 105-inch metal bar with built-in thermometers at either end to indicate the slightest variation in temperature with which to measure the available passages. A mere change of .01 degree Fahrenheit was enough to produce a sensible change in the length of the standard bars.

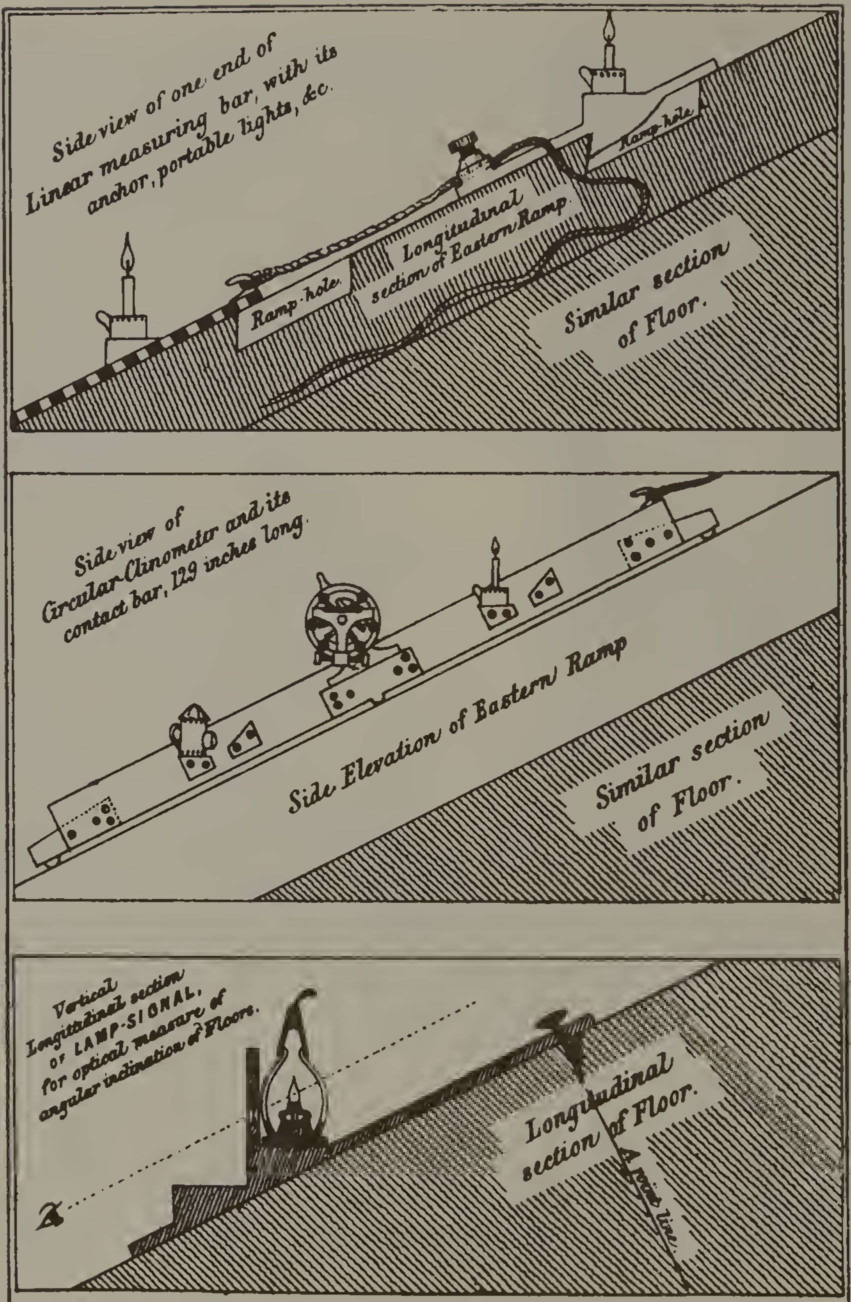
To obtain the exact angle of the Descending Passage, Smyth had a specially designed clinometer equipped with a gunmetal circle 8 inches in diameter, divided into units of



The Grand Gallery as Piazzi Smyth saw it in 1865.

Brass-tipped mahogany measuring rod.

Piazzi Smyth's special apparatus for measuring the Grand Gallery.

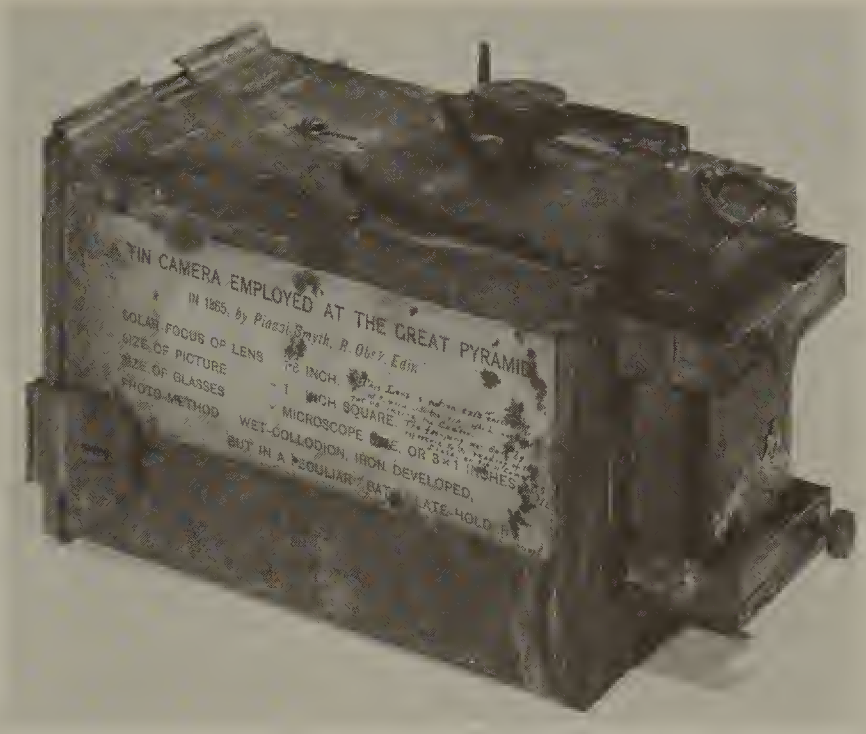


Special forms of apparatus, employed in measuring in the Grand Gallery.

10 seconds, and fitted with three pairs of verniers. The slope he calculated was the most precise to date: 26° 27′.

For measuring the individual stones of the floors, walls and ceilings, Smyth had mahogany and teak rods tipped with brass, carefully painted or waxed to prevent variation from humidity or temperature. One special ruler, remarkable for its straight, fine grain, had been obtained from an antique musical organ dating from the reign of Queen Anne. To fashion these measuring instruments, Smyth had obtained the services of an expert optician.

Each rod was checked daily for atmospheric shrinkage



"Miniature" camera, 8 inches long, used by Piazzi Smyth to photograph the interior and exterior of the Great Pyramid. On the right is a tiny container for the vulcanite nitrate bath which held the exposed wet-collodion plates which measured an inch square. Some two hundred microscope negatives, packed in a storage box, are still missing, but 48 lantern slides, 24 transparencies and 23 stereotypes are in the possession of the Royal Society of Edinburgh, examples of which are reproduced with their permission.

The camera is in the possession of the present Astronomer Royal for Scotland, Prof. H. A. Brück, and is here reproduced by kind permission.

or enlargement against a basic fine-grained clinkstone which could be measured with a magnifying glass to 1/100 inch.*

Thus began the first really systematic analysis of the Pyramid with modern measuring equipment. For weeks on end Smyth measured and remeasured whatever he could reach in the interior of the Pyramid, counting the stones in passages and chambers, computing angles and declinations.

Measuring the coffer in the King's Chamber, Smyth concluded that Taylor had been correct in recognizing it as a standard of linear and cubic measure. Unlike the European standards, such as the yardstick kept at Whitehall, which vary with temperature and barometric pressure, shrink, decompose, tarnish or oxidize with time, the coffer appeared to be designed to remain at a constant temperature and barometric pressure, its polished sides unaffected by decomposition over a period of thousands of years, subject only to the vandalism of man.†

* A clinkstone is a compact grayish-blue felspathic rock little subject to atmospheric changes which makes a clink sound when struck.

† Smyth echoed Herschel's complaint about the standard yard at Whitehall. Herschel had called it "a purely individual object, multiplied and perpetuated by careful copying, from which all reference to a natural origin is studiously excluded, as much as if it had dropped from the clouds."

Today our yard is related to the meter, which is determined by a finite number of wavelengths per second in vacuum of an atom of Krypton 86—measured by means of light waves. A second is no longer defined as the 3600th part of an hour but as the duration of cycles of radiation in a cesium atom.

Photograph of Mrs. Piazzi Smyth taken by her husband outside their tomb apartment in the Giza Hill, which Piazzi Smyth characterized as "a quiet nook, looking out over the green Egyptian plain."

For outside measurements Smyth used a 500-inch cord, and for elevations he had theodolites, sextants and telescopes, which were laboriously carted from spot to spot, up and around the Pyramid, to measure all that could be measured, despite the mounds of debris.

With his long and varied experience in observational astronomy, Smyth had brought the requisite apparatus for obtaining astronomical observations with a high degree of precision.

To obtain the correct latitude of the Great Pyramid without having his plumb line diverted from the perpendicular

Photograph of Ali Gabri (sometimes spelt Alee Dobree) seated outside the tomb in the east bank of Pyramid Hill where Piazzi Smyth, who is handling the camera, had his quarters.

by the attraction of the huge bulk of the Pyramid, Smyth made his observations from the very summit; there the Pyramid's pull of gravity would be directly downward.

Smyth and his wife spent several nights on the circumscribed platform, close to the stars, along with Ali Gabri, who complained he could not sleep because of indigestion. Smyth described the first night as eerie but wonderful, with the ghostlike summit of Kephren's pyramid lurking in the misty darkness. At daybreak he saw "a broad pinioned eagle floating serenely along looking downwards on other things, as we were looking down on him."

From the vantage of the summit Smyth figured the latitude of the Pyramid to be 29° 58′ 51″. From this he concluded that the designers might have purposely not placed the Pyramid directly on the thirtieth parallel because of the atmospheric refraction, which would have caused an error in their observations of about that much. Later he attributed the displacement to a gradual shifting of latitude, registered at Greenwich as 1.38″ per century.*

As for the extraordinarily precise orientation of the Pyramid—which Smyth found to be far superior to that of the world-renowned observatory of the sixteenth-century Danish astronomer Tycho Brahe—the Scottish astronomer concluded that for such refinement a meridian must have been obtained by observing a polar star along the Descending Passage.

When Caviglia had cleared this passage of the rubble left by Al Mamun, he noticed one night that the North Star was observable in the small patch of sky—about 1° square—of the opening. Intrigued by this phenomenon, Howard-Vyse had asked Sir John Herschel whether the direction of the passage could have been determined by the polestar. Herschel replied that 4000 years earlier Ursa Minor could *not* have been seen from the passage at any time throughout the twenty-four hours. He added, however, that alpha Draconis, the leading star in the constellation of Drago, would have been near the pole, and that though a comparatively insignificant star of less than the third magnitude, it could nevertheless have been clearly seen by an observer at the bottom of the passage at the moment of its inferior culmination, when its circumpolar orbit was at its lowest.

Smyth proceeded to subtract the 26° 17′ angle he had found for the Descending Passage from the Pyramid's latitude of 30° (or height of a true North Star above the horizon as seen from 30° of latitude) and obtained an angle of 3° 43′. Calculating that alpha Draconis would have been 3°43′ from the pole at its lower culmination in 2123 B.C. and again in 3440 B.C., Smyth concluded that either date might be taken as the one when the Great Pyramid had been laid out.

* Other pyramid experts have attributed the slight displacement to the fact that the Pyramid needed the solid basis of the Giza plateau for a foundation, and could not have been built any farther north, in the soft sand of the Nile valley. The astronomer Richard A. Proctor suggests that the emplacement was the result of the mean latitude obtained from observing sun shadows and star elevations, which are affected in opposite directions by the atmospheric refraction. An interesting explanation was produced by Dr. Everett W. Fish of Chicago who suggested at the turn of the century that the deviation of the Pyramid's latitude from 30° is neither an error in instrumentation, nor in polar axis, or latitude, but compensates for the spheroidal shape of the earth as postulated by Newton.

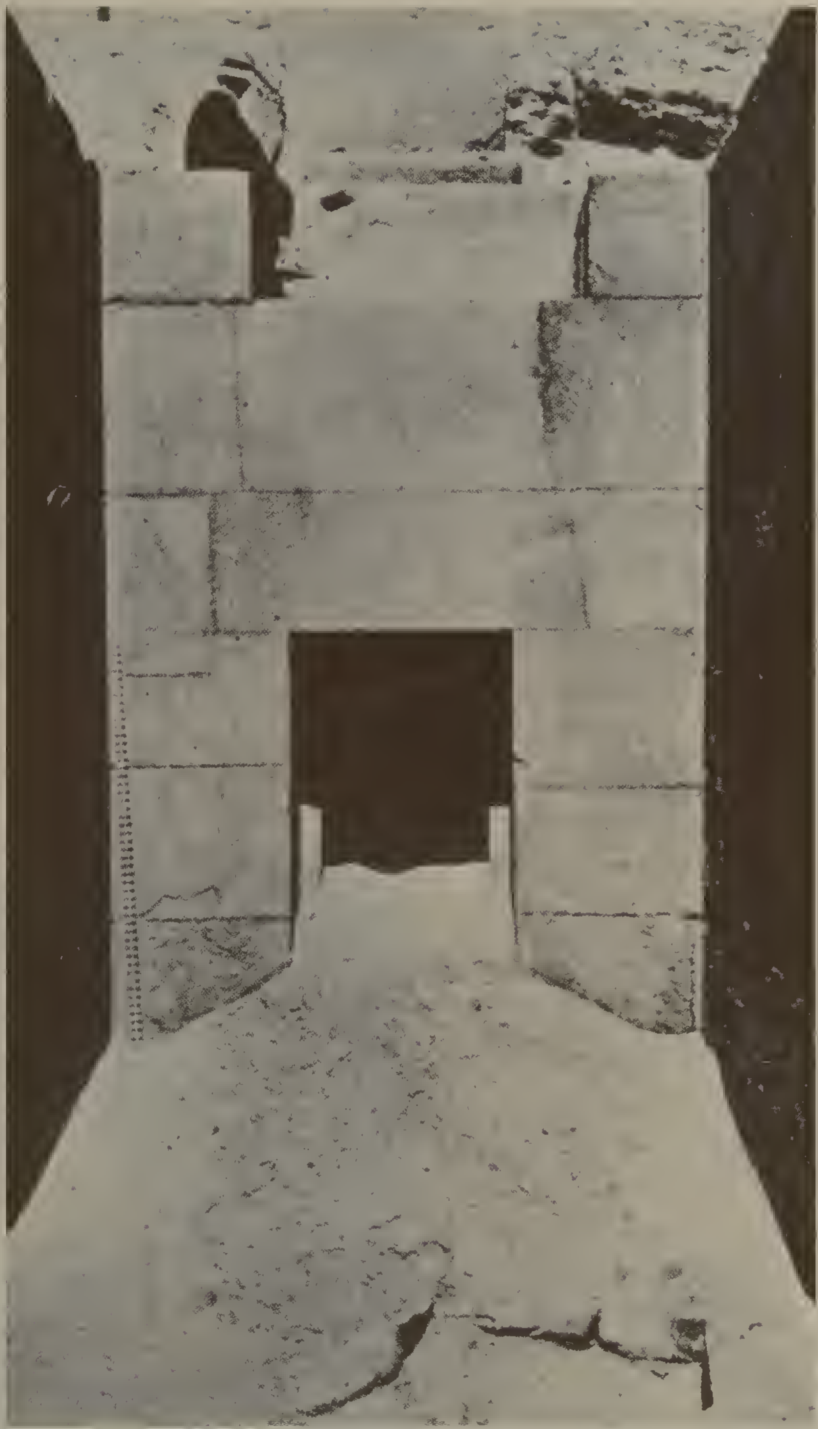
This photograph was taken by Piazzi Smyth and sold at auction after his death. It shows Mrs. Smyth sitting on the edge of what Smyth calls Shafre's burial chamber north of the Great Sphinx. It was taken at high noon to show that the tomb was correctly oriented along the meridian so that with the sun at its zenith, no light would fall on either the east or the west wall.

To ascertain the correct moment for noon Piazzi Smyth spent the previous night observing the stars with his telescope.

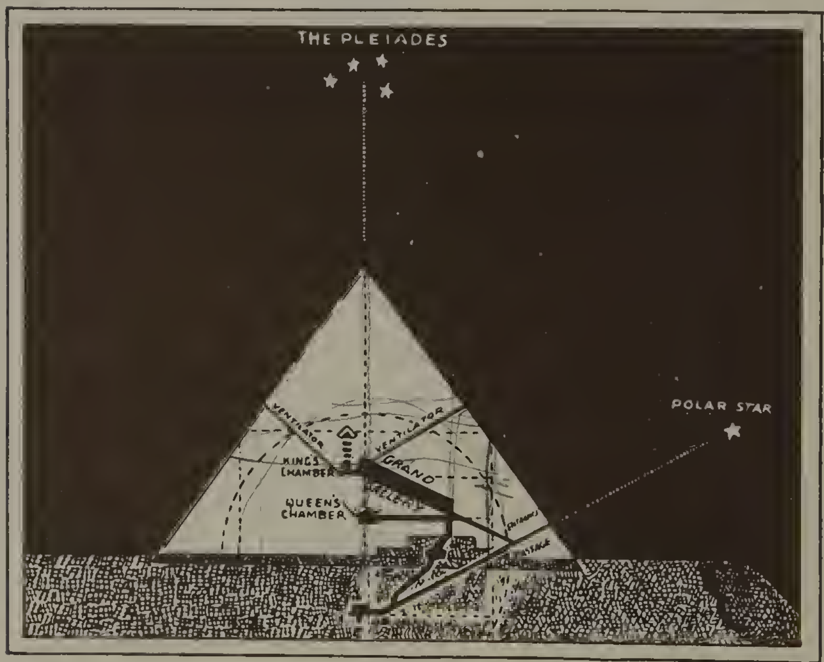
Piazzi Smyth photographed the Great Pyramid with the same scientific thoroughness with which he measured it, despite the difficulties of developing in the desert. He brought all his own chemicals, and used a special 1-inch plate "as small as an ordinary microscopic slide," which gave results that could be blown up with almost the detail of the larger photographic plate. To light the interiors of the Pyramid he used magnesium flares, experimenting with varying amounts so as to obtain the best exposure and the clearest detail. He had to wait hours between exposures in the King's Chamber, which filled up with smoke from each magnesium flare.

Smyth also achieved some remarkable stereoscopic effects by shooting with two cameras, and is responsible for the innovation of placing his cameras much farther apart than the standard 2 inches.

For lack of funds Smyth was unable to publish some fourscore photographs thus obtained at the Great Pyramid. The positive prints which he made were lent to scientific exhibitions or donated to friends interested in pyramidology, and gradually became lost, with the exception of this rather poor reproduction.



In support of the later date Smyth worked out that if the foundation of the Pyramid had occurred at midnight of the equinox in 2170 B.C., when alpha Draconis was at meridian below the pole, another very important star would have been crossing the meridian above the pole: *n*-Tauri, or Alcyone, of the Pleiades. In other words, when alpha Draconis was visible down the Descending Passage, the chief star of the Pleiades, *n*-Tauri, would have been crossing the meridian in the vertical plane of the Grand Gallery, at the moment of the autumn equinox.



Piazzi Smyth's ground plan of the circles of the heavens above the Great Pyramid, at the epoch when he believed it was founded: midnight of the autumnal equinox 2170 B.C. Smyth noted that *alpha* Draconis was on the meridian below the pole while the Pleiades were on the meridian above the pole, coincidentally with the vernal equinox.

Piazzi Smyth figured that the Great Pyramid might have been built so its Descending Passage was aligned with the polestar and at a time when the Pleiades were at the zenith at midnight.

Casing stones donated by Smyth to the Edinburgh Museum, showing the angle of the slope of the Great Pyramid.

Smyth considered this a very important date in history, as many ancient peoples dated the beginning of their year at Halloween, when the Pleiades and the equinoctial point were on the meridian together at midnight.

But Smyth's prime preoccupation was still with establishing whether Taylor's π proportion was really incorporated in the structure.

Along the face of the Pyramid, Smyth checked the angle of the casing stones discovered by Howard-Vyse. Unfortunately the sharp lines had already been almost obliterated by the Arabs and by the chipping away of souvenir hunters. But searching through the debris piled high round the base, Smyth was able to find fragments of casing stones with the angles still intact.

Invariably the angle checked out at about 52°, or its complement of 128°, confirming Taylor's theory that the height of the Pyramid was designed to be in relation to the perimeter of its base as the radius of a circle is to its circumference.

To see if he could refine this angle, Smyth observed the silhouette of all the backing stones against the sky by means of a very accurate altitude azimuth circle which had been donated to his friend and mentor Professor Lyon Playfair by his students in 1806 and in turn lent to Smyth.

By this method Smyth obtained an angle of 51° 49′. Meanwhile Sir John Herschel had obtained a figure of 51° 52′ 15.5″ from the dimensions of the casing stones as reported by Howard-Vyse. Smyth chose to take the mean of these available measures as 51° 51′ 14.3″—a difference of less than a minute from either figure. He also chose to take the mean of the 763.62-foot base line measured by the

Magnesium-light photography had been developed only a few months before Piazzi Smyth took this double exposure of the coffer in the King's Chamber. The apparent reflections are those of Ali Gabri and another Arab. Mrs. Smyth's head appears beyond the coffer. Smyth's method of burning magnesium powder in a spirit-lamp flame was an innovation in photography.

French and the 764 feet measured by Howard-Vyse, and got 763.81—a difference of barely 2 inches on a length of 763 feet.

This was an arbitrary act, but the result produced an astounding value for π in the Great Pyramid proportions of 3.14159+.

Searching for a reason for the incorporation in the Pyramid of this relation of the radius of a circle to its circumference, Smyth pursued Taylor's theory of the base being divided into 366 units to coincide with the number of days in the year.

To have been absolutely precise, the perimeter should have measured 365,24.2 Pyramid inches. This would require that each side be 9140.18 British inches. The measure obtained by Howard-Vyse and the French savants, though within 6 inches of each other, were both about 2 feet too long.

The only solution appeared to be to dig up the sockets and remeasure the base line more accurately; but time and money were running short. Fortunately two engineers from Glasgow, Messrs. Inglis and Aiton, happened to pass through Egypt on their way from a tour of the Holy Land. Cajoled by their fellow Scot, they agreed to help him uncover the sockets originally found by the French (which had once more become covered with debris in the intervening half century) and make a truly accurate survey.

Following Smyth's complex computations, the engineers were able to uncover not only the sockets but a perfectly leveled stretch of pavement at the perimeter of the base.

Stereographic photo taken by Piazzi Smyth of Mr. Inglis and Arab workers in the northeast socket cleared in April of 1865. The Royal Engineer surveyor went all over the floor of the socket with a spirit level and found it absolutely level.

To measure the distance between the sockets, up and around the debris, required a great deal of digging and moving of rocks. But Smyth could not tarry. His own instruments were already packed and his passage had been booked by the British consul. When the engineers promised to take great care in their measurements and forward the results to Scotland, Smyth disconsolately agreed to depart as scheduled.

All that remained to be done was to dispense the customary baksheesh to the neighboring Arabs who had helped during four months' stay. The Smyths gave each man a gold sovereign plus a present depending on the willingness with which he had served his Scottish employers: the best got globe lamps mounted in copper; the middling got frying pans; and the worst got mousetraps.

When the ancient Arab who guarded their cave by night appeared for his just reward, Piazzi Smyth puritanically noted that the old man "seized on the money with such an agony of clutch, and his eyes brightened with so strange a fire, that alas for perverted human nature! we feared we had done more harm to his soul than good to his body."

As the camel train was prepared for departure, the faithful Ali Gabri stood silent for a time, "then suddenly putting his fingers to his eyes" rushed into the desert to conceal his crying.

Back in Scotland, Piazzi Smyth received the results of the engineers' survey; these gave a much shorter length of 9110 inches for a side of the Pyramid. Smyth concluded that the true length must be the mean between this figure and the

longer one of 9168 inches obtained by Howard-Vyse, or 9140 inches, which was just 1 inch less than was required for Smyth's theory, resulting in a year of 365.2 days instead of the precise 365.24 required by theory.

A great deal now hung on the exactness of these figures. If Smyth's theory could be proved correct, it could mean that the ancient Egyptians had produced a structure whose basic unit, the Pyramid inch, incorporated not only a system for linear measurement—with the cubit and the inch—but also for temporal measurement, with a year of 365.24 days, both based on the most sensible foundation: the polar axis of the planet around which it rotates once in a day.

In Smyth's opinion "the linear measure of the base of this colossal monument, viewed in the light of the philosophical connexion between time and space, has yielded a standard measure of length which is more admirably and learnedly earth-commensurable than anything which has ever yet entered into the mind of man to conceive. . . ."

Smyth summed up his work: the Pyramid "revealed a most surprisingly accurate knowledge of high astronomical and geographical physics . . . nearly 1500 years earlier than the extremely infantine beginning of such things among the ancient Greeks."

From the Royal Society of Edinburgh, Smyth received a gold medal for the careful measurements he had taken in Egypt; these he published in monographs, and in a three-volume opus running to 1600 pages entitled *Life and Work at the Great Pyramid of Jeezeh during the Months of January, February, March and April, A.D. 1865.*

The work was not well received. As much of a religious zealot as had been his predecessor Taylor, Smyth was unable to account for the mathematics displayed by the ancient Egyptians. Like Taylor he was obliged to attribute this science to Divine Wisdom, somehow imparted to an earthly architect who had constructed the Pyramid under the direct influence of revelation. "The Bible," said Smyth, "tells us that in very early historic days, wisdom, and metrical instructions for buildings, were occasionally imparted perfect and complete, for some special and unknown purpose, to chosen men, by the Author of all wisdom."

The idea was received by some with derision, by others with acrimonious opposition. One reviewer remarked that Smyth's book contained "more extraordinary hallucinations than had appeared in any other three volumes published during the past or present century." A friendly reviewer summed up reaction to the book saying "it evoked numerous illustrations of envy, hatred, malice, and much uncharitableness from vain, flippant, and unqualified writers, the author being scoffed at, traduced, worried and all but *argued* with, by opponents who only succeeded in proving their egotistic inefficiency to apprehend the truth."

To make things worse another Scot, a religious enthusiast called Robert Menzies, advanced the theory that the passage system in the Great Pyramid was nothing less than a chronological representation of prophecy, corroborating the Bible, built on a scale of one pyramid inch to the solar year.*

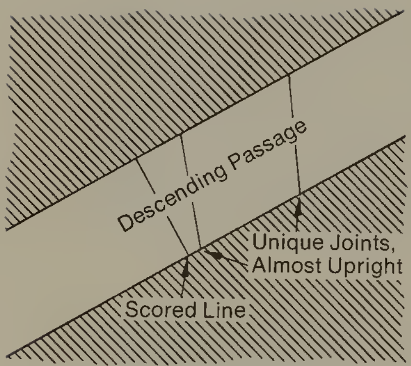
As Menzies' theory was formulated before anything was known of ancient Egyptian messianic prophecy, such as *The Book of the Dead,* the texts of which had not yet been deciphered, this new contribution merely added to Smyth's problems. Smyth was further derided and lampooned by his

* Menzies, knowing that Smyth had made an approximate calculation of the date at which alpha Draconis shone exactly down the Descending Passage, put forward the theory that the date of this important astronomical phenomenon should be clearly marked some way in the Descending Passage itself, at the place representing the said date on the chronological scale. To Menzies' delight, Smyth replied that he had discovered two scored lines on each side of the passage at the very spot indicated. Although the joints in the walls of the Descending Passage were perpendicular to the floor, said Smyth, there were two joints on each wall, immediately to the north of the scored lines, that were not so: these were peculiarly vertical joints, as if intended to draw attention to something of importance: in Smyth's and Menzies' opinion, evidently the scored lines.

fellow academicians. Sir James Y. Simpson, an eminent member of the Royal Society of Edinburgh, publicly ridiculed Smyth before his fellow members, saying, "the whole of Professor Smyth's theory about the Great Pyramid is a series of strange hallucinations, which only a few weak women believe, and perhaps a few womenly men, but no more." Simpson added that he had "talked about it to a great many engineers, mathematicians, and others, and found them scoffing at and despising it."

Smyth's mixing of religious and prophetic conclusions with sound scientific discoveries caused his entire theory to be discarded by skeptics. To this day, the lampooning persists. One modern writer on pyramidology still refers to Smyth as the world's "pyramidiot," and laments that "such a first-class mathematical brain should have wasted its energies in so unprofitable a field."

But Piazzi Smyth was far from being quashed. He continued to produce even more fantastic theories from the results of his measurements of the Pyramid. Recomputing the height of the Pyramid, Smyth found it to be about 6 inches longer than Taylor's figure of 5813 inches from base rock to apex. The new measurement revealed that the Pyramid rose from its base in a proportion of 10:9, that is, for every 10 units of height, the Pyramid extended 9 units in width. To Smyth this was an indication that the proportions were intended to symbolize in yet another way the earth's circuit round the sun. Multiplying the height by 10^9, he obtained an astonishing result. Reduced to British miles, the answer was 91,840.000—or a very good figure for the mean radius of the earth's orbit round the sun. The present figure varies between 91 and 92 million miles. Was this mere coincidence? The argument between the supporters of Smyth's theories and the entrenched academicians who opposed them became intensely heated.



Scored lines in Descending Passage.

Basic to the whole argument was the fact that no one had a series of absolutely reliable measurements for the *exterior* of the building, especially beneath its debris where the base line must actually be measured. Even a new survey by the Ordnance surveyors made in 1869, which gave a length of 9130 inches, was made on the basis of cumulative measurements up and down and around the piles of debris that still clogged part of the base of the Pyramid between the exposed sockets. Results which varied by even 3 or 4 inches could not be considered accurate enough to prove or disprove the theories of Taylor and Smyth. So long as the *actual* dimensions of the Pyramid, both interior and exterior, were not obtained, correct to a fraction of an inch, there would be no real way of *knowing* if Smyth had a point or not.

VIII. FIRST REFUTATION OF SCIENTIFIC THEORIES

To resolve the problem of the dimensions of the Pyramid once and for all, a mechanical engineer by the name of William Petrie, who had become fascinated by the theories of both Taylor and Smyth, set about designing and constructing even more specialized sextants, theodolites, and verniers with which to tackle the technical problems encountered by Smyth. It was no easy job. Smyth had gone a long way in perfecting his own equipment, and it was to take William Petrie all of twenty years to accomplish the task to his own satisfaction. Petrie stressed the importance of further exploration of the Pyramid because of its "paleologic, chronologic, metrologic, geodetic, geologic and astronomic interest to mankind," and above all "for its symbolic interest relating to the higher ideas intentionally embodied therein by its originator." Yet Petrie kept tinkering with the new instruments and postponing his departure for Egypt.

His young son, William Flinders Petrie, perhaps because of a spirit of adventure inherited from his maternal grandfather, the great explorer Matthew Flinders, became so impatient he finally decided to prime the pump by leaving ahead of his father, convinced that his father would quickly follow.

Fascinated by the varied standards of measure used in different parts of the world, young Petrie had read all he could on the subject; instead of going to school, he tramped around England, becoming proficient as a surveyor by measuring churches, buildings and ancient megalithic ruins such as Stonehenge, about which he was to write the first of his several score books.

At the age of thirteen, young Petrie had read Piazzi Smyth's *Our Inheritance in the Great Pyramid*. It had not only revived in him the ideas of Greaves and Burattini, but convinced him that a real history of measures might be deduced from a careful measurement of surviving monuments and objects. He was also determined to prove, one way or another, whether or not Taylor and Smyth had been correct in their theories regarding the Pyramid. To do so he would have to resurvey and measure the entire building.

William Flinders Petrie.

On a stormy day in November of 1880, Flinders Petrie, now a bearded professional surveyor of twenty-six, set off from Liverpool with a vast quantity of boxes containing the rare instruments designed by his father to eliminate the defects revealed by Smyth's experience. He also had with him the necessary supplies with which to survive for a long period in the inhospitable, bandit-infested desert. The gale blew so hard Petrie slept on the engine grating, too seasick to go below deck. Within a week of landing at Alexandria, Petrie had transported his equipment to Cairo, where he managed to get hold of Ali Gabri to help transport his food and instruments to the Giza plateau.

Ali Gabri was now a veteran of 40 years' service with Caviglia, Howard-Vyse and Piazzi Smyth. Reaching the Pyramid in December, Petrie followed the established practice of setting up house in an abandoned tomb.

Ali helped Petrie furnish his quarters with shelves and a hammock, helped him stock the larder with ship's biscuits,

Petrie standing before his living quarters in a tomb on the Giza plateau.

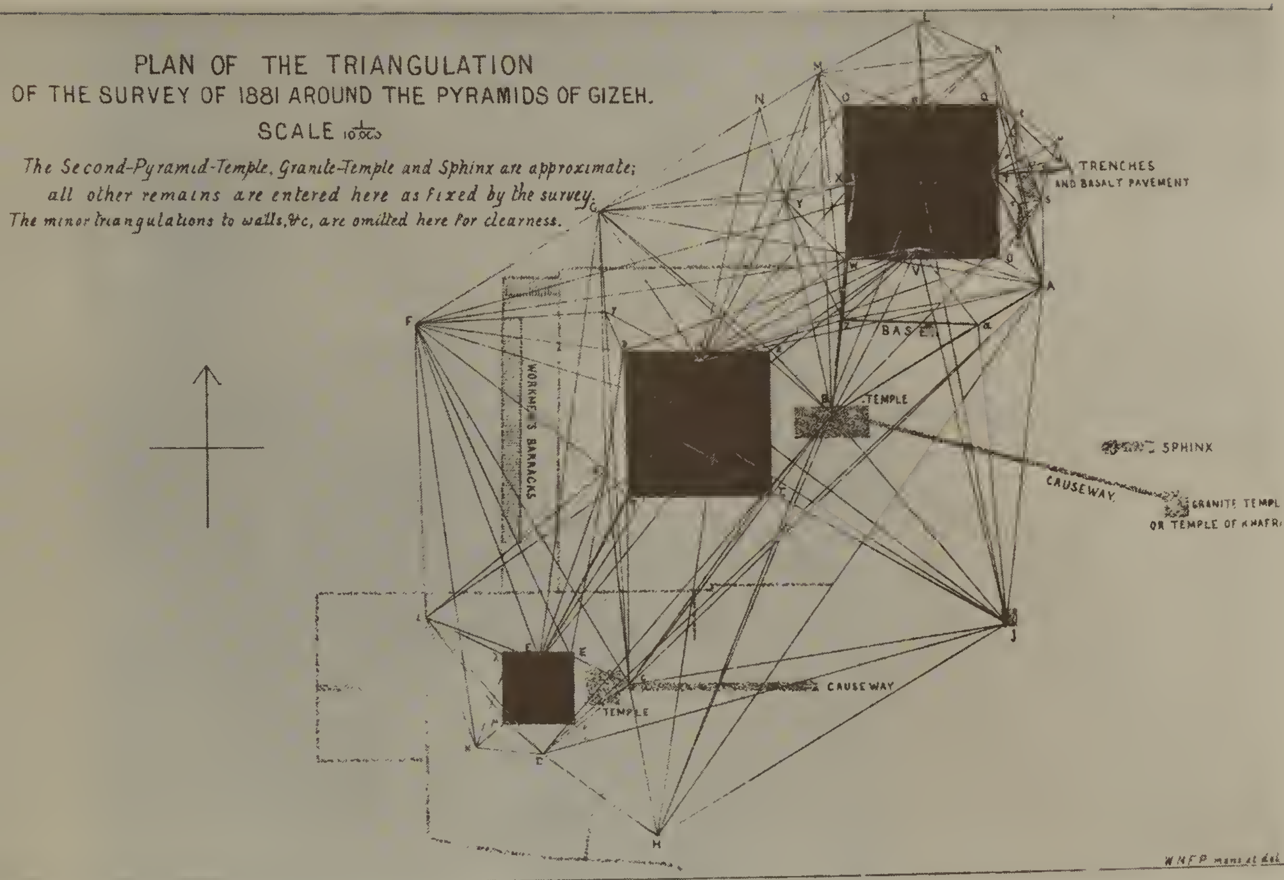
canned soups, tapioca and chocolate. To cook his evening meal Petrie had brought along a kerosene stove. Like his predecessors, Petrie found the solid rock of the tomb an extremely hospitable home, remarking that it seemed "as good as a fire in cold weather, and deliciously cool in the heat."

Petrie's day started with the lighting of his kerosene stove and the ritual boiling of tea water while he enjoyed a makeshift bath.

Breakfast was the time he accorded to reception. Men and women would look in at the door of his tomb, and if a special Arab friend paid a visit, Petrie would brew some coffee in his honor on the little stove by the door.

Petrie got along well with the Arabs, noting that "the smallest entering into their ways pleases them enormously; only sit squat, return the proper replies to salutations, catch their tricks of manner, and imitate their voice, and they will laugh heartily and treat you as a friend."

Petrie's first preoccupation was to accomplish what had been beyond the means of Smyth: a very precise triangulation all over the hill of Giza, including points around all three large pyramids, as well as the surrounding temples and walls which belonged to the complex. Though he couldn't remove the rubble, Petrie hoped to establish the dimensions of the pyramids by triangulation to within a fraction of an inch.



Petrie accomplished his triangulation of the Great Pyramid over a period of months, by means of a ten-inch French theodolite, "a splendid theodolite by Gambay" with a ×35 telescope. Some of the angles were read as many as 14 times from as many as 50 fixed stations. Petrie estimated the probable error in his base measurement of the Pyramid to be ±.03 inch, or 1/260.000 of the whole. But because of the debris and the fact that the cornerstones were missing, Petrie could not establish where the original corners had actually been placed.

Using a highly accurate theodolite by means of which single seconds of angle could be read, Petrie repeated his observations so many times that it would take him from dawn till sunset to accomplish the work at a single station. A second of arc is so fine that it is commonly referred to as the angle subtended by a dime at the distance of a mile.

All the while Ali Gabri held a huge parasol over the theodolite to keep the sun from shining on the metal circle and expanding it unevenly. Once the sun had gone down Petrie would have a solitary meal, washing his own dishes—because he distrusted the Arab's idea of cleanliness—and then sit down to meticulously write up his figures, laying the groundwork for that scientific archeology of which he was to become the prime promoter. His sole entertainment was the "indescribable" tunes played on a reed flute by Ali Gabri's nephew, whose job was to guard him from a neighboring tomb through the night.

Choosing good days, with cool air but no wind, and working for ten hours at a stretch without food, Petrie was able to get a figure to within a quarter of an inch, and usually to within a tenth of an inch, for the actual layout of the three large pyramids at Giza. He was amazed to find the layout of the Great Pyramid "a triumph of skill. Its errors, both in length and in angles, could be covered by placing one's thumb on them."

Victorian tourist and her escort being helped up the Pyramid courses by Arab guides.

The Great Pyramid was so precisely aligned with the cardinal points of the compass that it surpassed in accuracy any human construction to date.

As the weeks wore on, Petrie realized he would not complete the exteriors before springtime and the arrival of the tourist season; so he had the way prepared for his indoor measurements by having a gang of Arab workmen clear the Descending Passage down to the lower "pit" which Smyth had been unable to reach because of the rubble. Armed with baskets, a chain of workers were able to carry the debris up and out of the main entrance.

When the tourists did begin to trickle toward the Pyramid, Petrie devised a system to avoid being bothered by going about outside the Pyramid in nothing but his pink underwear. At the sight of him, the good Victorian ladies kept a safe distance.

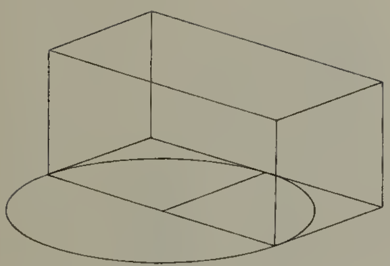
That the tourists were a formidable menace to the pursuit of science had been made clear by Piazzi Smyth, who described "many and multitudinous scenes of lurid-lighted revelry, indulged in by many smoking, tobacco-stinking gentlemen and a few ladies, from some vulgar steamer" who performed "whirling dances over King Cheops' tombstone with ignorant cursing of his ancient name . . . and the painful thunder of the coffer being banged, to close upon breaking, with a big stone swung by their Arab helps."

For lack of salacious statues or pictorial attractions at the Pyramid, the more boisterous tourists would amuse themselves by removing loose blocks from the summit which they would send crashing down to the already vast heaps of rubble accumulated round the base.

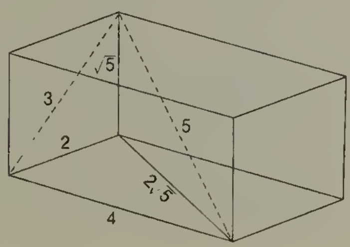
At the end of the day, once the tourists had left, Petrie would work in the intense accumulated heat of the Pyramid, often till midnight and sometimes right through till morning, like "the Japanese carpenter who had nothing on but a pair of spectacles, except that I do not need the spectacles." The ventilating shafts in the King's Chamber, which had been opened by Howard-Vyse, had once more been clogged by vandals, making the air unwholesome. After the first few hours the dust which was raised at every move caused Petrie feverish headaches; but he persevered in his task.

With steel tapes and special chains 1200 inches long, as well as self-compensating accessory appliances, Petrie set about measuring with a far finer accuracy than Smyth could obtain all that was worth noting. Most of Petrie's instruments allowed him to measure to within 1/100 inch, and some, for really careful work, enabled him to do so to within 1/1000 inch.

To measure upright surfaces he used plumb lines; for horizontal surfaces a leveling instrument. Thus he could find the dimensions of a room at any level, and establish where any faults might lie.



To measure the straightness of the sides of the Descending Passage Petrie used fine observations of Polaris at elongation—when it was farthest east and west from the pole. He was amazed to find that the average error in the part built of masonry was an infinitesimal 1/50 inch in 150 feet; and over the entire length of 350 feet the sides were within 1/4 inch of being absolutely straight.



In the King's Chamber, Petrie established to his satisfaction that the walls had been constructed on the basis of the same π proportion which ruled the exterior of the building. Its length was to the circuit of its side wall as 1 is to π.

This value was not immediately evident, because the floor of the chamber had been inserted between the walls so as to cut off a fraction at the bottom. But the cut was cunning in

President Ulysses S. Grant visited the Pyramid as part of a world tour.

In the archives of the Library of Congress lies a faded daguerreotype, with the unmistakable features of the general.

Piazzi Smyth describes the arrival of a party of enthusiastic Yankee tourists atop the Great Pyramid while Smyth was making early-morning observations. "In the short time they were there," writes Smyth, the Americans "arranged themselves into a meeting on constitutional principles of Anglo-Saxon derivation, with a chairman, secretary and audience; wherein a resolution was proposed, recorded and carried unanimously, to the effect—'that whereas this here pile whips everything in the way of building we've seen in all our grand tour through the used-up, worn-out world, yet we calculate King Cheops, its builder, must have been such a horrid old tyrant and cruel oppressor of the people, that it is hereby resolved by us free and independent citizens of the *Unyted* States that we *won't* give him a cheer.' "

After offering thanks to their "excellent chairman for his well-balanced conduct and impartial attitude on his very elevated seat," says Piazzi Smyth, "the gentlemen liquored up, the ladies, as they bashfully expressed it, consented to take a swallow, and the whole party disappeared down the steep slope of the pyramid . . . every man of them with little Confederate flags picked out on the soles of their boots, so that they might have pleasure in trampling on the hated ensign of the South wherever they went."

As an indication of how *tutto il mondo è paese*, Cheops is said (by Sir Gardiner Wilkinson) to have engraved the figures of the Gods of Egypt on the public roads "in order that they might be trodden under foot by man and beast."

that it thus incorporated in the chamber both the 2–$\sqrt{5}$–3 and the 3–4–5 Pythagorean triangles.

Checking to see if the π proportion could also apply to the coffer, Petrie found that its dimensions appeared to be all multiples of a square fifth of a cubit. The difference between the requirements of the theory and the actual squares being a mere 1/1500.*

All of this tended to corroborate Smyth's theory that the builders of the Pyramid had been possessed of an advanced science of mathematics. But Petrie also found in the Pyramid an extraordinary mixture of brilliant workmanship and astonishing clumsiness. He was amazed to find that the granite in the antechamber had never been dressed: many of the stones had been left unfinished and some were even defective. From such indications Petrie concluded that "the original architect, a true master of accuracy and fine methods, must have ceased to superintend the work when it was but half done."

From a careful scrutiny of the coffer in the King's Chamber, Petrie established that the ancients had used saws with 9-foot blades, their teeth made of hard jewels, to cut the sides of the coffer out of a single solid block. To hollow it out they had used drills with fixed cutting points also made of hard jewels, probably diamond or corundum.

Petrie estimated that in order to cut through the hard granite a pressure of 2 tons would have had to be placed on the drill. How this could be done was a mystery to Petrie, who concluded: "Truth to tell, modern drill cores cannot hold a candle to the Egyptians . . . their fine work shows the marks of such tools as we have only now reinvented."

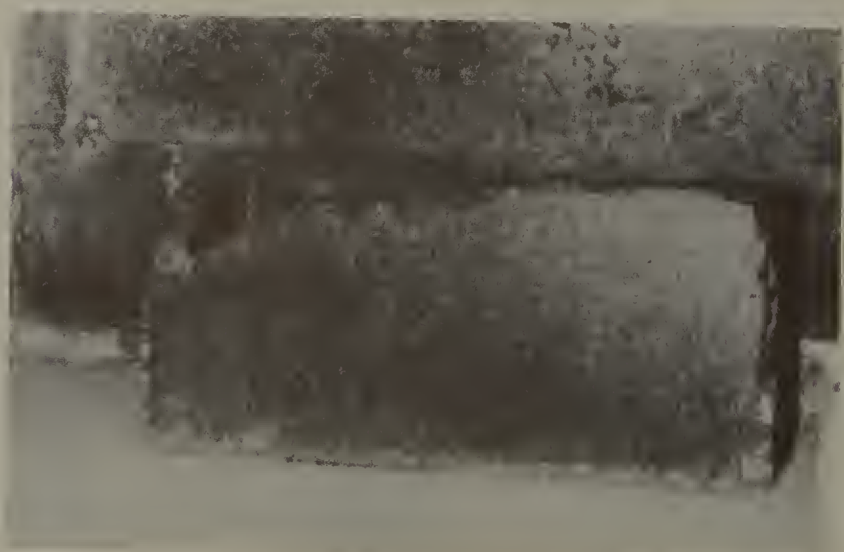
With such tools the ancient Egyptians were somehow able to cut sharp hieroglyphs into incredibly hard diorite, and also to turn stone bowls to paper-thin surfaces.

To measure the bottom of the coffer and to see if there were any secret opening beneath it, Petrie had its 3 tons raised about 8 inches, but found no sign of any opening. When raised and struck, the coffer produced a deep bell-like sound of extraordinary, eerie beauty.

Outside the building Petrie searched for more casing stones still in their original position such as had been

* Petrie also noted that the squares of the dimensions of the King's Chamber, Queen's Chamber, antechamber and subterranean chamber were all even numbers of cubits, nearly all multiples of ten. From this it followed that the squares of the diagonals were likewise multiples of 10 square cubits. And the King's and Queen's Chambers were so arranged that the cubic diagonals were in even hundreds of square cubits, or multiples of 10 square cubits.

Measuring the granite coffer before it was vandalized.



The coffer showing corner chipped away by tourists.

uncovered by Howard-Vyse at the base of the Pyramid. It was a painstaking and dangerous job to dig down through the accumulated debris. The rubble kept sliding back into the holes dug by the Arabs, and at one point Petrie nearly was killed.

Eventually he did manage to uncover more casing stones, as well as the base of the Pyramid. Petrie found the workmanship on the original casing stones, some of which weighed over 15 tons, quite as remarkable as Howard-Vyse had described it. The faces were so straight and so truly square that when the stones had been placed together the film of mortar left between them was on the average no thicker than a man's nail, or 1/50 inch over an area of 35 square feet.

Petrie found that the mean variation of the casings from a straight line and a true square was but 1/100 inch on a length of 75 inches. This staggering accuracy was equivalent to the most modern optician's straight edges.

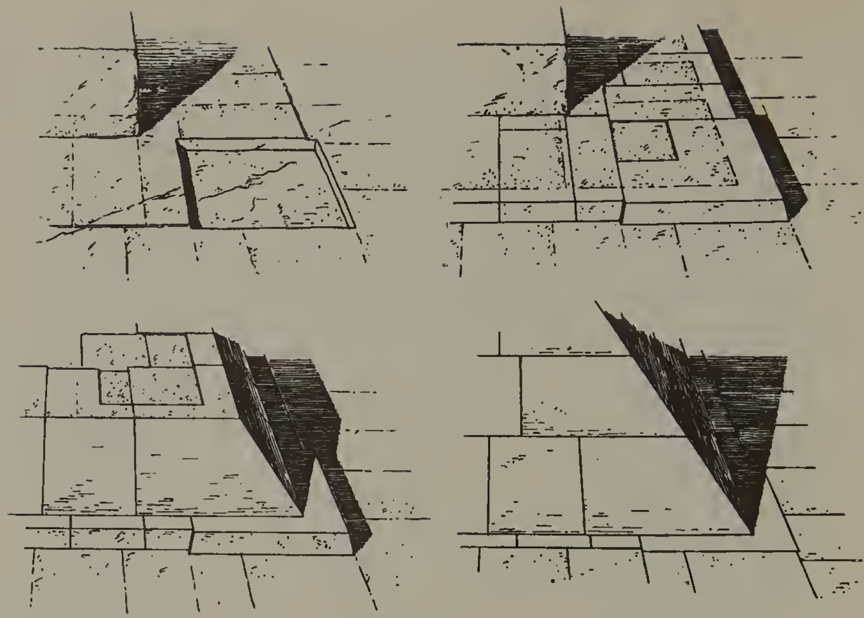
As Petrie remarked, "Merely to place such stones in exact contact would be careful work, but to do so with cement in the joint seems almost impossible: it is to be compared to the finest opticians' work on a scale of acres."

So fine was the texture of the cement that after millennia of exposure to the elements, the stones shattered before the cement would yield.

The casing stones of the Great Pyramid (looking east), showing the platform on which they rest, the pavement in front, and the leveled natural rock.

Shallow sockets dug into the rock at the corners of the Pyramid were designed to hold the four cornerstones for the base, and were apparently cut through the pavement at these points. This has engendered an argument among pyramidologists as to whether the base circuit should be measured from the edge of the pavement or the edge or bottom of the sockets.

It was at first assumed that the bottom of the Pyramid cornerstones had been fitted into these sockets so as to counterbalance any eventual thrust produced by sliding away from the center of the structure, but modern archeologists discount the assumption because at the northeast corner, the depth of the socket is virtually zero; and the outer edge of the southwest socket is merely an incised line In the rock, more for measurement than for structural support.



But the principal result of Petrie's survey was to prove a little abstruse. He considered the true base length of the Pyramid to be defined *not* by the limit of the sockets as measured by Smyth, but by the edge of the pavement 20 inches higher.

According to Petrie's measurements, the base of the Pyramid at the *pavement* was shorter than the distance between the outer corners of the sockets, as estimated by Smyth. Instead of measuring the 9140 British inches claimed by the Scottish astronomer, Petrie obtained a length of only 9069 inches for the base line.

Discarding Piazzi Smyth's theory that the Pyramid had been designed on an extra-long pyramidal cubit of 25.025 inches, Petrie showed by his own careful measurements that the builders of the Pyramid had used the royal cubit of 20.63 inches in order to produce a base line of 440 cubits and a height of 280 cubits. This confirmed Taylor's theory to the extent that the Pyramid was intended to symbolize the globe by giving a very effective π value of 22/7, or 3.14285, but apparently nullified Smyth's theories about the perimeter of the Pyramid giving the exact number of days in the year. The new product gave only 362.76 days.

Summing up the results of his measurements in a book entitled *The Pyramids and Temples of Gizeh* (which he was able to publish with a fortuitous grant of £100 from the Royal Society in London), Petrie remarked that he had never suspected, 15 years earlier, when he had first read Smyth's fascinating theory, that it would be he who "would reach the ugly little fact which killed the beautiful theory."

With success and recognition, Petrie turned from the romantic exploits of discovery to the prosaic minutiae of scientific archeology.

In the wake of Petrie's demolition of Smyth's basic contention about the length of the year being incorporated in the Pyramid's perimeter, soured academicians were happy to bury Smyth along with his theories. Foremost among such undertakers was Professor F. A. P. Barnard, president of Columbia College in New York, whose spadework in the 1890s consisted in arguing that the value of π was a modern discovery and therefore could *not* have been known to the ancients. In long-winded pieces for small periodicals, Barnard attacked Smyth for his "folly," and the builders of the Pyramid for the "stupidly idiotic task of heaping up a pile of massive rock a million-and-a-half cubic yards in volume."

In Barnard's opinion the Pyramids "originated before anything like intellectual culture existed; have been constructed without thought of scientific method, and have owed their earliest forms to accident and caprice."

Other academicians mocked the theory that the ancient Egyptians could have had an advanced knowledge of geometry, geodesy or astronomy. As recently as 1963 an eminent engineer in Baltimore, author of an expensive privately printed booklet, *Designing and Building the Great Pyramid,* was to write: "Because the sides of the Great Pyramid faced the four cardinal points almost precisely it is usually assumed that the designers intended they should, but it is unlikely that they had more than a vague idea, if any, of the four cardinal points. Like all peoples, the ancient Egyptians knew east and west from seeing the heavenly bodies rise in one and set in the other, but north and south were probably only known to them as general directions. There is no evidence in the Great Pyramid that they had any conception of true north or knew that a north-south line was perpendicular to an east-west line."

For years Smyth's painstaking measurements, carefully collected and illustrated in several large volumes (which went through several editions in his lifetime), were labeled by the academicians so much "trash and fancy."

In the conflict of opinions between biblical scholars and men of science, the true purpose of the Great Pyramid was buried in a rubble of verbiage.

Petrie had become Sir Flinders, and was on his way to becoming the dean of academic archeologists. Had it not been for the careful work of some conscientious scholars, Smyth and Taylor would have suffered the fate of Paracelsus and Mesmer, being relegated in the history books to the role of mountebanks.

IX. SCIENTIFIC THEORY DEVELOPED

Ironically, the next great investigator to throw light on the question of the Pyramid was a man whose object was to destroy and dispose of the theories of Robert Menzies, whose ideas about the prophetic revelations in the passage system had added to the difficulties of Piazzi Smyth.

An agnostic and a sober structural engineer from Leeds, in the north of England, David Davidson was determined to destroy Menzies' prophetic theory. But the more he attacked the data, the more he was obliged to assimilate it. In the end he was to produce an encyclopedic literature in support of Menzies' own idea, and to become convinced that the Pyramid was "an expression of the Truth in structural form" and that it "establishes the Bible as the inspired work of God."

From further analysis of the Pyramid, Davidson believed he could confirm Taylor's premise that the science of weights and measures of the ancients was founded upon two functions of the earth and its orbit, the standard time unit being the solar year, and the standard linear unit a decimal fraction of the polar axis about which the earth rotates.

On the question of the length of the Pyramid's base, Davidson was to vindicate Smyth, yet avoid harming Petrie. According to Davidson, not only was Petrie's survey correct, so was Smyth's theory that the Pyramid's base incorporated the length of the solar year.

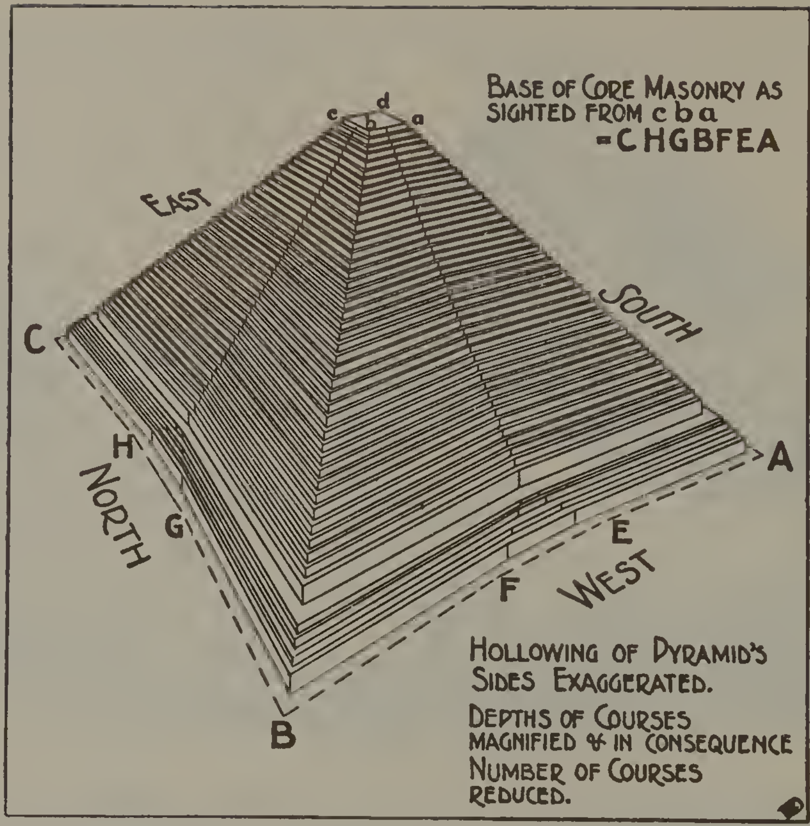
Petrie, with his meticulously careful measurements, had managed to observe a definite hollowing of the core masonry on each side of the Pyramid. The accuracy of this observation, normally invisible to the human eye, was revealed in Petrie's lifetime in a dramatic aerial photograph taken accidentally at a specific time and angle by Brigadier P. R. C. Groves, the British prophet of air power. A similar line along the apothem, visible in an etching made by Napoleon's savants, had been ignored for a century.

Davidson noted that Petrie had failed to extend this hollowing feature of the core material to his measurement of the outside casing. If this were done, a base length was obtained which fitted Smyth's theoretical length to account for the solar year, to four points of decimal.

Sir Flinders Petrie noted a distinct hollowing of the core masonry in the central portion of each face of the Pyramid. Though the hollowing amounts to as much as 37 inches on the north face, it is not directly observable unless special lines of sight are taken.

Petrie found no evidence of hollowing along the lower-level casing stones, running along the base of the Pyramid, which have now been completely uncovered.

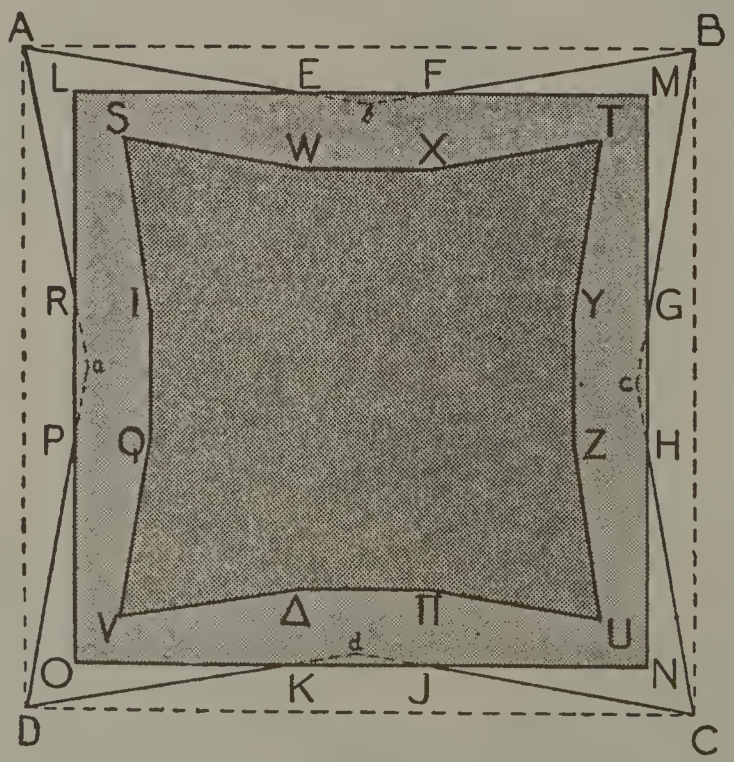
A recent survey by two Italian scholars, Maragioglio and Rinaldi, indicates the casing stones *above* the base line may have been slightly sloped toward a central line.



Davidson's plan of the base of the Pyramid, showing three different ways of measuring the year's length.

CONSTRUCTION OF THE GREAT PYRAMID'S BASE.

(Hollowing-in of core masonry GREATLY EXAGGERATED to show effect.)



LMNO—Base as actually built.
SWXTYZUΠΔVQI—Base of core masonry.

As Davidson put it: "By reason of this unfortunate omission, scientists have been led to believe that the theory of the late Astronomer Royal of Scotland—Professor Piazzi Smyth—requiring a Great Pyramid base circuit of 36,524 inches, was nothing more than a delusion."

The ideal length postulated by Smyth for each side of the base in order to obtain the required length of 9131.5 Pyramid inches was 9141.1 British inches. Petrie's figure, revised by Davidson, came out to 9141.4, or about a third of an inch too long.

According to Davidson, the hollowing effect would give three basic lengths of the year as recorded in the base of the Pyramid: an outer or shortest length, from corner to corner, bypassing the hollowing, a second, slightly longer, which included part of the indentation of the four hollowed faces at the base; and a third, which included the entire angle within each hollowed face. These three measurements, which could have been performed by the ancients at their leisure, could have given the equivalents, according to Davidson, of the three lengths of the year as computed by modern science: the solar, the sidereal, and the anomalistic years, each of which is dependent on the system used for observation.*

The academicians rebutted that all this was purely attributable to chance. An American naval officer who dabbled in digging at Giza remarked that "if a suitable unit of measurement is found—say versts, hands or cables—an exact equivalent to the distance of Timbuctu is certain to be found in the roof girder work of the Crystal Palace, or in the number of street lamps in Bond Street, or the Specific Gravity of mud, or the mean weight of an adult goldfish."

But Davidson's conclusions were to reopen the entire subject of Pyramid measurements and breed a whole new school of pyramidologists.

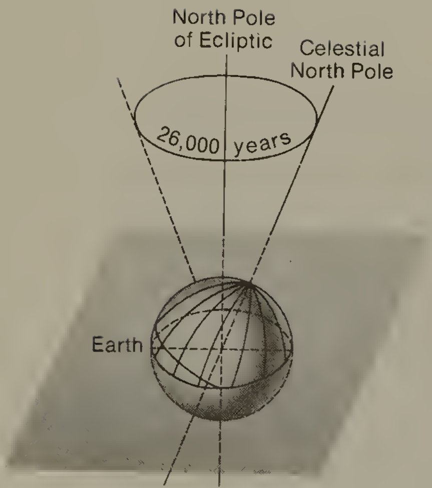
* The solar year is obtained by observing the exact time between two successive vernal or autumnal equinoxes, when the day is exactly as long as the night. It is now 365 days, 5 hours, 8 minutes and 49.7 seconds, or in decimals: 365.2242. The sidereal year (from the Latin *sidus,* for star) is the time it takes a star to reappear in the same spot in the sky, as seen by an earth observer. It is about 20 minutes longer than the solar year, or 365.25636 days. This 20-minute lag causes what is known as the precession of the equinoxes, which come 20 minutes earlier each year in relation to the stars behind the equinoctial point. The anomalistic, or orbital, year is the time it takes the earth to return to the point in its elliptical orbit nearest the sun, or perihelion. This is about 4 3/4 minutes longer than the sidereal year. According to Davidson, not only does the Pyramid give this value, but it gives the number of solar years it takes for the perihelion to complete a full circle of 360°.

The president of the French College of Astrologers, D. Neroman, a mining engineer by profession, showed in his *La Clé Secrète de la Pyramide,* published shortly after World War I, that Smyth's sacred cubit and Petrie's royal cubit were mathematically related. Neroman revived Newton's conclusion that the Pyramid had been built with both basic cubits, Petrie's shorter cubit for the common workmen, and Smyth's longer cubit for the hermetic science of the designers. Neroman showed that the Pyramid was the precise height and width to contain a round number of each unit. As 33 sacred cubits are equal to 40 profane, or royal, ones, the base measured 440 royal cubits or 363 sacred cubits; the height 280 or 221.*

It was suggested that the priests measured the year's length with a sacred cubit so that they alone could make use of the Pyramid's hermetic science. But why this yielded a base of 363 days was not satisfactorily explained.

Another necromantic solution was provided by John B. Schmaltz in a small book entitled *Nuggets from King Solomon's Mines.* Schmaltz demonstrated that the modern deck of cards could be taken as a symbol of the Egyptian year incorporated in the Great Pyramid. According to Schmaltz the 52 cards represent the weeks, the 12 face cards the months, the 13 cards in a suit the lunations, the suits the seasons, the total face value of the cards (counting jack as 11, queen as 12 and king as 13) 364 days, plus the joker as the magic 1.234, for a total of 365.234 days in the year.

A more solid boost to the memory of Piazzi Smyth—quickly made much of by the pyramidologists—was the refined figure for the polar axis of the earth obtained in 1910 by the American geodesist John Fillmore Hayford, who computed it at 6,356,910 meters, the ten-millionth part of which gives a cubit of 635.69 millimeters, or Piazzi Smyth's sacred cubit, correct to .03 millimeter.



The precession of the equinoxes.

Another extraordinary figure found by the pyramidologists in the base of the Pyramid was the sum of its diagonals, which they computed as 25,826.68 pyramid inches. This gave a very close approximation of the number of solar years in what is known as the great year, which is determined by the precession of the equinoxes. The great year is the time it takes the earth to make a complete gyration in the wobble of its axis in relation to the plane of its orbit; this with the solar year, are the two prime standards for astronomical time.

Actually, the rate of precession is far from uniform, and

* $33 \times 25.025 = 825.72$ and $40 \times 20.643 = 825.72$. It will be noticed from Neroman's figuring that to obtain this result he arbitrarily lengthened the royal cubit by about 1/100 of an inch.

is at present slowly increasing. According to Davidson, the Great Pyramid recognized this fact and provided a method of sums of diagonals at different levels of the monument to indicate the all-time mean, or average length of the precessional cycle.

To add to the coincidences, Morton Edgar, an ardent supporter of Davidson, who traveled to Egypt just prior to World War I and made extensive measurements and calculations, found that the perimeter of the thirty-fifth course, which is much thicker than any of the other courses, *also* gives a figure for the precession of the equinoxes.

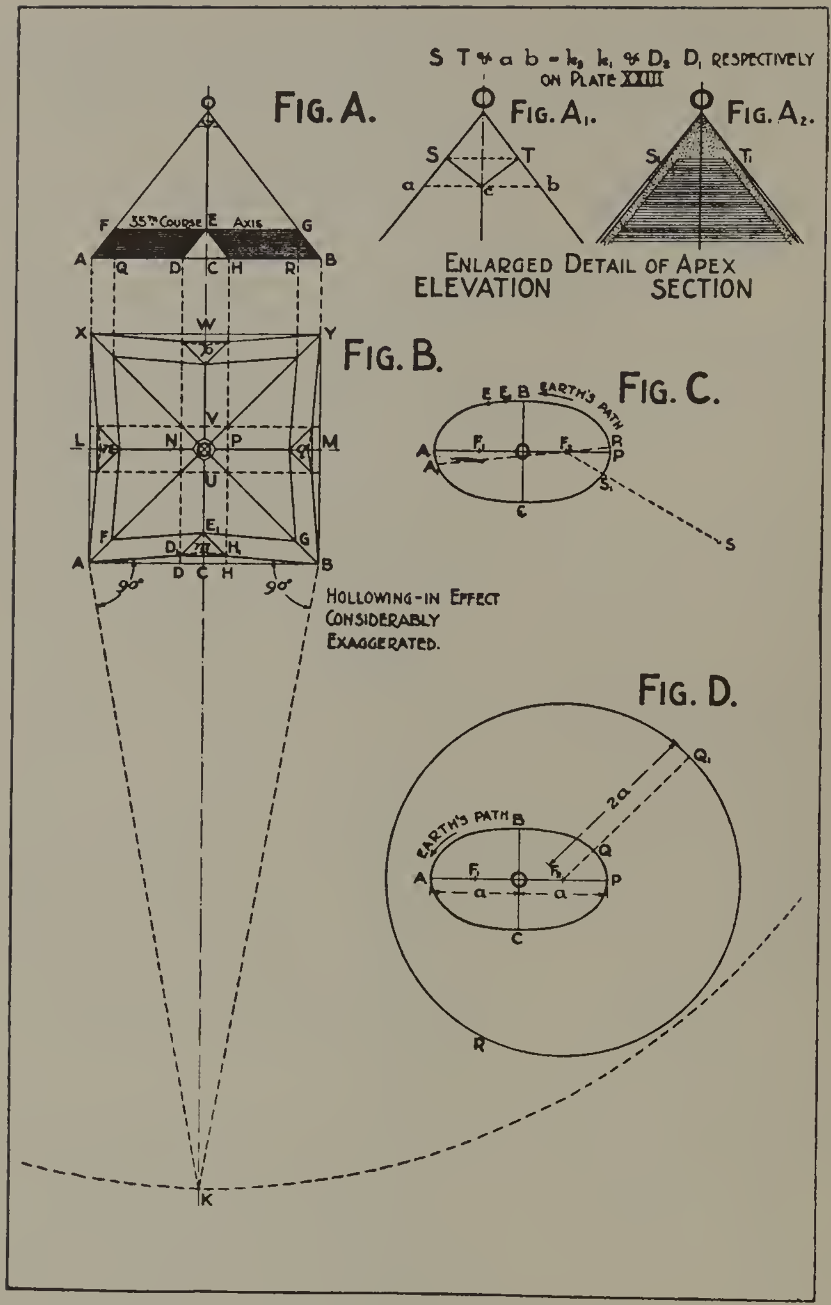
Egyptologists and astronomers argued that if the Pyramid had been designed to incorporate the π proportion, and its base had been designed to be 365.2422 cubits long, the chances of its diagonals being intentionally designed to mark the length of the precession would be simply astronomical.

Davidson replied that to build the Pyramid its designer must have been deeply acquainted with the workings of natural law: that before such a design could be put into effect, the astronomical properties of the solar year would have to be reduced to a simple pyramidical expression.

Davidson claimed that—without getting into higher mathematics—it was evident that if you know the earth's distance from the sun and the length of the sidereal year in seconds, you can compute the rate at which the earth is falling toward the sun. This in turn would lead to finding the specific gravity of the earth, of the sun, of the earth and moon combined, the solar parallax, and even the speed of light.

To Davidson the mathematics of the Pyramid indicate that the former civilization was more highly skilled in the science of gravitational astronomy—and therefore in the mathematical basis of the mechanical arts and sciences—than modern civilization. It was his conclusion "that it has taken man thousands of years to discover by experiment what he knew originally by a surer and simpler method." In Davidson's words: "It means that the whole empirical basis of modern civilization is a makeshift collection of hypotheses compared with the Natural Law basis of the civilization of the past."

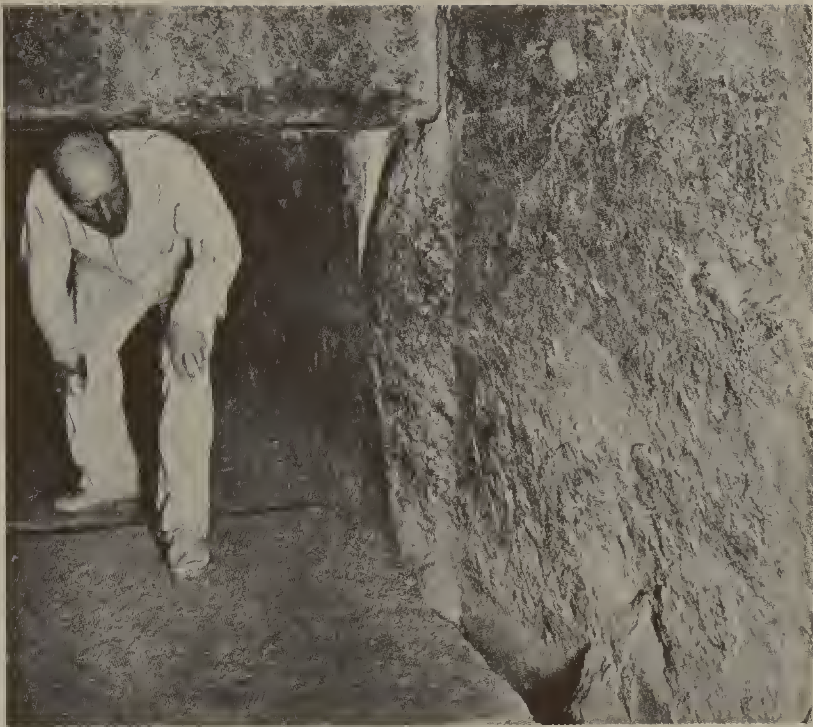
As to why the Pyramid was built and its passages carefully secreted, Davidson surmised that the builder intended to monumentalize the science of his time for another civilization far in the future, much as we go about burying time capsules. According to Davidson, the builder knew that the faculties by which he was able to handle the formulas of natural law could atrophy in man, and that by conveying his science to beings of a later civilization he might spur them to recover those powers.



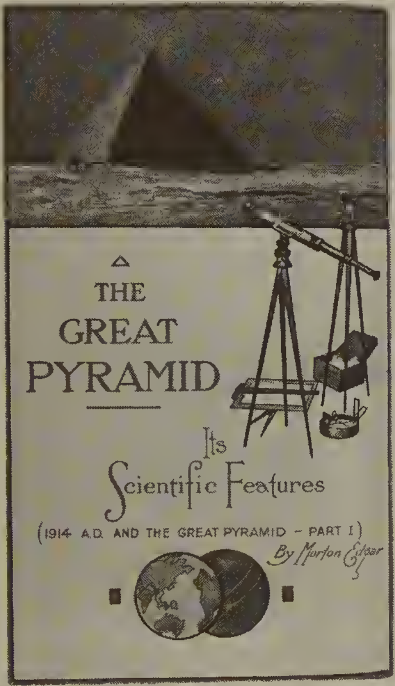
Davidson's computations to show that the Pyramid's base defines the earth and its orbit "in dimensions and motion."

Like Menzies and Smyth before him, all that Davidson managed to accomplish was to antagonize the scientific world with his insistence upon the record-preserving nature of the Pyramid while swamping the average pyramid enthusiast with the overwhelming bulk of his detailed mathematical analyses and computations.

Even worse were the efforts of a succession of pyramidologists who attempted to prove the Great Pyramid contained a six-thousand-year prophetic history of the world commencing in 4000 B.C. and going to A.D. 2045 which coincided with the prophecies of the Bible. They saw in the Pyramid an allegory in stone in which the Descending Passage represented humanity on its way down toward



Morton Edgar, supporter of the prophetic theories about the Pyramid, stooping to enter the King's Chamber. The picture shows how the floor was inserted between the walls so as to obtain both the π value and the 3–4–5 triangle.



ignorance and evil. At the juncture of the Ascending Passage, evil spirits were to continue toward the pit, whereas the rest of humanity, benefiting by the Christian Dispensation, moved upward along the Ascending Passage toward the Light of the Grand Gallery. Having passed the Great Step, humanity must continue bent in submission through the Antechamber of Chaos—representing the modern age—before it could come out into the King's Chamber and the glory of the Second Coming.

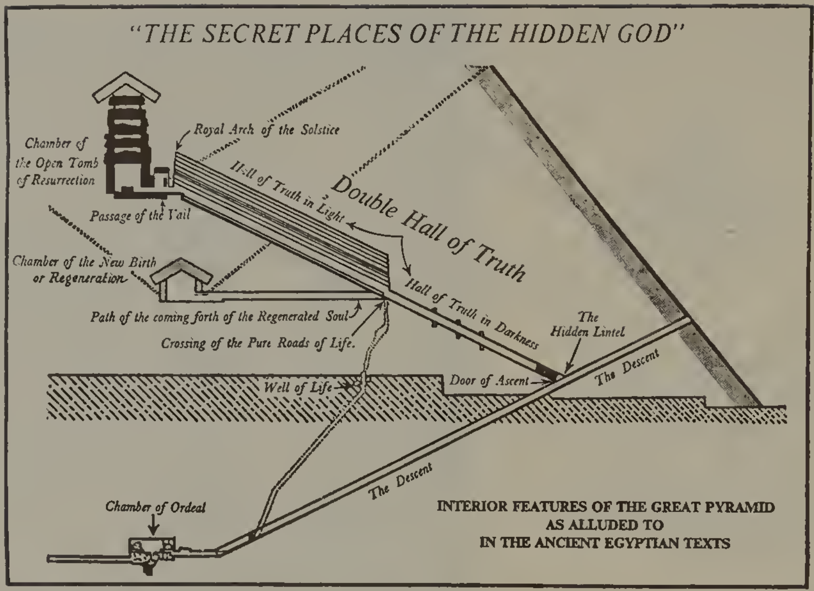
The prophetic chronology was supposed to be marked out along the passages and chambers, with one year corresponding to one pyramid inch, commencing with "Adam," or the "first created man," and ending with the "Day of Judgement."

According to Morton Edgar: "By the year 2914, the end of the 1000-year 'Day of Judgement,' mankind will have experienced the full benefit of the sacrificial work of Christ, and will regain that perfect human nature which father Adam lost in the beginning of his disobedience 7040 years previously."

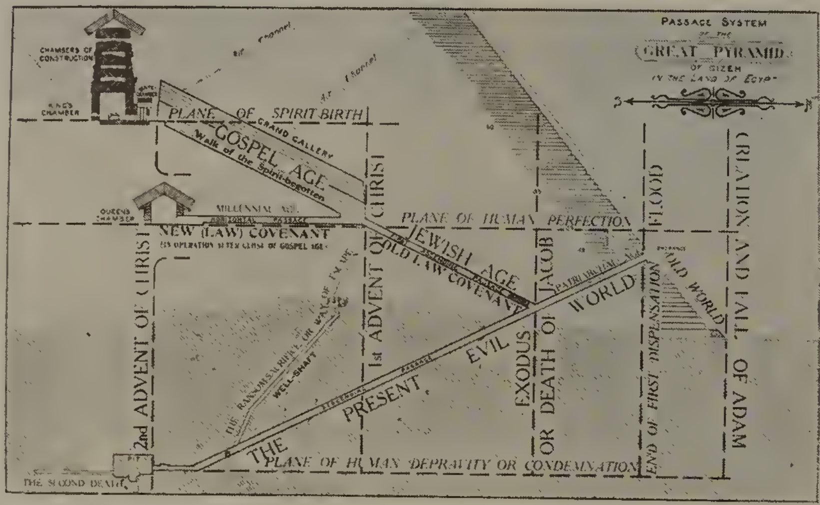
By general agreement the commencement of the Low Passage into the Antechamber was said to mark the beginning of the Great War in 1914. The end of the King's Chamber was supposed to be indicated by the year 1953.

Considering the wide popular acceptance of such medieval prophets as Nostradamus, and such modern prophets as Edgar Cayce and Jeane Dixon, it should not have been harder to believe that some ancient prophet could

Interior features in the Great Pyramid alluded to in the ancient Egyptian texts such as *The Book of the Dead,* according to the prophetic "pyramidologists."



Chronology of the past 6000 years as indicated in the Great Pyramid passages according to Menzies and Piazzi Smyth.



have had prescience of the following 6000 years, and built his vision into the Pyramid passages; but as each prophetic date went by with no appearance of a Second Coming, the idea of the Pyramid as a prophetic calendar became largely discredited.

By 1920, when the waters of the Mediterranean failed to become thick and viscid, and the rivers and fountains of the world failed to turn into blood, as prophesied by Colonel J. Garnier on the basis of the Pyramid chronology, the whole subject became so unpleasant in the halls of academe that few professors dared mention the Pyramid as anything but the supposed resting place of the Pharaoh Cheops.

Nevertheless, a few intrepid investigators kept minds open enough to continue their research into the structure and purpose of the Pyramid, and to put forth some theories that in the end paved the way for a general vindication of much that Jomard, Taylor, Smyth, and even Davidson had propounded.

X. A THEODOLITE FOR SURVEYORS

One basic function of the pyramids on the Giza plateau was discovered by a chief engineer of the Australian railways, Robert T. Ballard, as he watched them from the window of a passing train in the 1880s.

From the constantly changing relative position of their clear-cut lines against the sky, Ballard realized that the pyramids could serve as excellent theodolites for a land surveyor, enabling him to triangulate the land anywhere within sight of the pyramids.

The land of ancient Egypt was parceled out in small lots to individual priests and soldiers, the boundaries of which would regularly vanish with the flooding of the Nile.*

By means of the pyramids, not only could the surrounding country be quickly resurveyed, but boundaries destroyed by the Nile could be readily restored.

From the silhouettes of the pyramids, the engineer realized that lines could be obtained as perfect as can be laid out nowadays with all of our modern instruments. With a string and a stone held in the hand and the clear-cut point of a pyramid 20 miles away against the ball of the sun 90 million miles away, the error in such a line would be trifling.

What's more, the same building could also be used with either moon or stars.

Knowing the latitude of the pyramids, survey lines could be shown all the way to the coast of the Delta—with nothing more than a string and a weight.

As the engineer's train steamed southward along the bank of the Nile, more pyramids appeared on the horizon, and the engineer realized that with a procession of such theodolites it would have been possible to adjust the boundaries of Egypt from one end of the country to the other.

Ballard figured that the simplest portable survey instrument would be a small scale model of the Pyramid of Cheops in the center of a circular graduated board marked like a compass. When the north end of the card was pointed toward the north, and the faces of the model turned to indicate the same light and shade displayed by the Great Pyramid, the

* Statisticians estimate that eight million people were crowded into a space of only 11,500 square miles, giving a density of 695 per square mile—which is more than modern Belgium, the most densely populated part of Europe.

Fig. 38.
From the North West
Bearing 315°
Sun in the West.

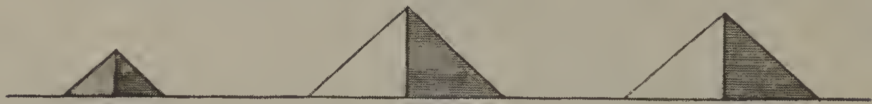


Fig. 39.
From the South East
Bearing 135°
Sun in the West

The pattern of shadows cast by the three large pyramids of the Giza plateau can serve to orient the viewer as accurately as a compass or theodolite. Ballard suggests that the smaller pyramid of Mykerinos was intentionally sheathed in red granite, in bold contrast to the other two pyramids, so as to facilitate the work of the surveyor.

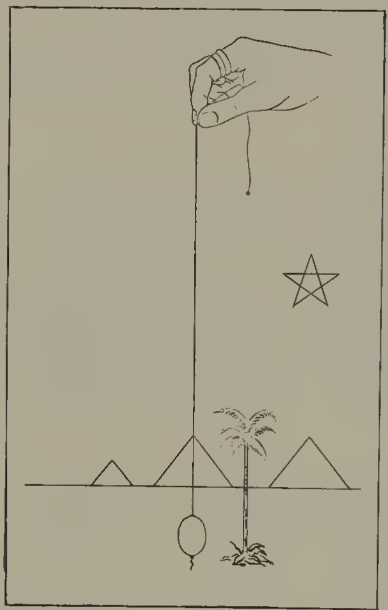


Fig. 40.
From the North East
Bearing 45°
Sun in the East.

Fig. 41.
From the South West
Bearing 225°
Sun in the East

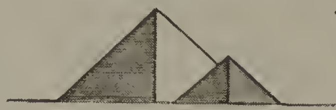


Fig. 42.
South 21 West 20.
Bearing 223°. 36'. 10·15".

Fig. 43
South 4. West 3.
Bearing 216°. 52'. 11·65".

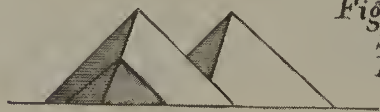


Fig. 44.
South 2. West 1.
Bearing 206°. 33'. 54·18".

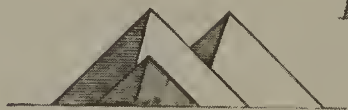


Fig. 45.
South 96. West 55.
Bearing 209°. 48'. 32·81".

Fig. 46.
South 3. West 1.
Bearing 198°. 26'. 5"82

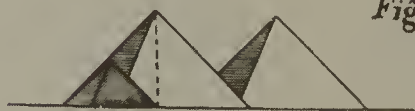
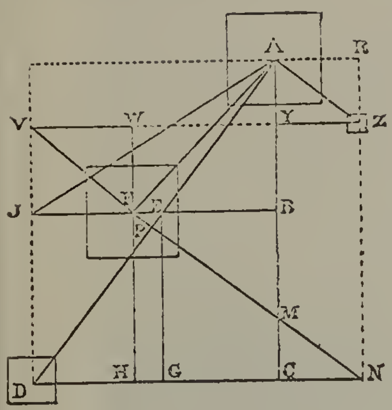


Fig. 47.
South 5, West 2.
Bearing 201°. 48'. 5".

Fig. 48.
South 7. West 3.
Bearing 203°. 11'. 55".



The Giza complex of pyramids, as depicted from the air, showing the north-south meridian through the center of the Great Pyramid.
According to Soviet space engineer Alexander Abramov the three large pyramids on the Giza plateau are arranged in a special geometric configuration known in ancient Egypt as an *abaka*. Ballard found that several Pythagorean triangles could be formed by the perimeters and centers of the pyramids.

surveyor could simply read off the angle of bearing. With a model of all three pyramids, the reading would be that much more exact. Furthermore, observation of the next pyramids farther to the south could be tied in with these readings.

The Australian engineer also worked out that the pyramids could be used for surveying by right-angled triangles with sides having whole numbers, such as the 3–4–5 triangle and the 2–$\sqrt{5}$–3 triangle Petrie had found in the King's Chamber, both of which were fundamental to land surveying. Similarly incorporated in the ziggurat of the Babylonians, the triangles were conceived by the ancients to explain the secret order of the cosmos, a conceit which percolated to Plato. In the *Timaeus* he explains the cosmos as being constructed by the triangle 3–4–5 and the number $\sqrt{5}$–1 or 1.236068 (which in common practice was taken as 1.2345).

For right-angled trigonometry, the Australian engineer realized, true straight lines could be extended from the pyramids in given directions by direct observation, without aid of other instruments, and that with the simplest of instruments, angles could be exactly observed from any point.

In a short time *anyone* might construct a table for himself answering to every degree or so in the circumference of a circle for which only forty or fifty triangles are required.

Such primary triangulation would be useful to men of almost every trade and profession in which tools or instruments were used.

Having come to these conclusions, Ballard incorporated them in a small illustrated volume with the rather grand title of *The Solution of the Pyramid Problem,* published in 1882.

XI. ALMANAC OF THE AGES

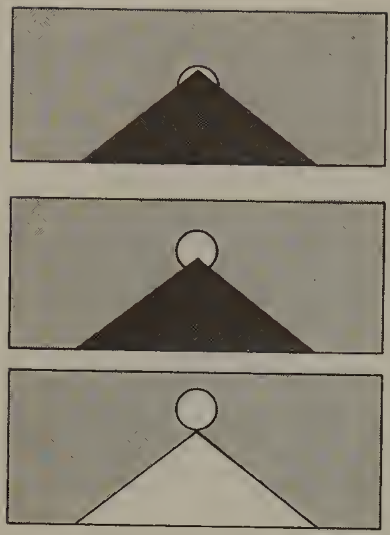
Ballard's little booklet and one of Smyth's discoveries at the Pyramid brought another strange investigator to the scene. Smyth had been astonished that with the advent of spring, when the sun rose high enough to shine down the northern slope of the Pyramid, the structure appeared to swallow its own shadow at noon. Smyth deduced that the Pyramid had been designed as a huge sundial whose shadows could indicate the seasons and the length of the year.

By Smyth's reckoning the Pyramid had been intentionally located, oriented, and sloped for the phenomenon to occur in that latitude at the spring equinox, when at noon the sun is directly over the equator, although for some reason the phenomenon no longer occurred precisely at that particular date.

Unbeknownst to Smyth, the French astronomer Jean Baptíste Biot had been to Egypt in 1853 and noted that "with or without intention by the Egyptians who built the Great Pyramid, it has, since it existed, functioned as an immense sundial which has marked annually the periods of the equinoxes with an error less than one day, and those of the solstices with an error less than a day and three quarters."

The phenomenon had a great impact on an obscure Yorkshireman, Moses B. Cotsworth, a legislative enthusiast whose life's ambition was to reform our present barbarous almanac.*

* The present calendar derives from the early Romans, who had a 10-month year of 334 days: hence our September, October, November, December. In the seventh century B.C. Numa Pompilius is credited with adding January and February for a lunar year of 354 days. The shortage of 11 1/4 days caused the seasons and the calendar to diverge to the point where Julius Caesar was obliged to add 91 days to 46 B.C. and succumb to the suggestion of Cleopatra that he adopt the Egyptian civil calendar of 365 1/4 days. Even so, the difference between the civil calendar and the actual solar year of 365.2422 days added up to an extra day every 128 years, which obliged Pope Gregory XIII to drop 10 days from 1582. When Protestant England refused to go along, Christendom celebrated different Christmases in England and France, till the British finally relented in 1752, though there were street riots in London with shouts of "give us back our ten days." By skipping leap days in centuries which are multiples of 400 and 4000, our calendar is now good for the next 20,000 years, but anyone who troubles to read Cotsworth's impassioned plea for a more rational system than our calendar of floating holidays will find it hard to dispute his logic.



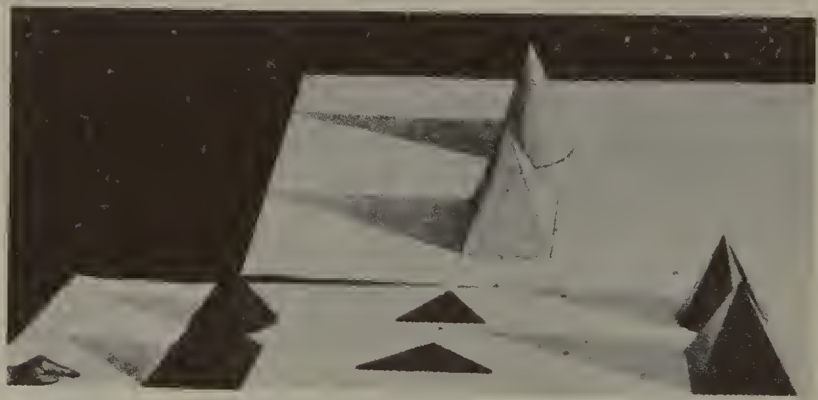
In early spring, when the sun rises just high enough above the apex of the Great Pyramid, the whole shadow on the north face vanishes at the stroke of noon.

Cotsworth was convinced that the designers of the Pyramid had intended their finished structure to serve as a perfect almanac for registering the seasons and the year. To prove his point Cotsworth went in search of further evidence.

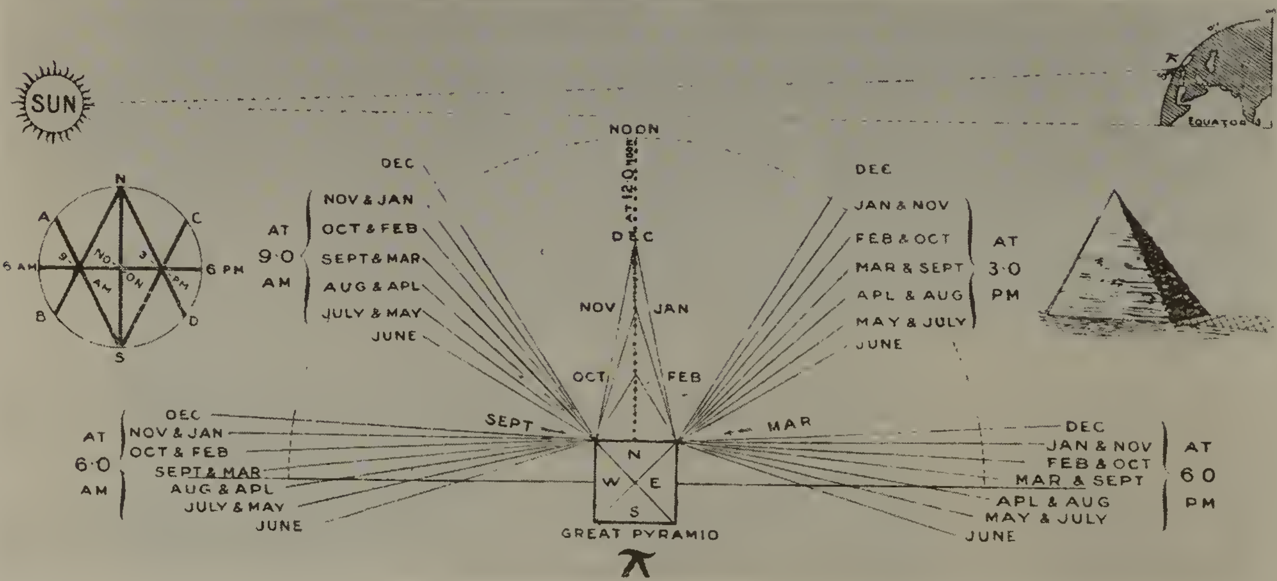
Just before Piazzi Smyth died in 1900, Cotsworth managed to have several conversations with him, and after his death was able to get hold of Smyth's books and papers when they were put up for auction. Though Cotsworth refused to accept Smyth's prophetic theories, he was determined to vindicate the astronomical theories of the ancient Egyptians, so he set about reconstructing with models the sundial system on which he believed the Pyramid had originally been designed.

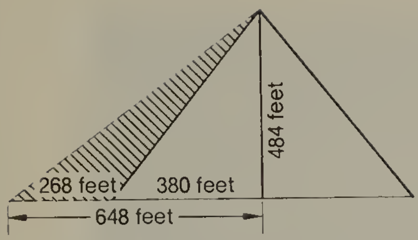
Cotsworth noted that at the latitude of the Pyramid, an ordinary obelisk would serve admirably for telling the time of day, or the general course of the seasons, but could not be built high enough to throw a shadow long enough to detect the length of a whole year of 365 days, let alone throw a shadow fine enough to distinguish the extra quarter of a day to four points of decimal. To obtain the difference in length of 1 foot per day would require an obelisk 450 feet tall, perfectly vertical and precisely oriented.

Cones and pyramids designed by Moses B. Cotsworth to demonstrate how shadow patterns could be used to measure the length of the year.

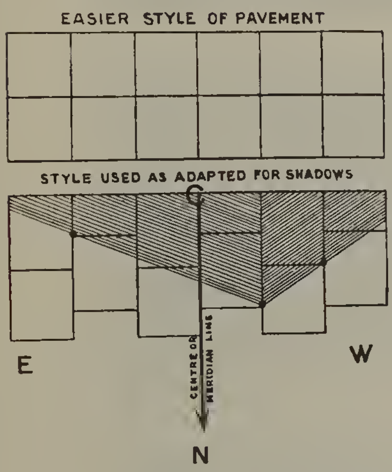


Cotsworth's models show how a square-based pyramid oriented to true north will cast a pointed shadow on the meridan line. A cone, showing no orientation, will not serve the purpose.





With the sun's winter solstice angle of 36° 45′, the Pyramid will throw a shadow of 648 feet. Deduct half the Pyramid's base length of 760 feet, or 380, and the maximum length of the Pyramid's winter shadow will be 268 feet.



Cotsworth found that part of the pavement north of the Pyramid was paved with blocks whose widths were close to the 4 1/2-foot gradation of the sun's shadows on successive days just before the Pyramid consumed its own shadow in the spring.

Cotsworth figured that the dimensions of the Pyramid would be ideal for measuring the six winter months, when the northern slope of the Pyramid is constantly shaded and when the shadow cast at noon onto the northern pavement grows longer up the meridian to a maximum at the winter solstice, gradually decreasing to the point of disappearance at noon on a certain day in March.

To test his theory, Cotsworth made several model pyramids and cones and laid them out on carefully diagrammed paper. On these sheets he marked the outline of the shadow cast by the sun each half hour during a period of several months.

To his satisfaction Cotsworth was able to prove that the pyramid was the best shape for the purpose. The pyramid was more easily oriented to a perfect north, its flat slope was easier to angle, and its sharp edges cast a better shadow. Also, the actual structure would be easier to build to the required height in the form of a pyramid than a cone.

To measure the Pyramid's lengthening and shortening shadows, Cotsworth realized that a wide and perfectly level pavement, or "shadow-floor," should have been constructed on the northern side of the Great Pyramid, presumably with a meridian line running due north, and a pavement laid in some geometric pattern to facilitate the measuring of the shadows.

Cotsworth worked out that a structure 484 feet high, such as the Pyramid of Cheops, would require a "shadow-floor" stretching 268 feet northward of the base in order to include the full length of its shadow at its longest point, at the winter solstice in December.

To verify his theory, Cotsworth sailed for Port Said in November of 1900 aboard the P. & O. liner S.S. *Osiris*. At the Giza plateau he found the north side of the Pyramid of Cheops reasonably clear of rubble and the rocky plateau leveled to the required distance. At the level of the main platform on which the Pyramid rests, he found a pavement, or "shadow-floor," which extended as far as the remains of an old wall which had once surrounded the pyramid complex.

Instead of being paved in adjacent squares, Cotsworth found it laid in alternate half squares, which provided twice the number of junction points by which to measure the daily shadow of the Pyramid along the meridian at noon.

To support his observations, Cotsworth made a series of photographs of these shadows as they grew shorter toward the vernal equinox. To his delight he found that the paving blocks had been cut in widths very close to the 4.45-foot gradation by which each noonday shadow succeeded the former as they approached the vanishing point in March.

Photograph taken by Cotsworth showing shadow cast by the sun close to the base of Pyramid at noon of the last day before the intended equinox. The negative was stolen and the print has suffered in reproduction; but the pattern of shadow can be measured on the northern pavement.

It was only thus, says Cotsworth, "that the ancient priests could have established by physical observation of the shadow on the flagstones, the precise length of a year to .24219 of a day."

William Kingsland, a professor of astronomy, commenting on Cotsworth's conclusions, pointed out that some of the paving stones are actually laid at all kinds of irregular angles and corners; but the corners of these stones are clearly cut out to fit into the adjoining stone—indicating, if anything, an even more sophisticated geometric pattern.*

To make up for the summer half of the year, when there

* According to Kingsland, Cotsworth's leveled rock area did not extend 268 feet north from the northern base of the Pyramid, but ended at a distance of only 33 1/2 feet, where there are the remains of a surrounding wall 9 1/2 feet thick; but there is no way of telling at what time this wall was built, or whether the pavement may not have once continued beyond it, and been dismantled by the Arabs for building blocks.

was no shadow on the northern slope of the Pyramid, Cotsworth figured that the priests could have subdivided and tabulated the intervening months.

In this he failed to realize that the southern face of the Pyramid, being highly polished, could throw a triangle, not of shadow, but of sunlight onto a southern pavement during the summer months, quite as definite as the winter shadows thrown on the northern side.

From May to August the south face would cast a triangular reflection of the sun onto the ground which would shorten as it approached the summer solstice, the shortest being at noon of the solstice, lengthening again till noon of the last day of summer.

Noon reflections would also be projected every day of the year from the east and west faces. But this was to remain for David Davidson to establish.

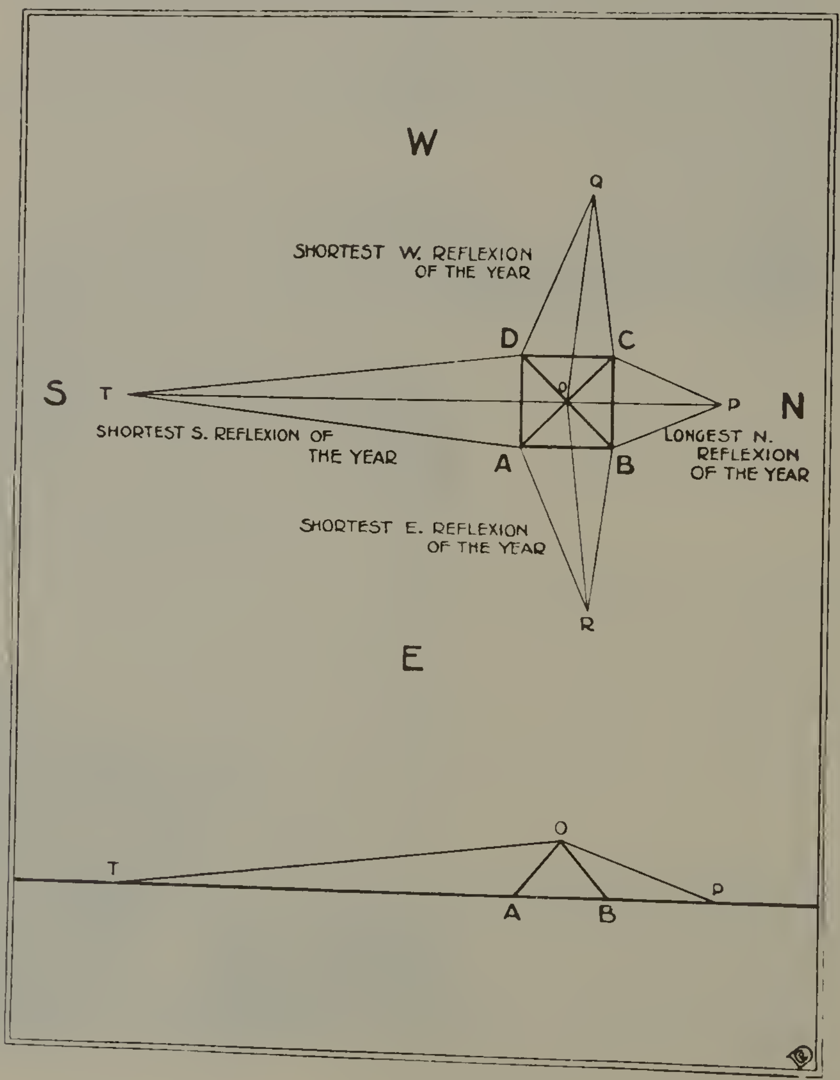
From a study of the sharper slopes of other pyramids, such as of Saqqara, Medûm and Dashur, Cotsworth deduced that their builders may have aimed these slopes not at the equinox, when the sun is midway, but at the summer solstice, when the sun is highest in the sky at noon. Sneferu's pyramid

Deliberately broken pattern of paving stones observed by William Kingsland on the north side of the Great Pyramid, apparently intended for finer mathematical measurement of the sun's shadow on successive days and years.

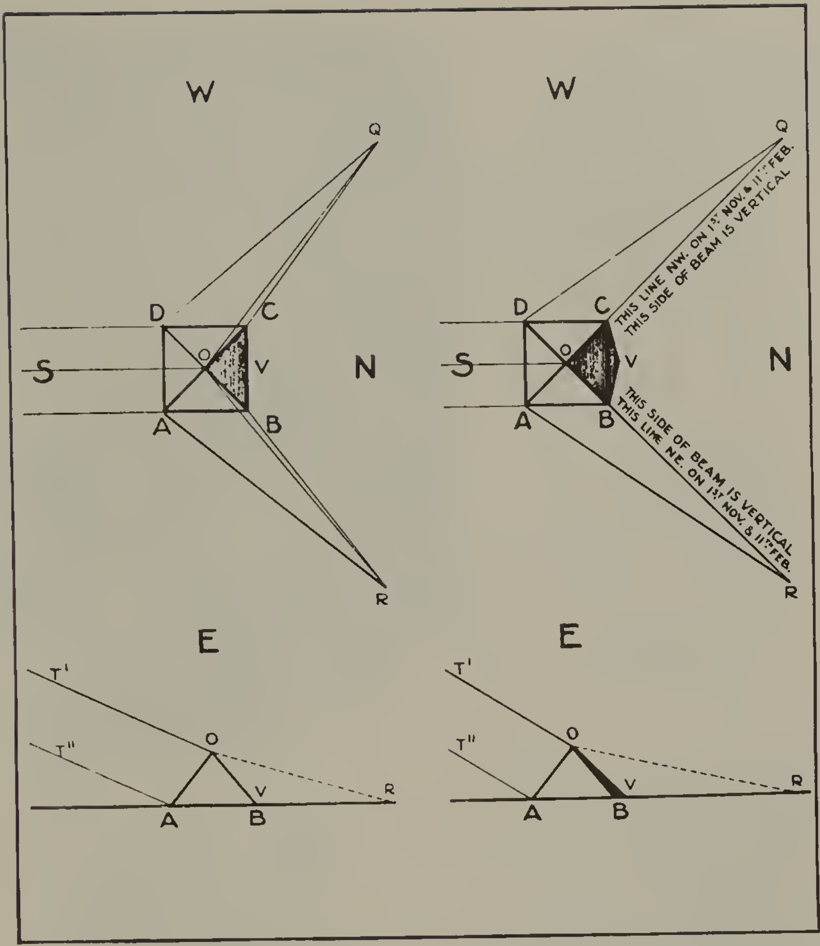
at Dashur, with its milder slope of 43°, may have been aimed at the winter solstice, when the sun is lowest at noon. From the gradually corrected slope of Saqqara and the change in angle in the bent pyramid at Dashur, Cotsworth concluded that the Egyptians may have progressed northward to the "truer" pyramid form, or π-shaped pyramid, at the thirtieth parallel, where morning and afternoon shadows form a series of perfectly straight lines.

In this, Cotsworth was supported by Joseph Norman Lockyer, the eminent British astronomer, who taught astronomical physics at the Royal College of Science. Lockyer noted that pyramids other than that of Cheops appeared to be oriented not to true north but to the rising sun at the solstice, which *changes with the latitude* of the place of construction.

According to Cotsworth the pyramids were originally developed from mastabas or raised terraces built to support an obelisk. To lengthen the shadow, the obelisk was successively raised on higher sloped platforms, which eventually turned into stepped pyramids.



Davidson's diagram of the reflections of sunlight cast by the Pyramid at noon of the summer solstice.



Davidson's diagram of winter shadows and reflections cast by the Great Pyramid. Left figure shows the noon shadow first appearing October 14–15. Other lines indicate reflected sunlight. Right figure shows the noon shadow first disappearing February 27–28. Other lines are pattern of reflected sunlight.

Cotsworth points out that the oldest true pyramid, that of Medûm, was constructed in several stages, as evidenced by the polished casings at each level.

The process, says Cotsworth, was developed to the point where the results no longer increased in proportion to the effort expended. A 60-foot platform which raised a 60-foot obelisk increased its shadow by 100 percent, but an added platform of 40 feet only increased the shadow by 19 percent; eventually the top platform became too small for raising an obelisk. According to Cotsworth, the optimum design turned out to be the solidified Pyramid of Cheops, with its slope set for a particular latitude to swallow the equinoctial shadow. Once this method of establishing the precise length of the year had been found, says Cotsworth, there was no further need for enormous pyramids.

Cotsworth obtained further confirmation of his theory from a comparison of the pyramids with the artificial hills built by ancient inhabitants of Britain who traced the year's end by the longest shadow of the year cast from vertical cones or artificial mounds such as Silbury Hill.

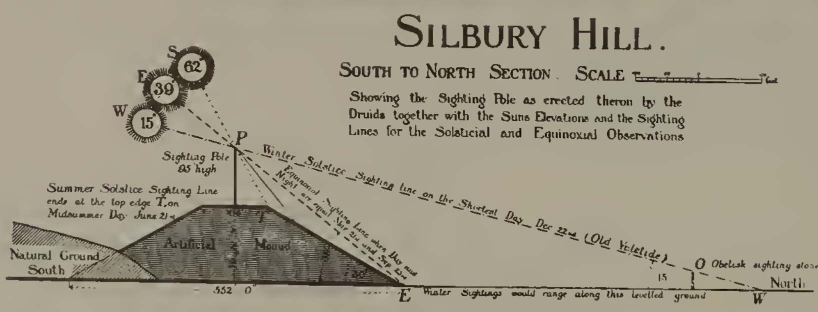
Later inhabitants of Britain, such as the Druids and Goths, continued to count the year's end from Yuletide, the December solstice.

Silbury Hill in Wiltshire, England, covers five acres and is built of over a million tons of hand-moved material. According to archeologists it is at least four thousand years old.

Cotsworth says that Silbury Hill was designed to have a Maypole on top to cast a shadow up and down the truncated hill and onto the level plain to the north, so as to mark the four seasons of the year.

The cone was truncated at a point where the shortest shadow thrown by the Maypole on the longest day of the year indicated the summer solstice. On the level plain north of the hill a stone was placed in the ground to mark the point of the longest shadow cast by the Maypole at the winter solstice, or shortest day of the year.

The juncture at the bottom of the hill, where it touched the plain, marked the spring and autumn equinoxes, when the day was exactly as long as the night.

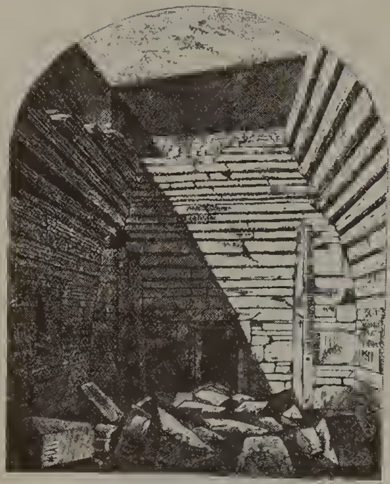


Aerial photograph of Silbury Hill, showing the footpath around the truncated top.

Druid in Old Irish meant "he who knows." Julius Caesar, our earliest source on the subject, considered the Druids highly educated and well organized. In *De Bello Gallico* he commented: "It is especially the object of the Druids to inculcate this—that souls do not perish, but after death pass into other bodies, and they consider that by this belief more than anything else men may be led to cast away the fear of death, and to become courageous. They discuss many points concerning the heavenly bodies and their motion, the extent of the universe and the world, the nature of things, the influence and ability of the immortal gods; and they instruct the youth in these things."

As Cotsworth reconstructed the system, the truncated cone of Silbury Hill enabled the ancient astronomers to measure the length of the seasons and the year by the length of shadow cast by a pine Maypole, which served as an obelisk, atop a hill intentionally truncated so that its edge would also mark the summer solstice, or the shortest shadow of the year.

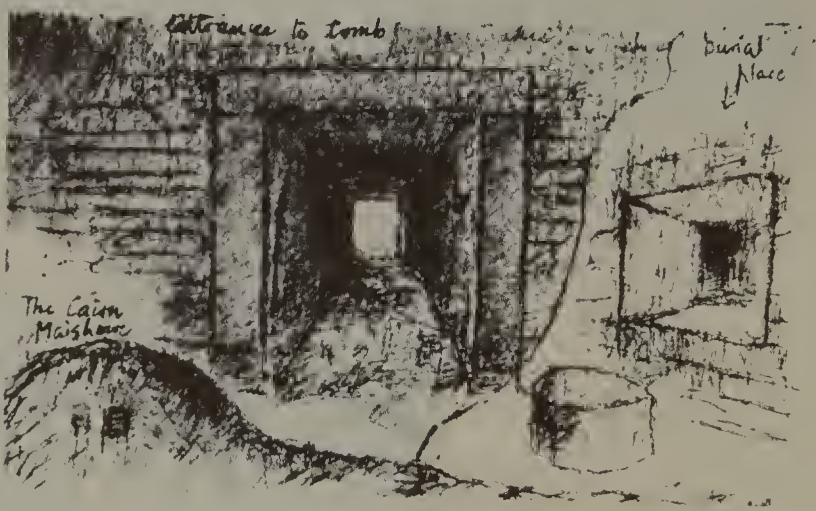
Had these astronomers simply required a great height, says Cotsworth, they would have used the adjacent Abury Hill, with its wide top which could easily have been raised. But this, says Cotsworth, would not do; they required an absolutely level piece of ground on which to mark the progress of the shadow. Hence they had no alternative but to pile up an artificial hill above the level plain. Fortunately, in latitudes of 50° or 60°, such as Brittany or Stonehenge, low mounds would give shadows long enough for detailed measurement. A height of 225 feet in Wiltshire gives a



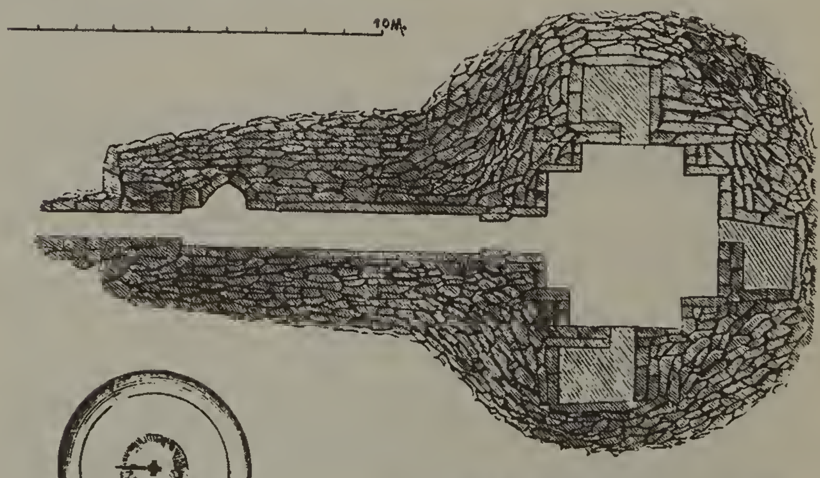
The main chamber in Maes-Howe, showing corbeled monoliths which could be closed at the top by a single movable slab. The jointing in this prehistoric masterpiece rivals that of the Great Pyramid.

shadow almost equivalent to the shadow of the 484-foot Pyramid of Cheops.

One of the most remarkable of these prehistoric European mounds still exists at Maes-Howe, near Stennes, in the Orkney Islands. It is equipped with a 15-foot square observatory chamber and a 54-foot sighting tunnel. The tube is aimed at a conspicuous man-raised monolith 42 chains (2772 feet) from the entrance, which lines up with a spot on the horizon where the sun now rises 10 days before the winter solstice. Another monolith, to the west, called the Watchstone, indicates the equinoxes. Like the Great Pyramid of Cheops, the observatory chamber is built of huge megaliths and its ceiling is corbeled. There are also three "retiring rooms for the observers," somewhat like the Queen's Chamber in the Great Pyramid.



The entrance passage to the Maes-Howe observatory is very similar to that of Egyptian pyramids.

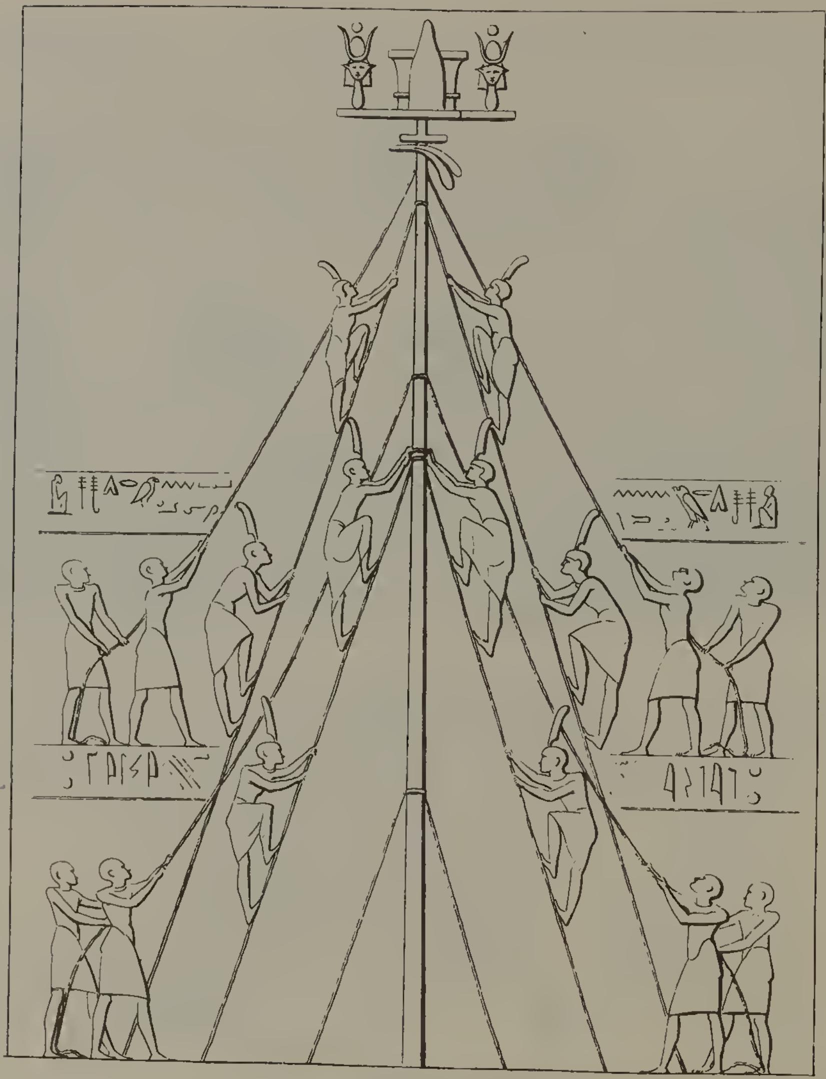


Maes-Howe, near Stennes in the Orkney Islands, is a man-made cone-shaped pyramid 27 feet high and 115 feet across, with an outer circling ditch 45 feet wide and 700 feet in circumference.
It has a 54-foot observation passage aimed like a telescope at a megalithic stone to indicate the summer solstice.
Its central observation chamber, corbeled like the Great Pyramid's Grand Gallery, is built of megaliths weighing 3 tons, carefully leveled, plumbed and so finely jointed they will not admit the blade of a knife.

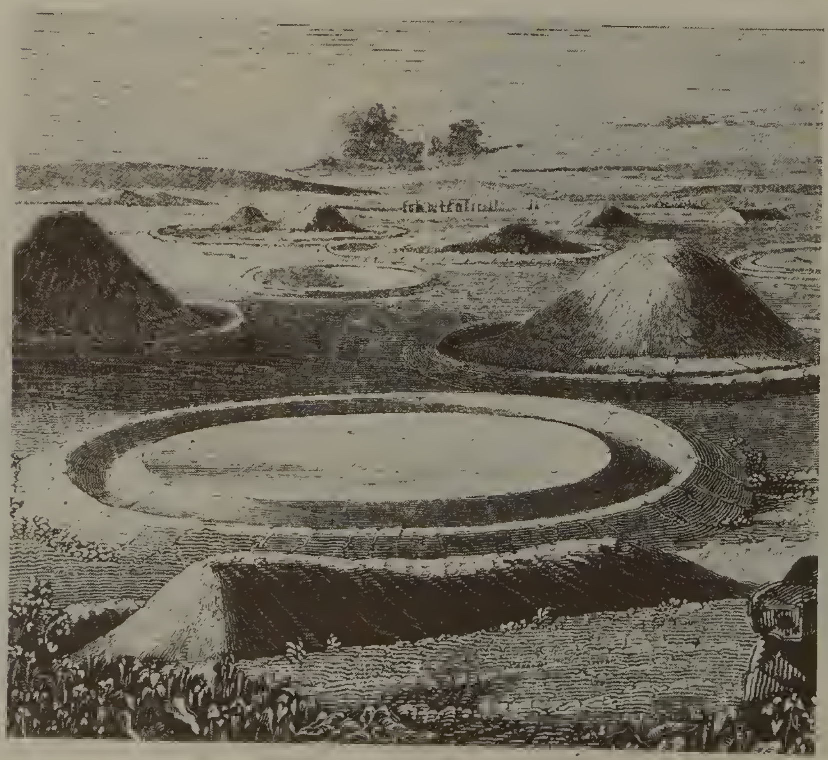
Circular monoliths similar to Stonehenge located at Stennes in the Orkneys near Maes-Howe.

In *Stonehenge, a British Temple Restored to the Druids,* which Piazzi Smyth considered a book "far before its age and perhaps not yet sufficiently appreciated," its author, Dr. William Stukely, attempted to show that such megalithic circles had always been arranged on even and round numbers of the "profane cubit of 20.7 inches nearly," and not in feet or any other known standard of length. Smyth remarked that although the idea "was pooh-poohed by more recent antiquarians, I have never heard of any of them having ascertained by actual measure at the place, that the Stukelian theory would not hold."

Professor Alexander Thom has recently shown they are built on a megalithic yard of 2.72 feet.



An Egyptian Maypole.



Various shaped mounds, or "barrows," were constructed in prehistoric Britain. Cotsworth considered them man-made instruments for observing the movements of heavenly bodies.

Alexander Thom considers Averbury Circle near Stonehenge the greatest and most remarkable circle in Britain, if not in the world. "Its greatness," says Thom, "does not lie in its size alone but in the remarkable manner in which its arcs are built up from a basic Pythagorean triangle so that each retains an integral character, and in the exceedingly high precision of the setting out, a precision only surpassed today in high-class surveying."

The Scottish lairds in residence at Maes-Howe—or Maiden's Mound—still plant a Maypole on the originally flat top, perpetuating the ceremony begun when observations were made of the shadows cast by the pole on the flat terrain to the north of the mound.

In England throughout the Middle Ages and the Renaissance, the Maypole with its tall garlanded and decorated shaft (stowed away for the rest of the year under the eave of a house) was set up on May Day. When Cromwell came to power he banned the Maypole. As the *National Encyclopedia* puts it: "The Puritans, to whom we owe the loss of so many of our public games, and so much of our merriment, ordered all Maypoles to be destroyed by Act of Parliament in 1644, as a 'heathenish vanity, abused to superstition and wickedness,' and fined the constables five shillings weekly as long as they stood."

The custom was revived with the Restoration, and the last Maypole erected in London—all of 100 feet high—stood on the spot where the church in the Strand now stands near Somerset House. It was taken down in 1717 and conveyed to Wanstead Park, in Essex, where it was fixed as part of the support of a large telescope set up by Sir Isaac Newton.

A glance at the outlines and cross sections of the pyramids of Saqqara, Dashur and Medûm will show that, like ancient British observatories, each had a sighting passage, pointed at a northern star. The passage ended in an

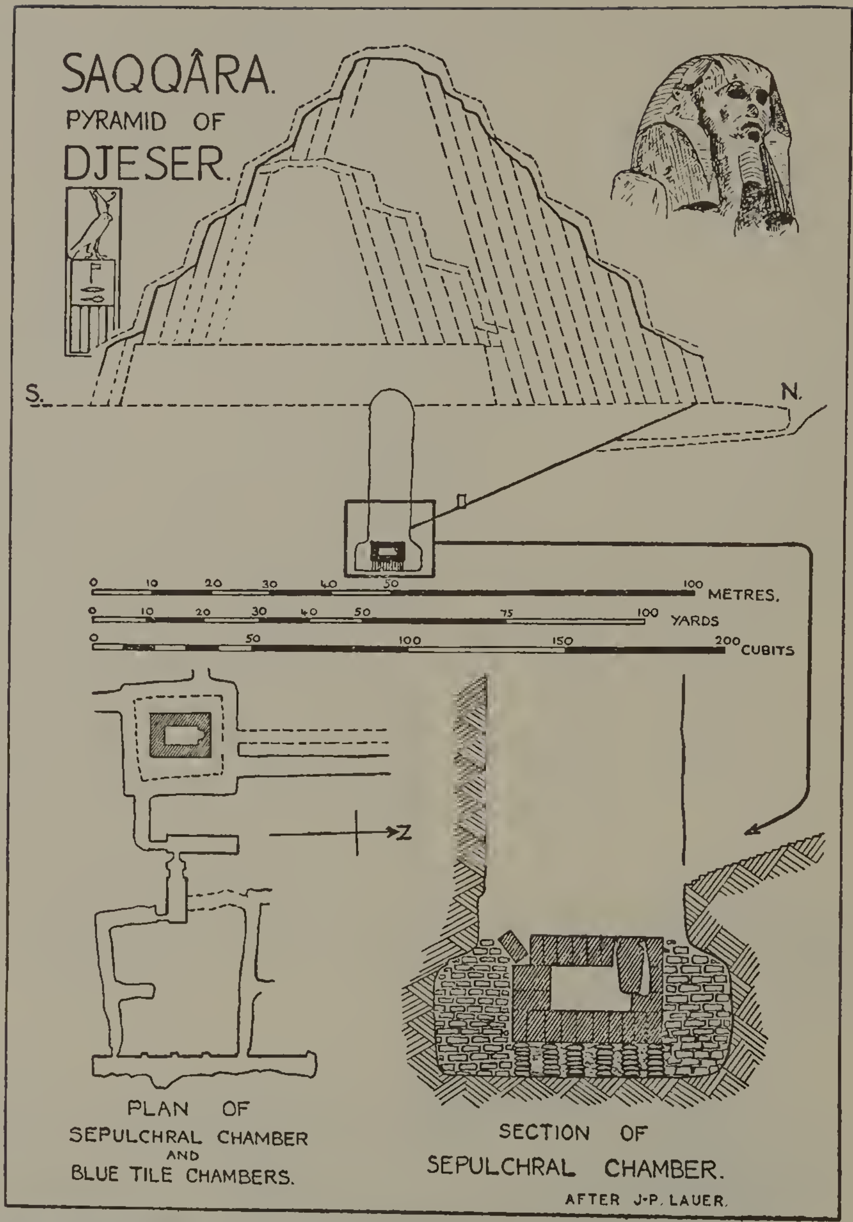
Remains of "Old Sarum," an ancient British stepped pyramid.

The original building of the stepped pyramid was a mastaba 63 meters square built of coarse rubble cased with fine white limestone, above a square pit.

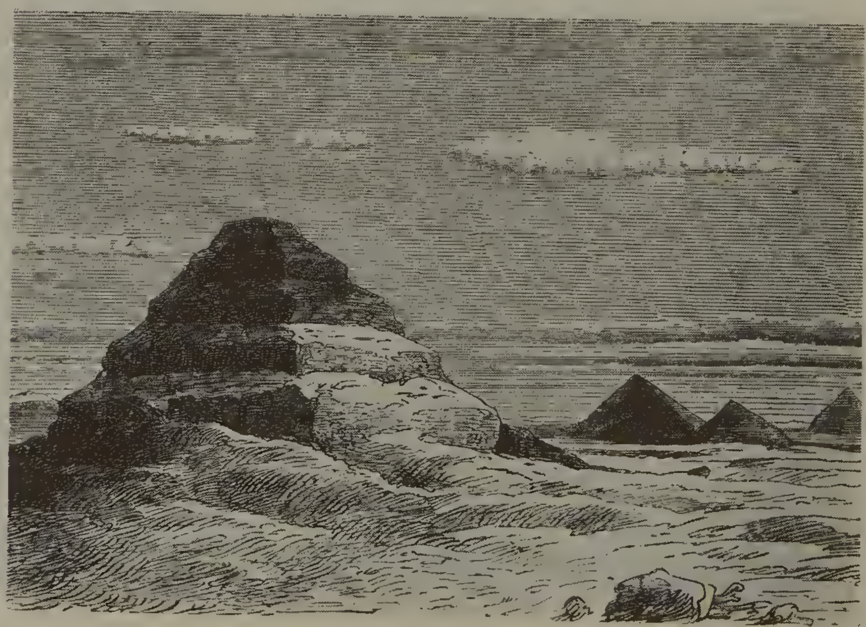
The original entrance was through a hole in the roof directly into a 28-meter shaft lined with granite. The mastaba was subsequently heightened into a stepped pyramid by the superimposition of three more terraces. Extended eastward (ostensibly to include graves for Zoser's family!), the structure was then a rectangle 120 meters by 108. Two more stories were added, so that it became a six-step pyramid, cased with fine limestone, at a slope angle of 72° 30′. A second entrance was placed in the north face leading down a rock-cut flight of steps to a more restricted "sepulchral chamber."

The building was attributed to King Zoser (of the Third Dynasty) on the basis of his cartouche on some stones and is believed to have been erected by his fabulous architect Imhotep.

In 1929 Frith found a bas-relief in the pyramid depicting Zoser, and in the 1950s Prof. Lauer found a mummified foot which he believes to have been Zoser's.



Stepped pyramid of Saqqara, believed to be the oldest Egyptian pyramid.



The pyramid of Medûm, on a square base of 144 meters, rises 92 meters high, and is so situated that it is a landmark for miles in all directions.

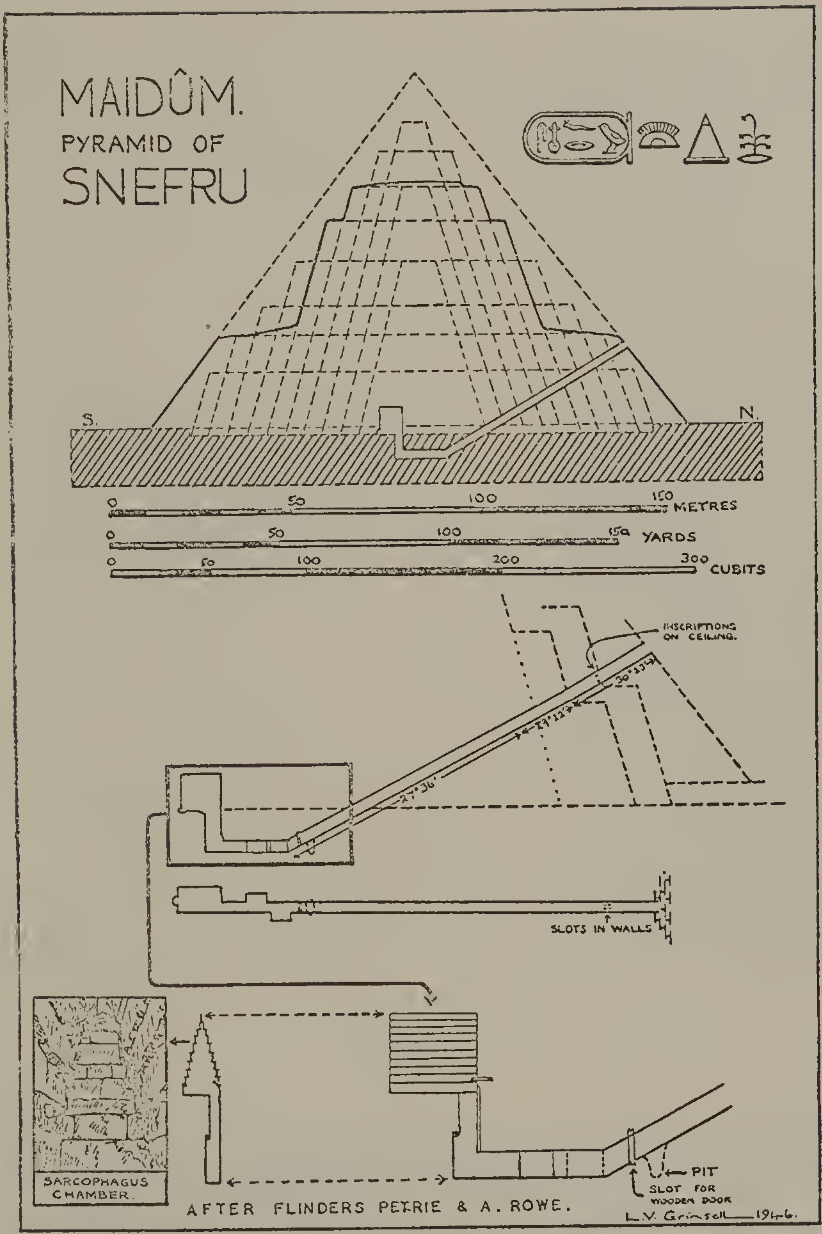
Most of the outside limestone casing, which sloped at 51° 52′, has been removed, showing that the pyramid was built in several stages from an original mastaba about 20 meters long, with slopes of 75°.

The pyramid grew in seven steps by means of a series of accretion walls, each of which was cased in fine white limestone; eventually the spaces between the steps were filled in, and the entire pyramid cased with white limestone, most of which was removed at an early date (possibly during the reign of Rameses II) though portions remain. Three accretion faces are presently visible.

The base is still covered with sand and debris.

An entrance on the north side, 30 meters aboveground, leads down a ramp 57 meters long, sloping at 27° 30′, to two antechambers and a vertical shaft in the center of the building. The shaft rises to the "sarcophagus chamber," which has a fine corbeled roof of limestone built in seven steps.

In 1891 Petrie found fragments of a wooden coffin believed to have belonged to Sneferu; so the pyramid has been attributed to Cheops' father.

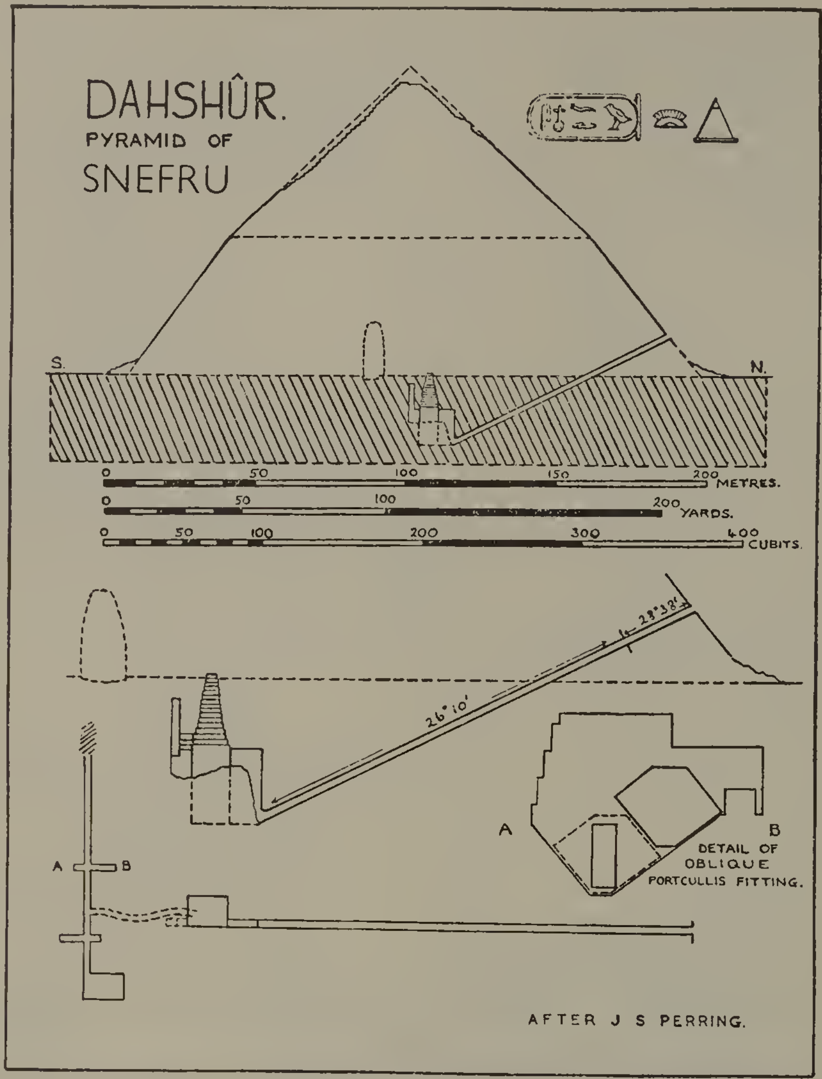


Sneferu's blunted or rhomboidal pyramid at Dashur is 190 meters square at the base and 100 meters high. The lower portion slopes 54° 41′, the upper portion 43°. The casing is of fine white limestone; the body is believed to be of coarser limestone.

There are two entrances, one on the north and one on the west side, leading to two main chambers.

The northern entrance is 11 meters aboveground in the center of the lower face and leads down a ramp inclined at 28° 38′ for the first 13 meters, then at 26° 10′ for the remaining 65 meters. A short horizontal passage 12 meters high leads to a fine chamber whose roof is corbeled on all four sides.

The western entrance, which is 29 meters above the base, leads to a ramp descending at 26° 36′ for 68 meters to a horizontal passage with two portcullis slabs and a chamber with a roughly corbeled roof.

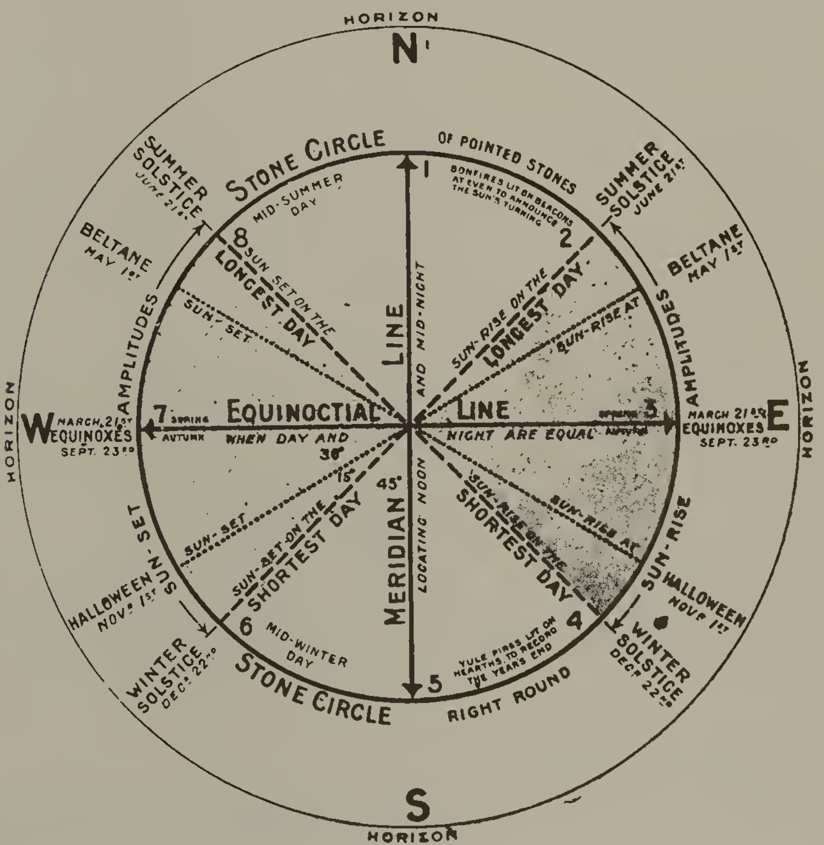


observation chamber with a corbeled roof with a small opening just at ground level, presumably for sighting a star directly overhead at the zenith, or for lowering a plumb line to coincide with a line sighted down the sloping passage. The similarity to the structure at Maes-Howe is indeed amazing. Yet Maes-Howe has also been considered as nothing but a burial chamber. A recent writer on Maes-Howe discarded the theory that the mound might have had astronomical significance, saying that the belief is accepted by no "serious students of archeology."

Scientists of other disciplines are in disagreement, and have produced interesting data on the orientation and purpose of megalithic monuments.

In his *Megalithic Sites in Britain,* published in 1967, Professor Alexander Thom, who for many years held the chair of Engineering Science at Oxford, shows how the stone and wood henges of Britain of the second millennium B.C. were aligned on certain stars, were planned on the basis of a geometry which anticipated Pythagoras, and were uniformly built on a unit of measure which he calls a megalithic yard of 2.72 feet or .829 meter.

According to Thom, megalithic sites in Britain served the purpose of calendars and clocks. During the long winter nights the only indicators of time were the stars. By observing the rising and setting of stars of the first magnitude, or their



Cotsworth's explanation of Druidical circles such as Stonehenge.

transit over the meridian, it was possible to tell the hour of night.

Thom says that in Britain between 2000 and 1600 B.C. there were about ten or twelve stars of the first magnitude whose rising and setting could be clearly observed. Thom also found a great number of stones set to indicate the point of rising and setting of first magnitude stars, and many slabs and alignments which accurately marked the meridian.

For such pointers to be accurate the observer also had to know the date. This was obtained from the sun calendar arrangement of the stones.

As for the accuracy of the alignments, Thom says the ancient engineers managed to raise perhaps ten thousand megaliths from one end of Britain to the other, and set them with an accuracy of 0.1. When they wanted to, says Thom, they could measure with an accuracy of 1 in 500.

R. J. C. Atkinson, professor of archeology at University College, Cardiff, an authority on Stonehenge, and a severe critic in this field, concludes from Thom's data that a high degree of competence in empirical astronomy existed in Britain 4000 years ago.

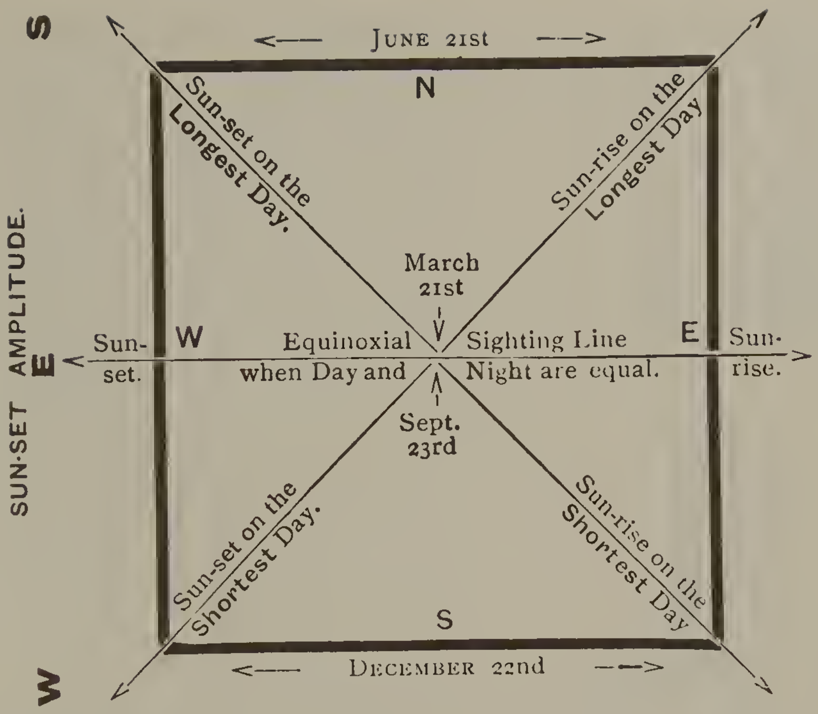
This supports the data of the contemporary Greek astronomer C. S. Chassapis, whose analysis of the Orphic Hymns indicates that the Greeks of the second millennium B.C., also had an advanced knowledge of astronomy.* These ancient Greeks, says Chassapis, knew that the seasons were caused by the earth's rotation around the sun along the ecliptic, and had determined the torrid, temperate and frigid zones. They had established the equinoxes and solstices, and knew that the apparent daily rotation of the stars in the heavens was due to the earth's rotation on its axis, which formed a northern pole in the sky. This knowledge, says Chassapis, was taught by the Orphics to the initiate who distinguished between the "fiery" stars and the seven planets which they called by today's names. The second millennium Greeks used a calendar of twelve conjuctive months from full moon to full moon, and accepted the presence of mountains on the moon. They believed that all phenomena were governed by a universal law, and conceived that space was filled with ether.

Lyle B. Borst, professor of astronomy and physics at New York State University in Buffalo, in an article in *Science* (November, 1969), notes that more than forty churches, mosques and temples have now been identified from Norway

* *Greek Astronomy in the Second Millennium B.C. according to the Orphic Hymns*. Athens, 1967.

Many churches in Europe continued to build with their towers oriented to the cardinal points, or to mark the solstices and equinoxes. Others were oriented to the sunrise of the saint for whom they were named.

St. Peter's Basilica in Rome is oriented due east so that at the vernal equinox the great doors can be thrown open at sunrise and the sun-rays passing through the nave will illuminate the high altar.



to Egypt, all laid out in megalithic yards of .829 to .840 meter.*

Professor Borst, who went to England to make a model of Stonehenge to demonstrate to his students how astronomy was practiced before there were telescopes, suggests that the axes of many early Christian churches in Britain are laid out on top of megalithic foundations originally determined by an alignment with stars; he suggests that Canterbury Cathedral was aligned with the equinoctial rising of Betelguese about 2300 B.C.

Borst also shows that the geometric plans of the megalithic monuments were obtained by means of 3–4–5 triangles and other right-angled triangles laid along the axis of stellar observations.

Alfred Watkins, in his *The Old Straight Track,* published in 1920, pointed out that many churches in England were situated on sight lines between beacon points and that ancient man was inclined to travel in a straight line from beacon to beacon. The churches served as relay points.

Watkins suggested that where topographical features were lacking, observation towers were built, and such geodetic points, initially guarded by the surveyor priesthood, remained hallowed spots even after the reason for them had been forgotten. Later arrivals built churches on these spots, as is indicated by Bede who reports that Pope Greg-

* If .840 meter is taken as a megalithic yard, there are exactly 275 such yards in a 231 meter base of the Great Pyramid of Cheops, 220 in the apothem and 175 in the height.

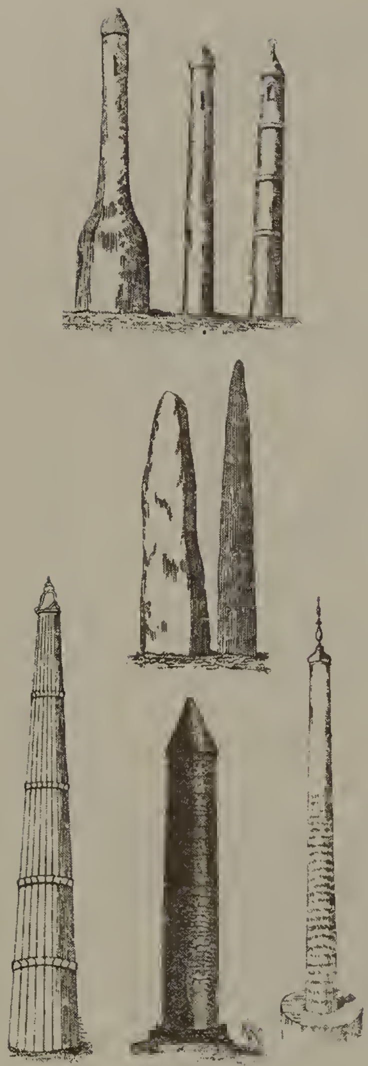
ory I explicitly ordered Bishop Miletus to build churches on pagan shrines.

In the Middle Ages in Ireland, Catholic monks still used tall conical towers with carefully oriented openings at the top to observe the skies and record the passage of the days, months and years by shadows on the walls and floors.

These "Round Towers," as they were called, were fitted for Polaris observations at the north window, for transit observations at the south window, and for noting the moment of the rising and setting of heavenly bodies at the east and west windows. H. G. Wood in his *Ideal Metrology* says that by threads drawn across the openings, like the spider lines in a telescope, the exact position of a star could be noted. The walls being two or three feet thick, the solar shadows of the jamb and lintel cast upon the floor within would show the hour of day and the time of the year. Every month could have its transit floor-mark.

Similar structures have been found in France. In a booklet oddly entitled *Falicon,* privately printed in 1970, the author Maurice Guignaud, a French artist and ceramist, describes a small pyramid in the south of France built in the thirteenth century by Knights Templar on their return from the Middle East.

Guignaud observed that at solar noon of the autumn equinox of September 21, 1969 (which in that region occurs at 12:53 P.M.) the pyramid projected no shadow on the ground around it. Guignaud also noted that a raised area in the doorway caused the sun to cast a shadow that precisely split the end of the entranceway.



Examples of Irish and other round towers.

There are remains of some 120 observation towers in Ireland, twenty of them still in good condition, ranging in height from 60 to 132 feet. The tower at Killcullen is the highest.

Built near churches between the eighth and thirteenth centuries, the towers have door and window jambs that are narrow like the doors of ancient Egyptian temples, which served to measure the shadow of the sun in its daily and seasonal movements.

At the equinox Guignaud measured the shadow of a meter stick held vertical at noon and found it to be exactly one meter long, whereas on June 21 it cast a shadow of .80 meter and on December 22 a shadow of 2.52 meters.

Guignaud found that this exotic truncated pyramid, which is known by the weird name of *Ratapignata* or "The Bat," was also built directly over two subterranean pits, one almost above the other, and that carved signs on its walls indicated it had been used for astronomical and astrological observation.

According to Cotsworth, the value of ancient astronomical observatories cannot be overestimated. The importance of establishing the exact length of the year so as to know when to plant and when to harvest crops could mean the difference between famine and plenty.

Far from being Professor Barnard's "stupendous monument of folly," the colossal effort employed by the ancients in building the Great Pyramid (or the million-ton mounds of the Britons) would have had a vital effect on the citizenry, redounding to the benefit not only of the builders, but of countless generations to come.

Cotsworth took several more photographs at the Great Pyramid to illustrate his thesis, but most of these were stolen from his carriage and irretrievably lost. This particular photograph, taken in 1900 by a third party, shows Cotsworth seated on a camel with the Sphinx and the Great Pyramid as a background. The white-whiskered Arab at the extreme right is none other than the indefatigable Ali Gabri, now over seventy, who added Cotsworth to the list of Great Pyramid explorers he guided round Giza since the time of Caviglia and Howard-Vyse in the 1830s.

Archeologists give varying opinions as to the age of the Sphinx. Petrie considered it possibly prehistoric. Budge refutes its being prehistoric. Most Egyptologists assign it to Kephren's reign in the Fourth Dynasty.

The Sphinx faces due east, which indicated to Cotsworth that it was used as a sighting device by priests who could stand on the flat platform of its rump and sight the rising sun in a direct line to the horizon marked by the point of the asp on the crown on the Sphinx. Cotsworth also found a series of ancient lines fanning out from the neck of the Sphinx which could have served to indicate the point of sunrise at different dates from solstice to equinox.

It has repeatedly taken several hundred men several years to clear the sand from its base and reveal a six-tiered obelisk against its chest (now missing), which Cotsworth believes was used for sighting the midday sun. Each time the base was cleared, windstorms filled it again with sand, indicating that when the Sphinx was originally built the Sahara was almost certainly not a desert.

Lancelot Hogben in *Science for the Citizen* says that "the continuity of careful observations which preceded, and the precision involved in settling the exact length of the year, entitle this achievement to be regarded as one of the half-dozen great cultural feats in the history of mankind."

With the present availability of cheap watches, radio signals and published almanacs, one is likely to underestimate the value to ancient people of a reliable system for telling the day, the season, the year, and, most important in Egypt, where the entire system of agriculture depended on the swamping of the arable land, the forthcoming flooding of the Nile.

For three-quarters of the year the Egyptian peasants would leave their protected villages on the hillsides and move into the flatland with their families, livestock and most of their belongings, to plow, seed and harvest the fields.

When the time came to move their families and belongings back to the hills, they required at least a fortnight's warning lest they linger too long and be cut off and drowned by the yearly rising of the waters.

According to Cotsworth, all efforts at tracing the number of days in the year by purely seasonal signs would have given imperfect and variable results.

In the early dynasties the flooding of the Nile was said to have been heralded by the annual heliacal rising of Sirius, known to us as the Dog Star. Once a year, with the first glimmer of dawn, Sirius, a bright star of the first magnitude, would appear in the eastern sky and dominate the heavens till its sparkle was eclipsed by the splendor of the risen sun. This stunning phenomenon was taken by the Egyptians as a sign that the Nile would be flooding in about twenty days.

But the flooding of the Nile is governed not by the stars but by the sun melting the snows and the rain falling in the Ethiopian highland sources of the Blue Nile. To have continued to date the flooding by the rising of Sirius would have gradually brought the phenomenon out of phase.

O. Muck, in his *Cheops and the Great Pyramid,* postulates that as a result of a series of disastrous inundations during the reign of Cheops, the Egyptians were obliged to change from a stellar calendar of 365.2563 days to a solar calendar of 365.2422 days, and that the historic Cheops introduced a new calendar by which an extra day was added every four years of 1460 days to account for the differing fraction.*

* According to Muck the new calendar was designed for Cheops not by an Egyptian but by a light-skinned European who brought to Egypt an older, more accurate calendar such as that of Dardanie. Muck says there is archeological evidence that Cheops married a light-eyed, white-skinned European with reddish-blond hair who bore him a blond, blue-eyed daughter whom Cheops gave in marriage to a European known as Didoufri who reformed the calendar and redesigned his pyramid. Other Egyptologists suggest that Cheops' wife, who is represented as a blonde in the Giza tomb of her daughter Meresank III, may be merely wearing a wig. Such divergencies give a slight idea of the general lack of concurrence among historians of Egypt. But there is no doubt that the Egyptians developed two basic calendars, a civil calendar of 365 days, and a sothic calendar one-quarter day longer. The extra quarter day caused the sothic New Year to fall back one full day every four years so that each and every day of the civil calendar coincided with the New Year over a period of 365×4, or 1460 years, until the New Year once more fell on its original July 19. Hence was generated what was known as the sothic cycle of 1460 years.

The double dating of sothic and civil years appears in many Egyptian documents, so that it has been possible to reconstruct the years in which the sothic new year coincided with the original new year and establish that sothic cycles began in A.D. 140, 1320 B.C., 2780 B.C., and 4240 B.C.

Muck and others believe the foundation of the sothic calendar occurred in the 2780 cycle, but Schwaller de Lubicz is convinced from his study of ancient texts and hieroglyphs that the year was 4240. He says that tradition always placed the heliacal rising of Sirius in the constellation of the Lion, and that this was so from 4240 on. The main objection to such an early date is the conviction of Egyptologists that the ancient Egyptians were not yet equipped for such careful astronomical observation.

That the Egyptians handled astronomical cycles of even greater duration is indicated by inscriptions recently found by Soviet archeologists in newly opened graves during the period of their work on the Aswan Dam. Here the cycles appear to cover periods of 35,525 years, which would be the equivalent of 25 cycles of 1461 years. The apparent discrepancy of one year in this recording of cycles is due to the sothic cycle of 1460 years being the equivalent of a civil cycle of 1461 years. According to Muck there were three main cycles: one of $365 \times 4 = 1460$; another of $1460 \times 25 = 36{,}500$; and a third of $36{,}500 \times 5 = 182{,}500$ years.

Dürer's woodcut of the zodiac. In the course of a year the earth makes a 360° circle round the sun. Seen from the earth, the sun appears to move through a circular belt of constellations. These are the stars of the zodiac. For convenience, the zodiac is divided into twelve constellations, so that every month at sunrise a new one appears to the earth viewer in the eastern sky; and every year the sequence is repeated, with a slight precession owing to the earth's wobble on its axis.

Schwaller de Lubicz in his *Le Temple de l'Homme* maintains the pharaonic Egyptians adopted neither the sidereal nor the solar tropical year, but a Sothic year based on the cycle of the fixed star Sirius, which is exactly 365.25 days. According to this archeologist and philosopher, who spent twelve years at Luxor measuring and studying its temples, tombs and hieroglyphs, the mere fact that the Egyptians were able to note that Sirius is the *only* fixed star with an unvaried cycle of 365.25 days denotes an extremely long period of previous careful observation.

From the texts it is clear, says Schwaller de Lubicz, that long after the heliacal rising of Sirius was no longer a visible phenomenon, it continued to be accurately computed by the priests of Heliopolis, who then broadcast their observations to the other temples of Egypt, there being a difference of as much as 4 days between the heliacal rising as noted at Thebes and at Memphis.

Muck suggests that to dramatize the importance of the 1460 cycle the figure was built into the pavement around the Pyramid of Cheops in such a way that a cortege of priests dressed in white could liturgically march round the pyramid rythmically counting out 1460 paces—which were subdivided into 25 inches, and again subdivided by 5.

By coincidence, Muck's pace of 25 inches is the same length as Newton's and Piazzi Smyth's sacred cubit, one hundred of which form the side of an English acre.

One incontestable deduction was drawn by Schwaller de Lubicz from the existence of the sothic calendar and the shifting of the annual festivals of the civil calendar: the ancient Egyptians must have been cognizant of and able to measure the phenomenon known as the precession of the equinoxes.

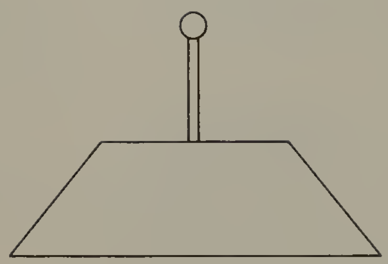
To obtain a simple picture of the precession, an earth observer in the northern hemisphere should be looking due east just before sunrise at the spring equinox. As the dawn tints the sky the observer will see a constellation on the eastern horizon: nowadays it is Pisces. In 2000 B.C. it was Aries. In 4000 B.C. it was Taurus. In A.D. 2300 it will be Aquarius.

The entire circle of the zodiac appears to be slipping back in relation to the sunrise at the equinox, at the slow rate of about 1 degree in 72 years; 30°, or one constellation, in 2160 years; and 360° in 25,920 years.

This *pre*cession of the equinox is said to have been discovered by Hipparchus in the second century. But a number of ancient representations of the zodiac bear the note: "The Bull marks the beginning of spring." This has been interpreted to indicate that astronomical observations of the constellations at the equinox were being made at least as early as 4000 B.C.

The phenomenon of the precession was not explained till Newton postulated that the earth's tilted axis was wobbling as it spun, causing the celestial pole of the earth's axis to draw a slow circle in the heavens around the fixed pole of the solar system, the pole of the ecliptic. To an observer on earth watching the sunrise at the equinox, this slow circling has the effect of making the equinoxes occur about 20 minutes earlier each year in relation to the zodiacal constellations then visible in the sky.

To have figured out the slow rate of the precession of the equinoxes, the ancient Egyptians must have had an appropriate system and equipment. According to Cotsworth, to devise an accurate *star* calendar to record the apparent movement of the stars around the heavens, someone first had to devise a structure that would provide a perfectly oriented meridian for the observation of stars in relation to a fixed point on earth.



According to Muck, to have an accurate *sun* calendar, with which to establish the solstices and equinoxes, someone would have had to build an enormously high obelisk.

Sir Gaston Maspero, director of the Department of Antiquities of the Cairo Museum, found a curious hieroglyph in inscriptions around Saqqara for which he could find no explanation: an obelisk atop a truncated pyramid, with a solar disk balanced on top of it. For Cotsworth he kindly made a drawing of it.

To Cotsworth the similarity of Maes-Howe, the Silbury Hill Maypoles and the obelisks atop a mastaba or unfinished pyramid was inescapable. Only, how did this fit with the Pyramid of Cheops?

XII. ASTRONOMICAL OBSERVATORY


Richard Anthony Proctor.

That the Great Pyramid had originally been designed as an astronomical observatory and that it had contained reproductions of the celestial spheres was repeatedly reported by Arab historians; yet none could put forward a sensible solution as to how its steep polished sides could be climbed as an observatory, or its interior passages employed for observations; that is, until the appearance of a book shortly before the turn of the century by the British astronomer Richard A. Proctor, called *The Great Pyramid, Observatory, Tomb, and Temple.* Proctor found a reference in the works of the Roman neo-Platonic philosopher Proclus to the effect that the Pyramid had been used as an observatory *before* its completion. Analyzing the report, which appears in Proclus's commentary on Plato's *Timeaus,* Proctor theorized that the Pyramid might have made an excellent observatory at the time it had reached the summit of the Grand Gallery, which would have given onto a large square platform where the priests could observe and record the movements of the heavenly bodies.

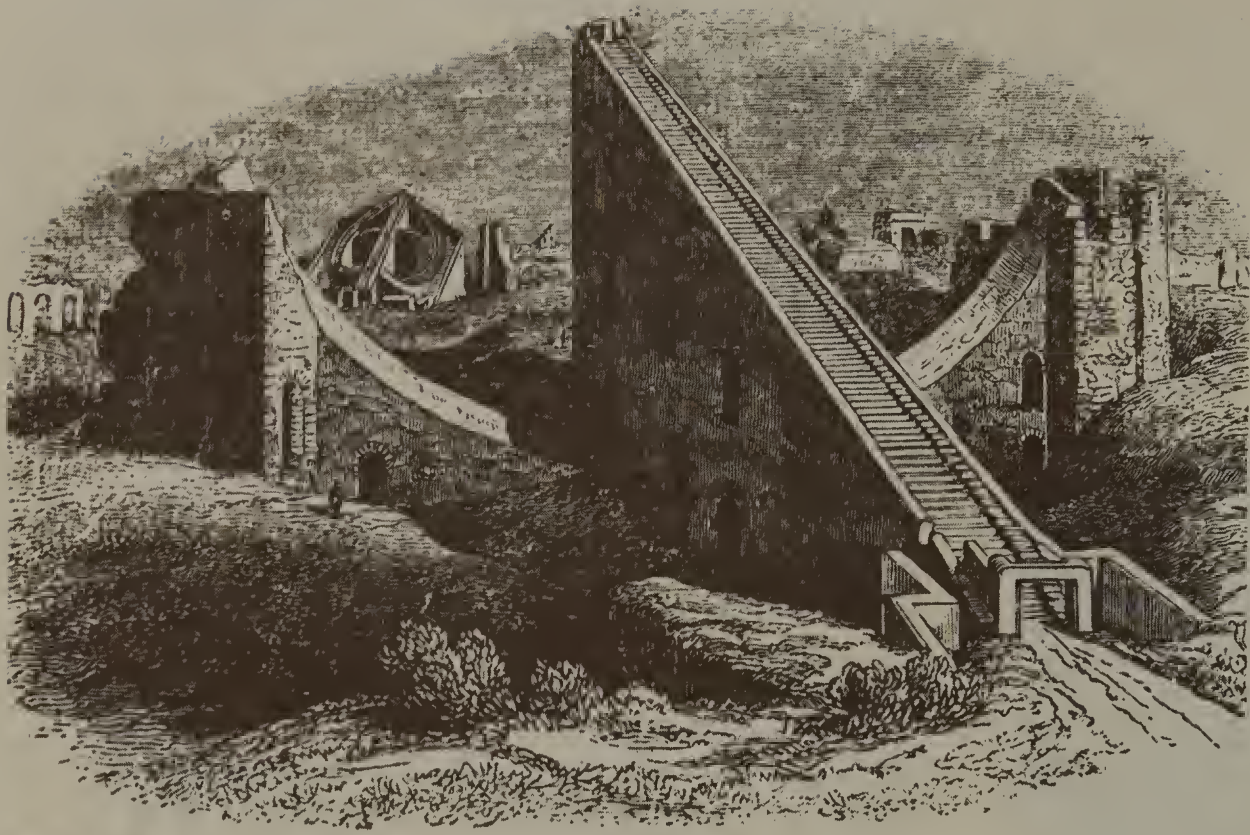
Proctor's theory was so shockingly simple that it was quickly ignored by academic Egyptologists, who were as skeptical of its astronomical value as they were of the value of Stonehenge or the other megalithic observatories scattered about Europe.

In order to create a firm body of astronomical data, the ancients needed a true meridian on the solid earth from which to extrapolate a meridian across the heavenly vault, so as to detect the precise moment when stars, sun, planets and moon transited this meridian in their apparent rotation through the heavens.

In Proctor's analysis the builders of the Great Pyramid had accomplished such a feat by building what he, as a modern astronomer, considered the only sensible instrument short of a great modern telescope.

On the Giza plateau, in the heart of the Great Pyramid, they first built a huge graduated slot, perfectly aligned on the meridian. Through this slot they could observe the apparent movement of the panoply of stars, accurately noting their several transits.

Proctor describes in detail how the ancient architects would have gone about building such an observatory. To



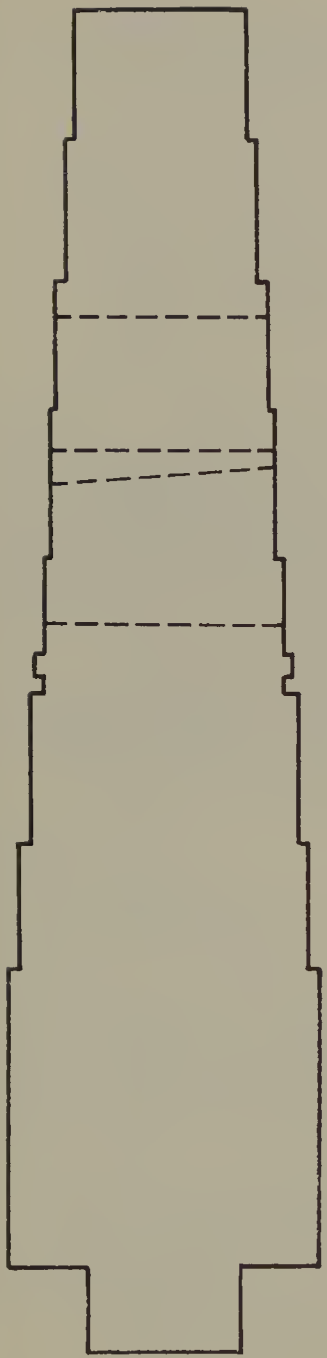
Indian astronomical observatory erected at Delhi by the Maharajah of Jaipur consists of a 56-foot triangular structure which casts a shadow onto an arc of masonry calibrated in hours, minutes and seconds (top).

Another Indian observatory at Benares, known as Yantra, provided fixed angles to check the position of the stars.

obtain a true north-south line for their terrestrial meridian, they would have observed across the tops of a couple of upright pillars whatever star was closest to the celestial north pole (the point around which the stars appear to wheel in their daily motion), then found the star's culmination, or the top and bottom of its circular path. A line through these two points, which could be measured with an ordinary plumb line, would be true north; and any such northern star would do, as all move in a small circle round the celestial pole.

Following the suggestion of Sir John Herschel, Proctor concluded that it might have been alpha Draconis, which was 3° 43′ from the pole in 2160 B.C. and again in 3440 B.C. The French astronomer A. Poge suggests that the ancients could have used Xi Mizar of the Great Bear any time before 1500; but alpha Draconis fits the rest of Proctor's theory quite adroitly.

The question of the method of orienting the pyramids has been the object of a detailed study by the Egyptologist Zbynek Zaba in a recent monograph for the Czechoslovakian Academy of Sciences entitled *L'orientation astronomique dans l'ancienne Egypte et la précision de l'axe du monde.* Far from considering the pyramids monuments to the



Meridian slot for observing the transit of the stars.

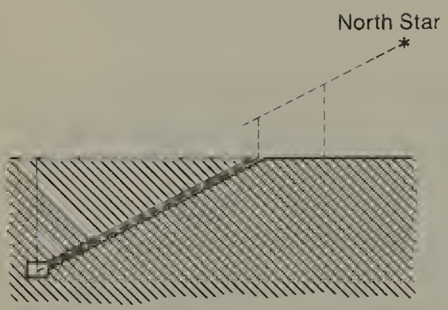
The stars appear to be carried around the pole of the heavens as if they were fixed points in the interior of a hollow revolving sphere. It is therefore possible to determine the position of the pole, even though no bright star actually occupies that point. Any bright star close to the pole revolves in a small circle whose center is the pole.

megalomaniac pride of some theocratic despot, Zaba considers them monuments incorporating the culture, science and technology of the times in which they were built.

The documents adduced by Zaba prove beyond question that the initial operation in erecting an important structure in Egypt was the ceremony of the "stretching of the cord," by which, through the observation of the culmination of some circumpolar star, the north-south direction was determined and marked out on the ground.

An inscription, translated by Johannes Dümichen, describes this royal ceremony: "Looking up at the sky at the course of the rising stars, recognizing the *āk* of the Bull's Thigh Constellation (our Great Bear), I establish the corners of the temple. . . ." "Dümichen says the word *āk* represents the star's culmination as it passes the meridian.*

Having transferred a true meridian from the sky to the ground, the ancient architects, says Proctor, could have begun to consolidate this line by digging it into a descending passage through the live rock, using their polar or circumpolar star to guide the tunnel downward at precisely the angle of its rays.



Proctor's design of how the North Star was sighted along the Descending Passage.

Such a cream-white tube, says Proctor, would have given perfect stability to this fundamental directional line, and the longer the passage the truer its orientation.†

For alpha Draconis, at 3° 43′ from the pole, to have shone directly down a passage at the thirtieth parallel, the passage would have had to be inclined at an angle of 26° 17′—just the angle of the Descending Passage beneath the base of the Great Pyramid.

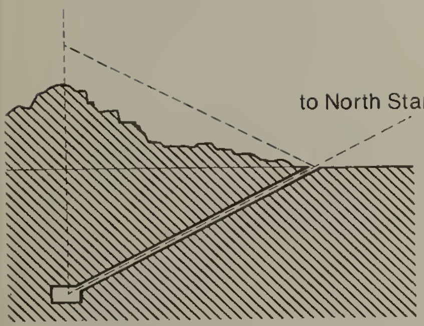
Proctor points out that there would have been no question about the advantage of taking the lower culmination of such a star in preference to its upper one; using the bottom of its circular path as a fixed point would have required far less depth of boring to reach a point directly beneath the center

* The meridian, or great circle through the earth's celestial poles, is the plane in which all the heavenly bodies culminate, or obtain the highest point in their passage midway from the eastern to the western horizon as seen from the earth. Circumpolar stars have a high and a low culminating point on the meridian above and below the celestial pole.

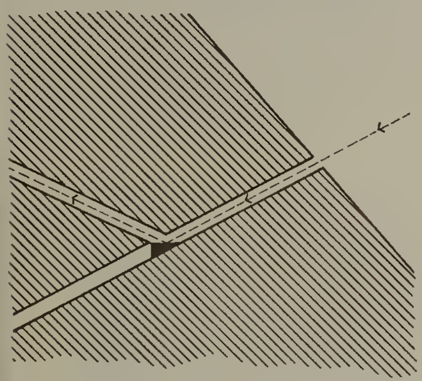
† The advantage of digging such a tunnel is obvious when compared with what would have been needed to achieve the same result aboveground. Someone would have had to hold a plumb line 100 yards high standing at a distance of 200 yards from the observer, who in turn would have had to line up the top of the plumb line with the polar star by night at a slant distance of 260 yards—without benefit of a telescope.

of the proposed building, which was the next object of the operation.

The theory provides an explanation for the quite extraordinary straightness of the walls of the Descending Passage, as measured by Petrie, who was astounded to find a mean variation from a central axis along the entire length of 350 feet of less than 1/4 inch in azimuth—from side to side—and only .1 inch in altitude—up and down. In the part nearest the aperture, which was to be the most important, the exactness is even greater, the mean error amounting to less than 1/50 inch!



How the central point of the Pyramid base could be located by knowing the angle of the Descending Passage.



Reflecting pool at the juncture of the Descending and Ascending Passages.

Once the ancients had measured the length of the Descending Passage and its angle of descent, it would have been simple, by elementary trigonometry, to locate a central spot immediately above the end of the Descending Passage as a center for the proposed pyramid—even if this were on roughly elevated ground.

With a central spot and a true meridian, the architects could set about laying the socket holes for a square base and begin to lay courses on a leveled platform. To obtain true levels, Proctor surmises that the ancient builders used water troughs in conjunction with the light rays from the star.

By continuing the tunneling up through the lower tiers of the growing pyramid, they could maintain a precise orientation for at least the first ten courses, or until the tunnel debouched from the narrowing side of the growing pyramid.

Thereafter their polar star would no longer serve directly, and a new system would be needed to continue the meridian alignment upward in the Pyramid. For this, says Proctor, the builders hit upon the idea of creating an Ascending Passage at precisely the reflecting angle of another 26° 17′. By plugging the Descending Passage and filling it with water, they could reflect the polar star back up an Ascending Passage and continue to keep the passage truly aligned and the building level as it rose another score or more of courses.

For the Descending Passage to have held water, says Proctor, its masonry at the point of juncture would have had to be of hard rock, carefully joined. For no other apparent reason, the stones at this particular point are quite different from the rest of the passage, much harder and smoother and more finely jointed. In fact, the feature escaped observation till 1865.

As Proctor expressed it in his Victorian style: "By using the known properties of liquids combined with the known property of light rays, the ancient builders were able to orient and level a building to a very great height."

But to what purpose? Of a sudden the constricted Ascending Passage changes to an overlapping gallery 28 feet high, in no way essential, or even desirable, to increase or maintain accuracy in orientation for the mounting courses. Yet so extraordinary an architectural design, so carefully executed, must, says Proctor, have served some definite purpose.

Analyzing the problem from the point of view of the astronomer rather than the architect, Proctor came up with an answer. Had an ancient astronomer wished for a large observation slot precisely bisected by a meridian through the north pole, so as to observe the transit of the heavenly bodies, what would he have requested of an architect? A very high slit with vertical walls, says Proctor, preferably narrower at the top, a gallery whose aperture, thanks to the reflected light of the polar star, could be designed so as to be exactly bisected by a true meridian.

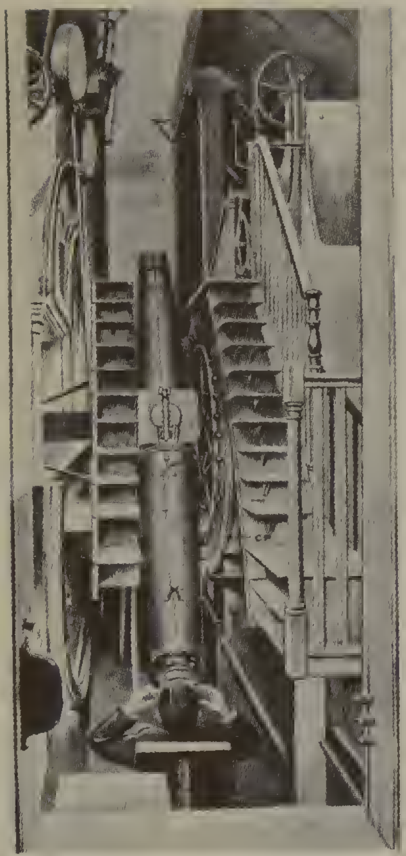
Interior of the Grand Gallery (about one-quarter of its length) showing how it could have been used to observe the stars circling in the southern sky.

Looking up through such a slot, an observer could watch the passage of the entire panoply of the zodiac, easily noting the transit of each star across a perfect meridian—precisely what is done today by the modern astronomer when he sets his transit circle to the vertical meridians. As Proctor points out, such a Grand Gallery might well be described as the *only* very accurate method available for preparing an accurate map of the sky and of the zodiacal cyclorama—before the invention of the telescope in the seventeenth century of our era.

With various observers in the Grand Gallery, placed one above the other on the slanted incline, the southing—or transit across the meridian—of every key star in an arc of about 80° could be observed with remarkable accuracy. As Proctor points out, the most important object of transit observation is to determine the exact moment at which the observed object crosses the meridian. This might have been best accomplished by noting the moment when the star was first seen on the eastern edge of the vertical sky space, and then when it disappeared past the western edge; the instant midway between these two would be the true time of transit.

Proctor surmises that someone in either the Queen's Chamber or on the flat platform of the truncated pyramid above the Grand Gallery could keep time by hourglass or water clock in coordination with the observers in the Gallery, who would signal the beginning or end of transit across the Gallery's field of view.*

* A container with a small hole which drips one drop at regular intervals makes a satisfactory timer. Ancient Chinese astronomers had a system of three such containers in a series to minimize the effect of resistance.



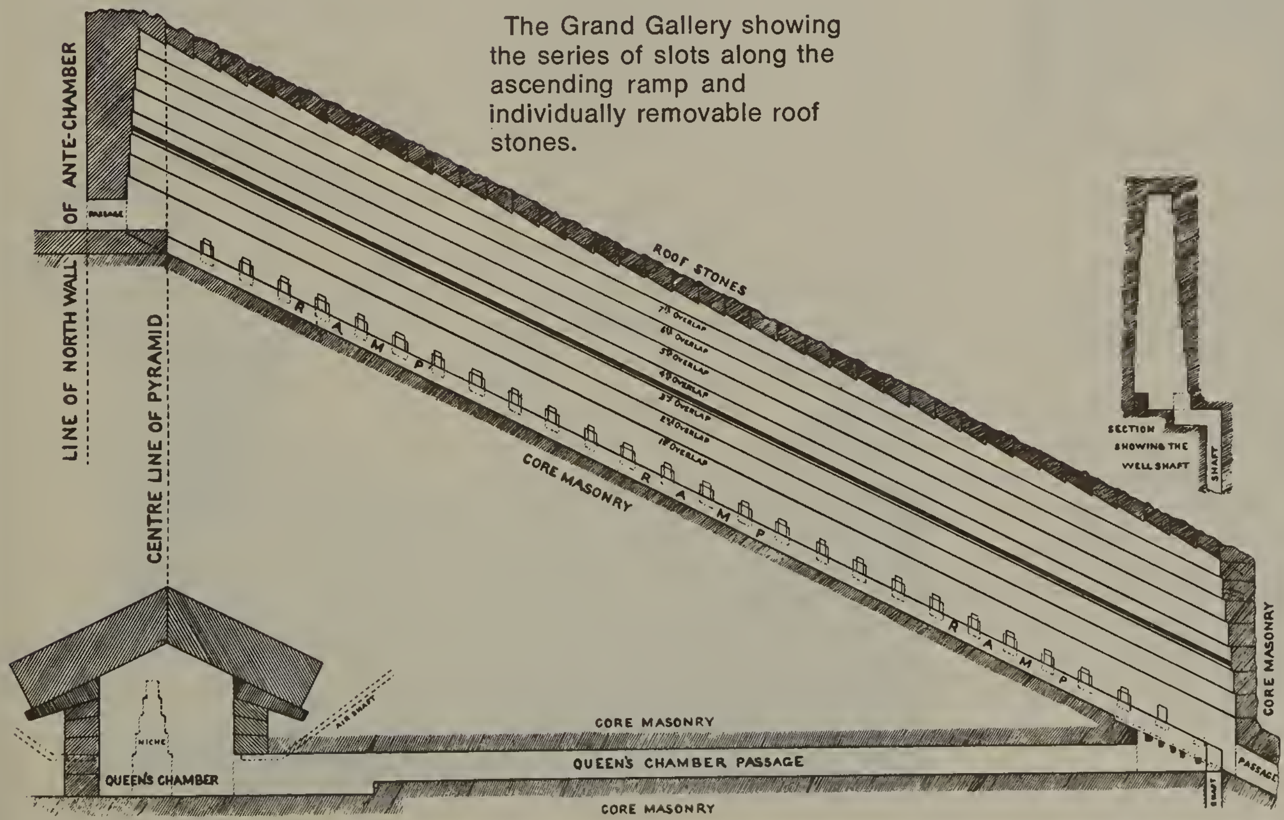
The Transit Circle, Royal Observatory, Greenwich.

By looking down the Descending Passage into a reflecting pool, an ancient astronomer could have noted the exact second of a star's transit, because only at that moment will its rays be reflected. The very same system is used today at the U.S. Naval Observatory in Washington, D.C., where the daily transit of stars is noted to a split second by their reflection in a pool of mercury.

The slope of the Gallery and the corbeling of its walls would also have made it remarkably easy to note the declination of a star—its distance above or below the celestial equator. By combining the observations made by several of what Proctor calls "watchmen of the night," stationed at different levels of the Grand Gallery, a very close approximation of true sidereal time could have been obtained. For such observers to function effectively, cross ramps or reclining benches of some sort would have had to be positioned at different levels of the Gallery.

In support of this theory, there is the series of 27 oblong holes cut vertically along the walls and into the ramps to a depth of 8 or 11 inches. They served to hold some sort of scaffolding across the Gallery. Proctor postulates that there were benches for observers at regular intervals up the Gallery.

The fact that the walls of the Gallery are corbeled like those of the earlier mastabas and of the megalithic observatories, whose top stones could be readily removed, and that each of the roofing stones of the Grand Gallery



The Grand Gallery showing the series of slots along the ascending ramp and individually removable roof stones.

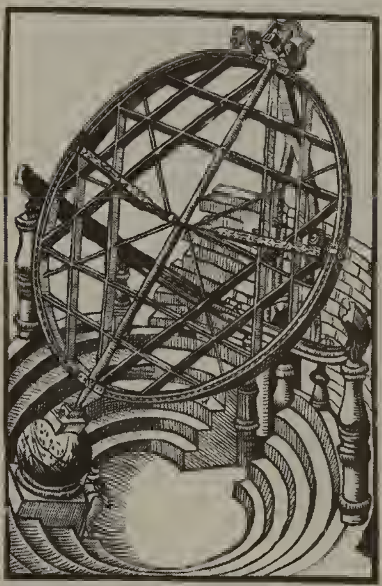
was independently removable (none presses down on its neighbor) may indicate that by the removal of these stones almost as much again of the northern arc of sky could be observed as was visible of the southern sky through the upper end of the Gallery. The movement of particular stars could be pinpointed by the removal of single stones.

Proctor surmises that the method used to determine the declination of a star involved a very practical use of the odd grooves that appear along the walls of the Gallery. At approximately half the height of the Gallery, just above the third overlap on each wall, a narrow groove runs the whole length of the gallery, 6 inches wide and 3/4 inch deep.

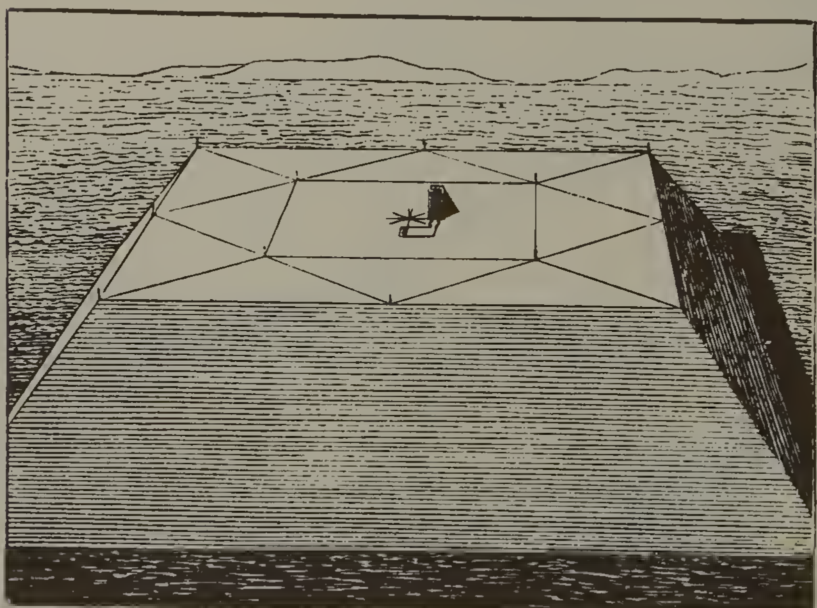
Proctor suggests that horizontal bars carrying vertical rods at suitable distances, perhaps with horizontal lines on them, were held between these grooves, and could be slid to any convenient position. The vertical rods could also have been adjustable.

To locate a star correctly, the transit observers would also have to determine what is called its "right ascension," or distance measured parallel to the equator from a certain assigned starting point on that circle. Knowing the time of transit, it is simple to position the celestial object in its "right ascension."

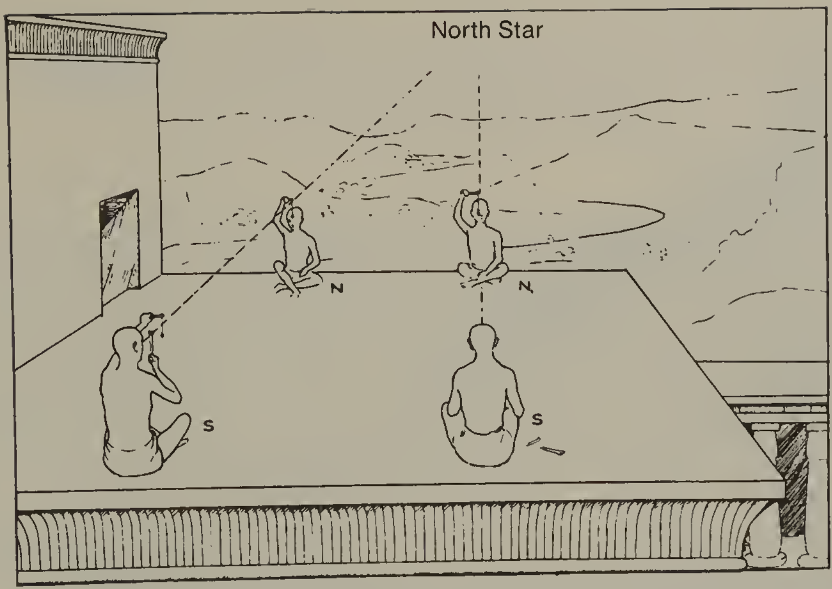
By placing observers not only in the Gallery but outside at the cardinal points of the great truncated pyramid, Proctor says that the entire visible sky could be accurately plotted. The ancient astronomers, says Proctor, would doubtless have made even more observations *off* the meridian, once they had established the meridian observations as their guide marks. They would certainly have made multitudinous observations of the risings and settings of stars at the



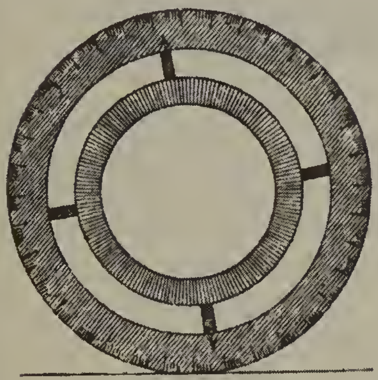
Ancient polar astrolabe.



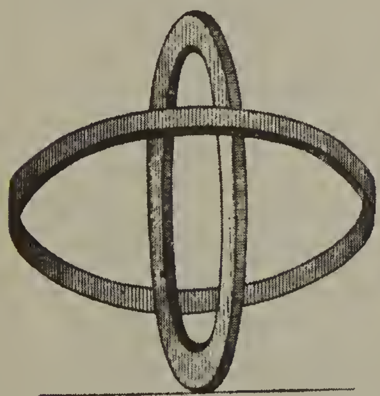
The truncated pyramid, as depicted by Proctor, would have made an observation platform 142 feet high and 175 feet square.
The cardinal points, or compass rose, could have been marked by upright posts on the periphery of the platform. To locate the rising and setting of stars east and west, azimuth observers could occupy the center of the square from which they could command the entire compass.



Ancient method of observing stars with rings and rods.



Late Egyptian armillary disk for measuring solstices.



Equinoctial armillary disk.

horizon, and especially their heliacal risings and settings just before dawn and just after sunset.

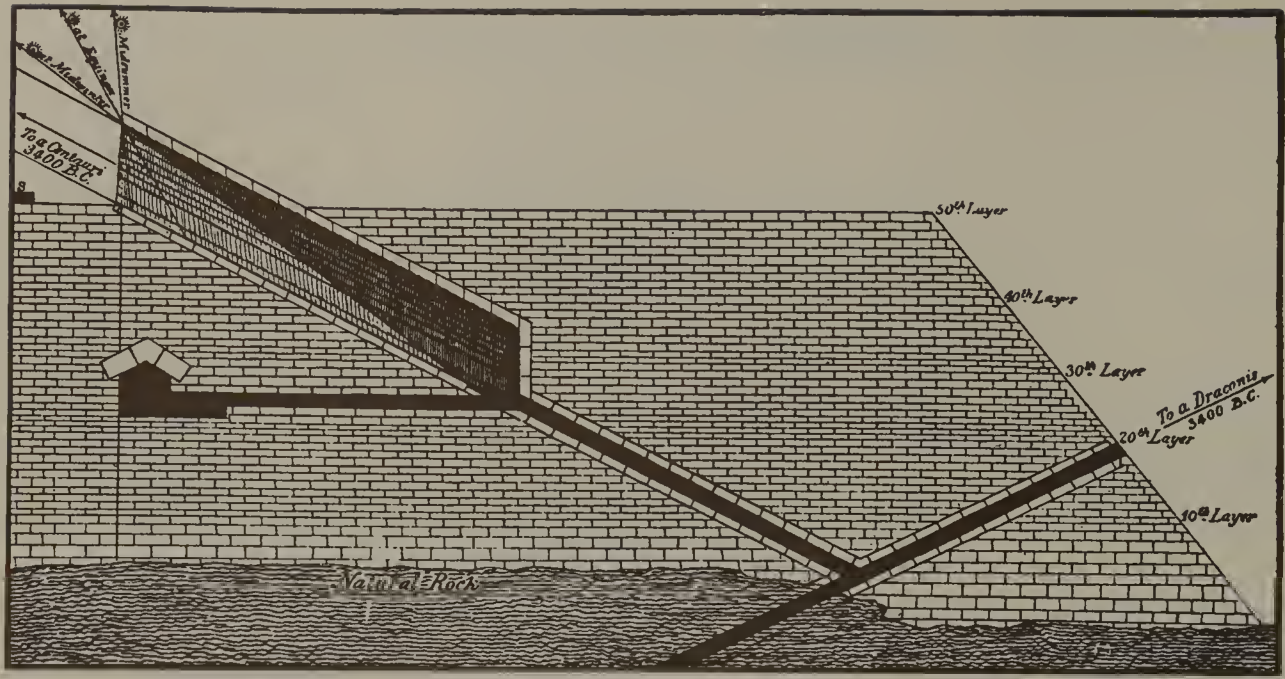
Proctor suggests that there were at least thirteen observers for azimuthal directions around the horizon, whose work could be combined with that of at least seven transit observers at different levels of the Grand Gallery.

The azimuthal observers would be supplied with astrolabes, armillary spheres of reference, direction tubes, or ring-carrying rods. Together with the transit watchers they would be able to make observations which, in Proctor's opinion, would be inferior only to those made in our own time with telescopic adjuncts.

George Sarton, professor of the history of science at Harvard, says the astronomical ability of the early Egyptians "is proved not only by their calendars, tables of star culminations, and tables of star risings, but also by some of their instruments such as ingenious sundials or the combination of a plumb line with a forked rod that enabled them to determine the azimuth of a star."

Proctor adds that for a greater knowledge of the sun's motion, the Grand Gallery slot could have been used to better effect than an obelisk or a sundial by noting the sun's shadow cast by the edges of the upper opening against the walls, sides and floor of the long Gallery. To make observations of the sun more exact, Proctor envisaged the use of screens: by placing an opaque screen at the upper end of the Gallery with a small aperture to receive the sun's light upon a smooth, white surface at right angles to the sun's direction, a much magnified image of the sun would be formed on which any sunspot could hardly have failed to appear. The movement of the spots would have indicated the sun's rotation on its axis.

The moon's monthly path and all its changes could have



Proctor's direction lines show the midday sun at midsummer, midwinter, and the equinoxes as they would strike the Grand Gallery of the Great Pyramid, forming light and shadow marks even more effective than those of obelisks.
He also shows the alignment of alpha Draconis with the Descending Passage, as it was in 3400 B.C. and a line to alpha Centauri, which was then on the meridian, from the Grand Gallery. Proctor believes that through such a sighting tube as the Grand Gallery, alpha Centauri could have been seen transiting in broad daylight.
It is noteworthy that the Grand Gallery debouches at precisely the fiftieth course of masonry, and that at that level the square platform is exactly half the area of the base of the Pyramid.

been dealt with in the same effective way, as indeed the geocentric paths of the planets or their true orbits around the sun: these could have been determined very accurately by combining the use of tubes or ring-carrying rods with the direction lines determined from the Gallery's sides, floor, etc.

Once the diurnal pattern of the stars' apparent rotation past a fixed meridian had become clear to the observers, they could more easily plot the irregular and sometimes apparently retrogressive path of the planets and the moon in relation to the "fixed" stars. The heliocentric pattern of our solar system could well have been extrapolated from a study of the relative motions of these planetary satellites, anticipating Copernicus by several thousand years.

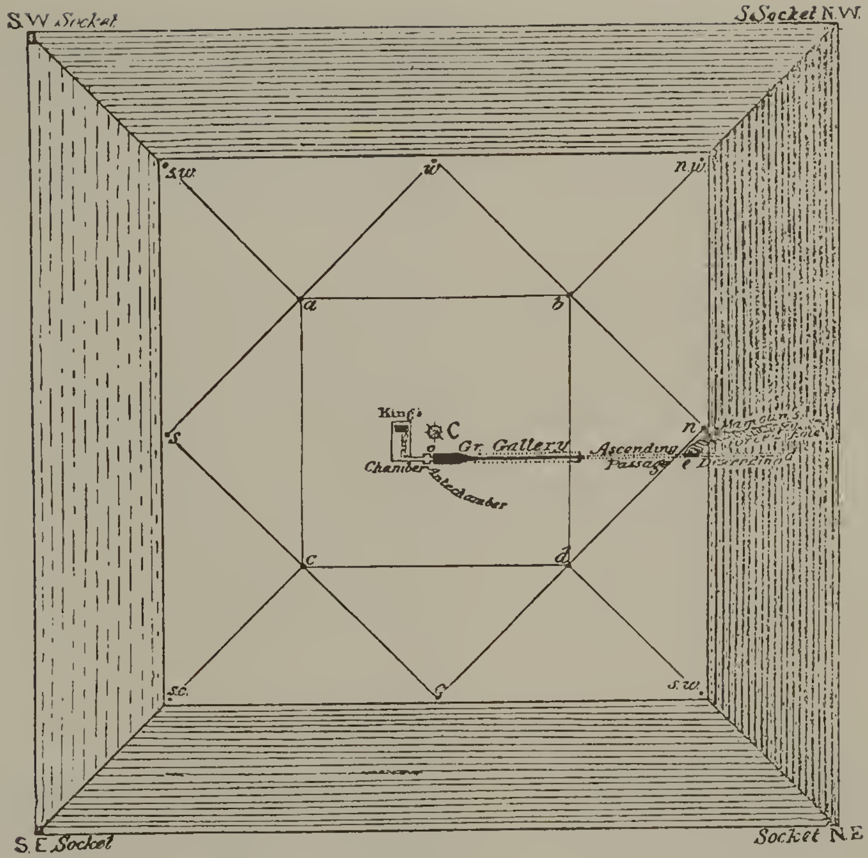
To Proctor, the Great Pyramid thus constructed would have been the greatest observatory and the most perfect till the art of the telescope could reveal a way to more exact observation without the need for such a massive structure.

That the flat top of the truncated pyramid served as the plan for mapping the zodiac is supported by the zodiacal maps of the early astrologers. Even Kepler and Galileo, when making a chart for someone's horoscope, used square charts for their zodiacs, which are the shape of the truncated pyramid.

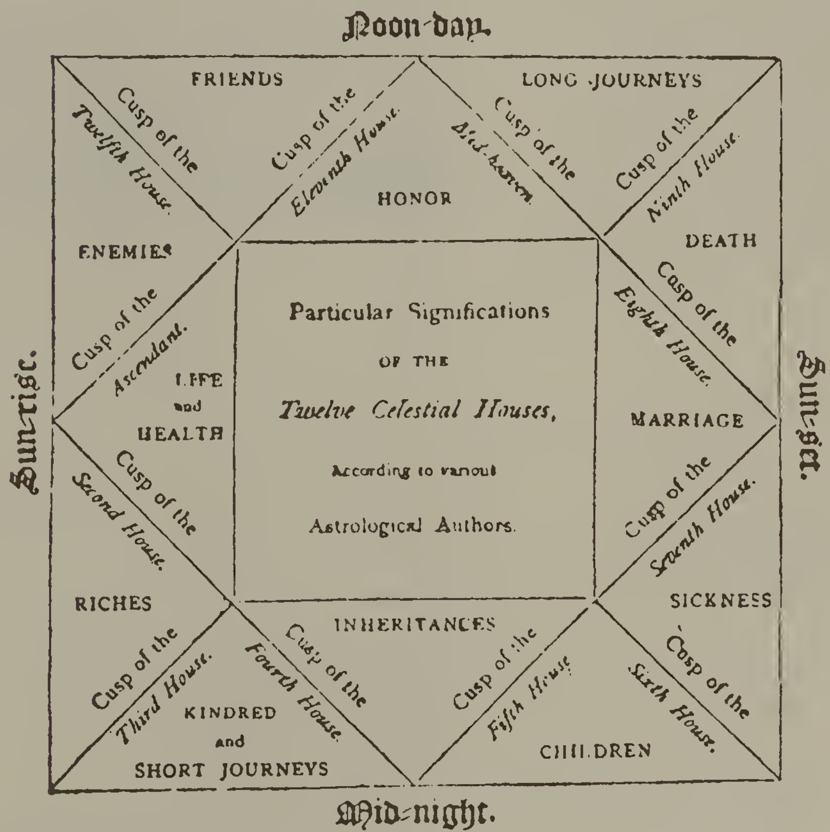
The French mathematician Funk-Hellet even suggests that the 24 holes in the sides of the Grand Gallery once supported, two by two, movable panels with symbolic figurations of the zodiac.

At the end of a few years' observation it would have been obvious to the ancient astronomers at the moment of the

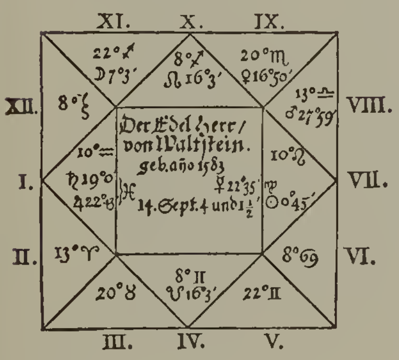
By placing the gallery slightly to the east of the north-south axis of the Pyramid, the ancient astronomers could make their observations from the center of the truncated square, and a gnomon, or shadow pole, could be raised in dead center. That such a square was the prototype for astrological as well as astronomical computations is strikingly illustrated by the format for horoscopes which persisted into the seventeenth century.



The twelve celestial houses of the zodiac according to astrological authors.



Horoscopium gestellet durch
Ioannem Kepplerum
1608.



Horoscope prepared by Kepler.

equinox that the whole stellar caravan was returning to its original position just a fraction later—hence each year the equinox itself appeared to move forward. By fine observation of the circumpolar stars, the ancient astronomers could have measured the angle of this precession and deduced its rate to be about 1° in 72 years, making a grand cycle of 25,920 years to cover a full circle of 360°.

Proctor's astronomical analysis of the Grand Gallery was discounted by Egyptologists on the grounds that they had no evidence the ancient Egyptians were capable of making accurate astronomical observations. But in 1934 Proctor received strong support from another professional astronomer, Eugene Michel Antoniadi, who was also an Egyptologist, attached to the Egyptian Observatory of Medûm, in a serious work dealing with the various branches of ancient Egyptian astronomy.* Antoniadi agreed that the Great Pyramid had been used as an observatory before the closing of its inner corridors. He also agreed with Proctor's theory of the alignment and use of the Grand Gallery.

Astronomer E. M. Antoniadi added a refinement to Proctor's theory, showing that the ancients might have used a temporary trestle to help start the alignment of the Descending Passage. However, such a trestle would have had to be 300 feet high and 600 feet long, with a slant height of 780 feet, merely to serve a function that could be better performed by digging the Descending Passage directly. It is more likely the builders avoided the scaffold.

Antoniadi figured that the Grand Gallery would have permitted priests to observe 80° of the sky. He says they should have been able to note the declination of all visible stars from −50° below the celestial equator to +30° above it, and that with the use of clepsydras (water clocks) they should have been able to measure hour angles and deduct the right ascension of stars and planets.

These two data are all that is required for constructing a star map or planisphere. "From a star map," says Lancelot Hogben, "it was a very short step to the recognition that the Earth itself could be divided into similar zones with simple relations to the fixed stars—hence the first world maps with latitude and longitude."

* *L'Astronomie égyptienne depuis les temps les plus reculés, jusqu'à la fin de l'époque alexandrine* (Paris, Gauthier-Villars, 1934).

XIII. ASTRONOMICAL TEMPLES OF EGYPT

In his avant-garde book *The Dawn of Astronomy,* written at the turn of the century, Sir Norman Lockyer minutely demonstrated how the Egyptians built and used their temples for astronomical observations from the very remotest antiquity. Lockyer showed how Egyptian solar temples were so arranged that at sunrise or sunset on the longest day of the year, a ray from the sun shot through a skillfully contrived passage into the dark interior of the inner sanctum of the temple. The illumination from the sun was cut off by means of pylon screens so that a concentrated shaft of light cut through the gloom.

Lockyer was the first English astronomer to conclude that Stonehenge had been accurately aligned in about 1680 B.C. to catch the first gleam of the midsummer sun at its solstice, a fact which was recently corroborated on the basis of computerized data by the astronomer Gerald S. Hawkins in *Stonehenge Decoded.*

Both of Lockyer's conclusions were ignored.

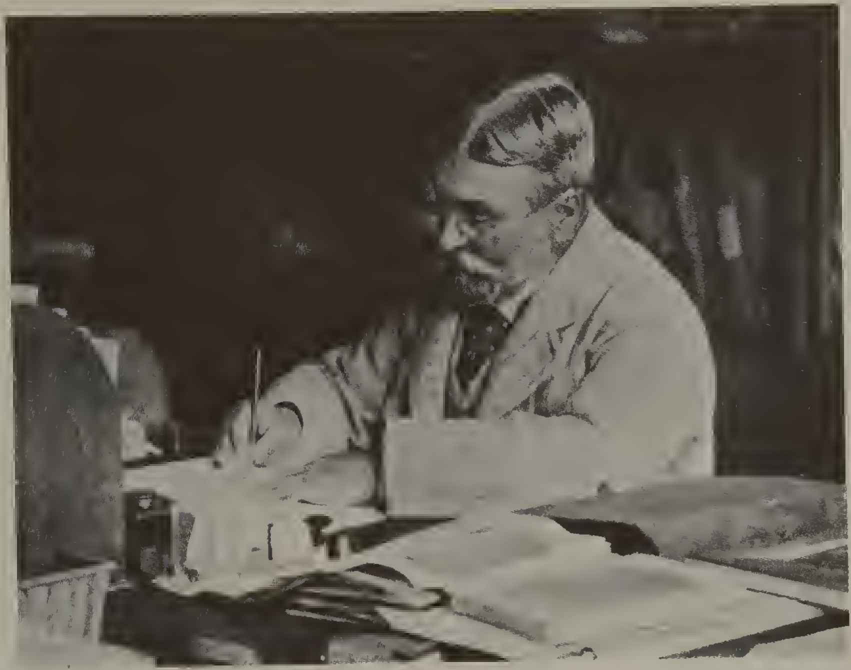
The difference between the megalithic and the Egyptian systems lies in the fact that anyone who can set up a circle of well-placed stones with a sighting avenue can note the farthest points north and south on the horizon where the sun rises at the summer and winter solstices; by taking the halfway mark along the semicircle of stones, the day of the equinox, when the sun is due east at the equator, can be geometrically fixed. To obtain a more precise length of the year—to within a matter of hours and minutes—requires a more sophisticated system.

Lockyer—whom Hawkins describes as "an extraordinary man whose true worth as an astronomer and theorizer concerning the history of astronomy has not yet been adequately appraised"—shows how the esthetically incomparable Egyptian temples scattered along the Nile were astronomical instruments designed like a modern telescope aimed at a specific point on the horizon.

Within the Egyptian temples the light of the sun, or other heavenly body, was funneled between two rows of delicately carved columns which ran through a chain of variously dimensioned halls, like the light of a heavenly body being funneled through the gradually narrowing diaphragms of a telescope.

Temple at Luxor (above) drawn by a member of Napoleon's expedition, showing a row of columns oriented as an astronomical observatory. Temples usually contained a pylon, forecourt, hypostyle hall, and sanctuary.

Astronomical temple at Edfu, later known as Appolonopolis Magna, half buried in the sand as it was found and drawn by Dominique Vivant, one of Napoleon's savants.



Sir Norman Lockyer.

The longer the temple's axis, the longer and narrower the beam, and the greater the accuracy in measuring it. The darker the sanctuary, the more obvious the path of light on the end wall.

The purpose, says Lockyer, was to narrow the beam of light to the point where it could indicate the precise moment of the solstice.

According to Lockyer, a beam of light coming through a narrow passage some 500 yards all the way to a properly oriented sanctuary would remain there no more than a couple of minutes, then pass away. What's more, it would come in a crescendo and go in a diminuendo with an observable peak at the precise solstice.

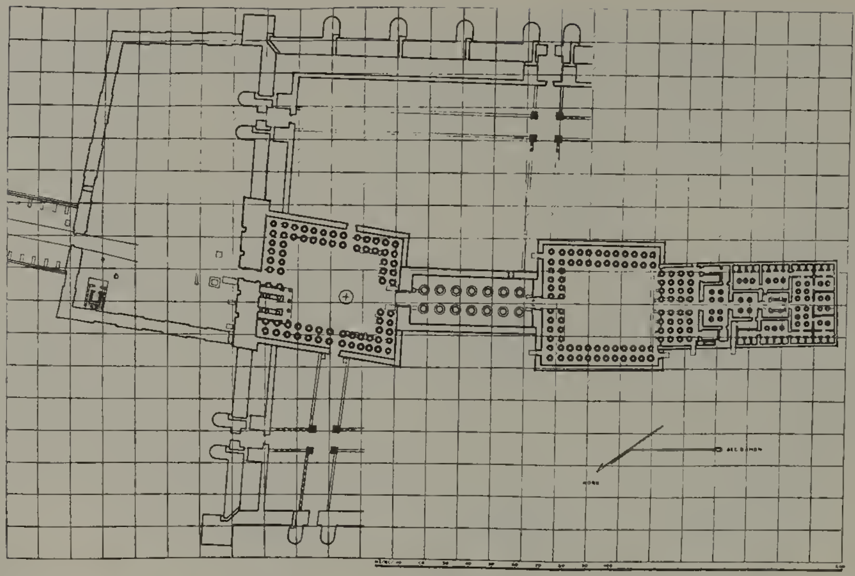
This would enable the priests to determine the length of the year to within a minute, or four points of decimal—or 365.2422: an otherwise very difficult feat because the sun appears to linger several days around the point of solstice, and its movement of a mere 50″ a day is almost imperceptible without some refined instrumental aid.

Lockyer, who went to Egypt regularly in the summer holidays, found that the sun temple of Amen-Ra at Karnak was built in such a way that at sunset at the summer solstice —the longest day in the year—the sunlight entered the temple and penetrated along the axis to the sanctuary. In Lockyer's words it was "a scientific instrument of very high precision, as by it the length of the year could be determined with the greatest possible accuracy."

Extrapolating backward from the present orientation of the building, and taking into account the small but gradual shift in the tilt of the axis of the earth, Lockyer applied the

(*Overleaf*)
Colonnade to the temple of Amon-Ra at Karnak as it was discovered by members of Napoleon's expedition. Lockyer found that the temple's axis was accurately oriented to the summer solstice and considered it "beyond all question the most majestic ruin in the world."

Reconstruction of the temple of Amon-Ra at Karnak showing how the colonnade was aimed like a telescope toward the sunset of the summer solstice. This romanticized etching was produced by the French savants for the *Description de l'Egypte*.



Rendering of the temple at Luxor by Schwaller de Lubicz, showing three successive changes in orientation.

Chiseled orientation line on subflooring of the temple at Luxor noted by Schwaller de Lubicz. The line was then hidden from view by superimposed finished flooring.

system he had used for Stonehenge and estimated the temple to have been originally laid out about 3700 B.C.

Lockyer found sun temples oriented to catch the sun at the solstice or equinox, and star temples oriented to frame a star rising on the horizon just before sunrise at the solstice or equinox, so as to give warning of the imminent solar event.

Herodotus describes two pillars of gold and green stone in the temple of Tyre which shone at midnight. According to Lockyer, "there can be little doubt that in the darkened sanctuary of an Egyptian temple the light of Alpha Lyrae, one of the brightest stars in the northern heavens, rising in the clear air of Egypt, would be quite strong enough to throw into an apparent glow such highly reflecting surfaces as those to which Herodotus refers."

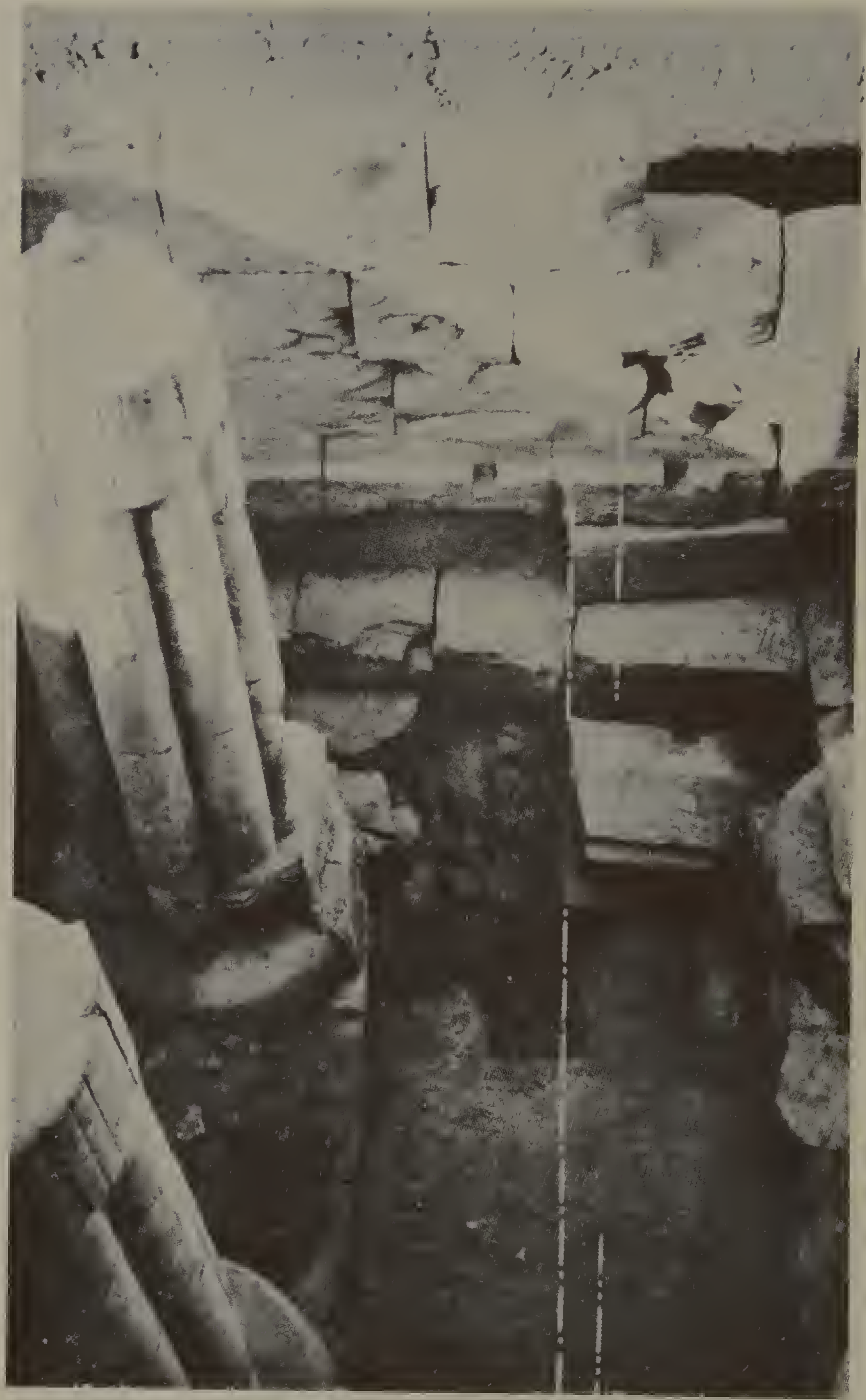
Maspero suggests that the priests were not above "pious frauds" accomplished by means of statues which were animated, spoke, moved and acted. For those not in on the secret, the priests may have achieved quite stunning effects by having a large jewel in the breastplate of a statue suddenly and mysteriously sparkle with light.

Lockyer realized that temples oriented to the sun could provide a useful calendar for thousands of years because the tilt of the earth's axis shifts no more than a degree in six or seven thousand years. But temples oriented to stars could function only for a limited 200 or 300 years because each year the rising or setting of stars just before sunrise or after sunset at the solstice or equinox would occur a little later because of the precession of the equinoxes. The stars' lag behind the sun along the circle of the zodiac—a barely noticeable 1/72° each year—could become as much as 3° in 200 years, superannuating the usefulness of the temple. The temple would then need to have its axis reoriented, or another temple would have to be built. "This change of direction," says Lockyer, "is one of the most striking things which have been observed for years past in Egyptian temples."

Luxor, for instance, has four definite, well-marked changes in orientation. Lockyer measured temples at Karnak and found they were changed to match the precessional change of the stars' declination so that the priests could continue to observe it. Pylons were added, more courts were added, the sanctuary was moved eastward, the front of the temple westward.

As Maspero pointed out, "all the Ptolemaic temples and most of the Pharaonic temples have been reconstructed" during the period of their use.

Gunther Martiny, who tabulated the orientation of Assyrian temples for which the dates of foundation can be established

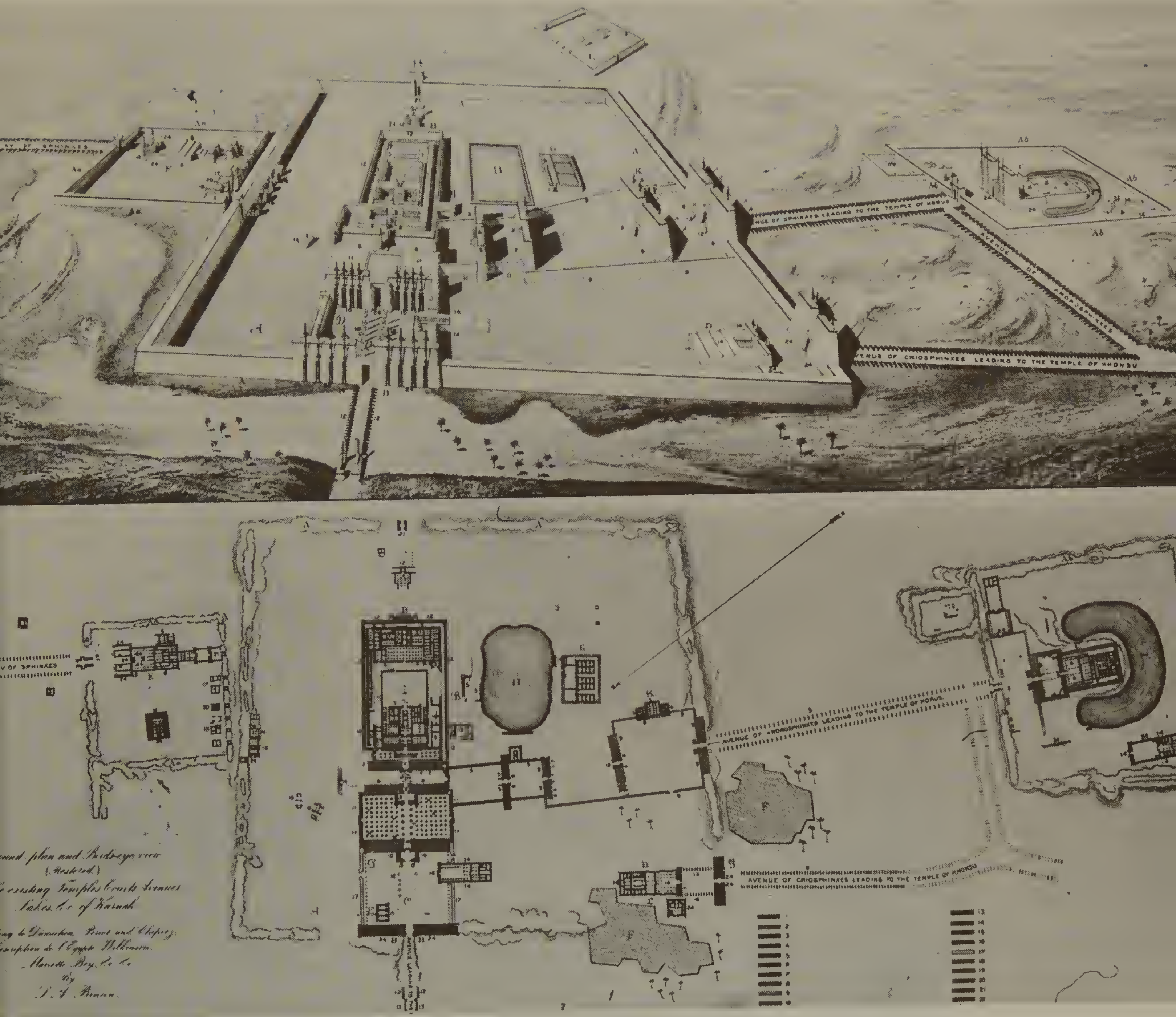


Small stones inserted in the regular masonry indicated a hidden line of orientation for the temple at Luxor.

(the oldest being about 1800 B.C.), found that the orientations also varied according to the angle of the precession of the equinoxes.

Nevertheless, says Lockyer, a temple once oriented to pick up the heliacal rising of a star could be *refitted* at a later time to mark the rising of some other heavenly body.

Lockyer drew up a stellar map with the positions of all the great stars along the sun's zodiacal path for the last 10,000 years, and he named a series of stars which could have been used to herald the solsticial dawn in different temples at different periods. In the course of centuries, according to



Reconstruction of the temple compound at Karnak showing the variation in axis of different buildings and colonnades.

Lockyer, the Egyptians oriented temples to alpha Ursa Major, Capella, Antares, Phact, and alpha Centauri. As early as 6000 B.C. they may have used Dubhe before it became a circumpolar star, and Canopus before 6400 B.C.

Professor Lockyer says that the earliest civilization in Egypt built temples at Annu or Heliopolis oriented to the heliacal rising of northern but noncircumpolar stars at the summer solstice. However, "the Great Pyramids were built by a new invading race representing an advance in astronomical thought" who used northern stars on the meridian and stars rising due east at the equinoxes.

The subsequent break in Egyptian history between the Sixth and the Eleventh Dynasties is associated by Lockyer with conflicts between these and two other races, which ended in a victory of the representatives of the old worship of Annu reinforced by supporters from the south, so that the north-star and south-star cults combined against the equinoctial cult.

Lockyer's deductions about the refurbishing of temples was to rekindle interest in the zodiac of Dendera found by Napoleon's General Desaix, and subsequently dynamited from the ceiling of the temple. It was purloined after a series of incredible adventures, to be sold to Louis XVIII for 150,000 francs and end up on display in the Louvre, where it resides today.

It was clear to Lockyer that there had been two temples of Dendera, one dedicated to Hathor and the other to Isis, both mythological personifications of heavenly bodies. Lockyer says the evidence is overwhelming that these two temples were also horizontal telescopes with the same number of pylons gradually getting narrower toward the holy of holies, so that a beam of horizontal light coming through the central door might pass uninterruptedly into the sanctuary to mark the rising of a celestial body. The columns, says Lockyer, shielded the eye from the sunrise light, so that the rising could be precisely indicated. According to Lockyer the present temples of Dendera were renovated in Ptolemaic times, but were built on much older sites.

The French astronomer Jean Baptiste Biot staked his academic reputation on his analysis of the circular zodiac. He said it represented the skies in Egypt in 700 B.C., and that it had probably been copied from older drawings made on papyrus or stone.

Lockyer confirmed that the Isis temple had been directed at Sirius in 700 B.C., when Sirius rose "cosmically," or in unison with the sun, at the Egyptian new year. But Lockyer quoted an old inscription which described a temple of Hathor at Dendera in the time of Khufu (Cheops) in the Fourth Dynasty (which he dated at 3733 B.C.) "when the star shone into the temple and mingled with the light of her father Ra."

Another inscription in a crypt of the temple indicated it had been built according to the plans of Imhotep, son of Ptah, who was the fabulous architect of the Third Dynasty King Zoser.

In Lockyer's opinion the temple of Dendera may have been rebuilt at least three times since then, once in the reign of King Pepi I (which Lockyer gives as 3233 B.C.), once again by Thothmes III in 1600 B.C., and finally by the Ptolemies about 100 B.C.

According to Lockyer the temple may previously have been directed at Dubhe, which ceased to be circumpolar about 4000 B.C., and before that at gamma Draconis, which ceased to be circumpolar in about 5000 B.C.

Egyptologists greeted Lockyer's astronomical theory about Egyptian temples with the same reserve they treated his theories about Stonehenge—which a computerized age has now shown to be correct. The Egyptologists objected to Lockyer's dragging in astronomy to straighten out the chronology of history, and dismissed his theory "with good-natured laughter, advising the cobbler to stick to his last"; so *The Dawn of Astronomy* dropped out of sight and became very hard to find, until reprinted in 1964 by Giorgio de Santillana at the Massachusetts Institute of Technology.

At the time of publication only Sir Gaston Maspero was impressed. He spent an Easter holiday at the sea studying Lockyer's theory, and he grudgingly agreed that "except for matters of detail I feel that on the whole your demonstration is conclusive, and in principle you must be correct."

Schwaller de Lubicz now supports Lockyer's conclusion, saying there can be no doubt about the orientation of temples or the fact that the ancient Egyptians understood the precession of the equinoxes, which brought a new constellation into position behind the rising sun at the vernal equinox every 2200 years. The mere fact that the cult of the Bull preceded the cult of the Ram in Egypt, and that the dates of these cults correspond with the equinoctial positions

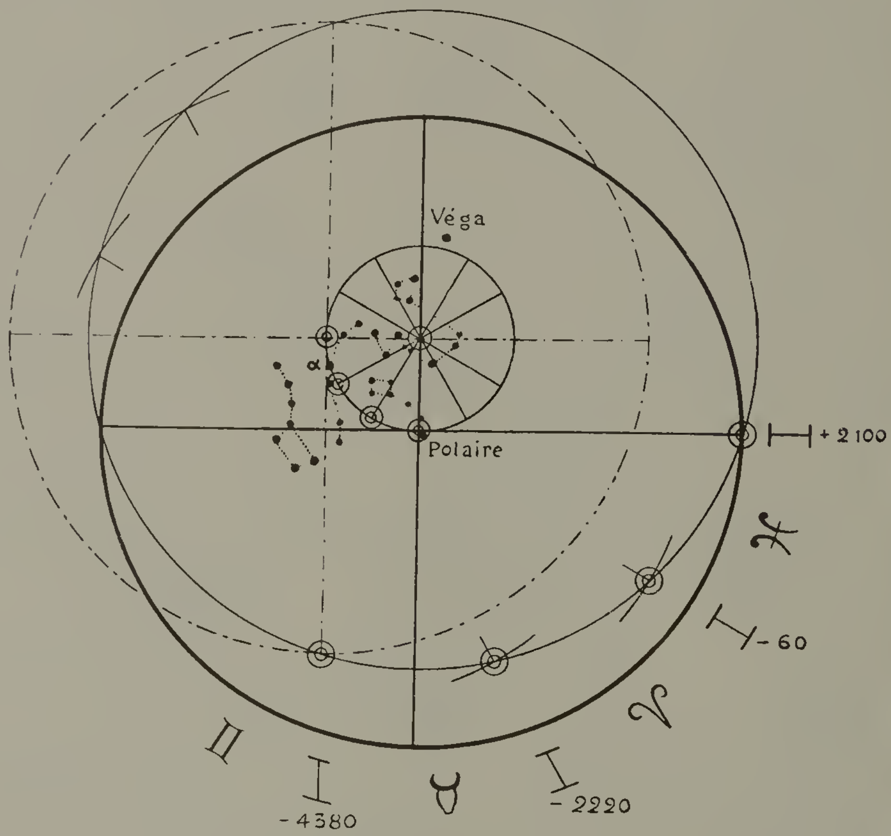
Temple of Hathor at Dendera, as drawn by Denon, showing main axis possibly oriented to gamma Draconis before 5000 B.C., according to Sir Norman Lockyer.

Interior of the temple of Hathor at Dendera as conceived by the French savants.

The circular zodiac of Dendera was on the ceiling of an upper room of the temple believed to have been used as an observatory.
The outer circle of figures, moving counterclockwise like the stars, represent the 36 *decans*, or 10-day weeks of the Egyptian year; the twelve arms of the supporting figures, the twelve months of the year.

of their constellations at the appropriate time—approximately 4000 and 2000 B.C.—is conclusive in his opinion. Furthermore, says Schwaller, an emphasis on duality in the Predynastic Period indicates a cult of Gemini coincident with the dominance of that constellation at the vernal equinox.

Schwaller also agrees with Lockyer that the temple of Hathor at Dendera is built on the remains of much older temples. To prove his point he produced a solution to the arrangement of the constellations in the circular zodiac which has been such a problem to archeologists for well over a hundred years. Schwaller shows that the zodiac discovered by General Desaix was indeed carved in Ptolemaic times, but incorporates a palpable demonstration



Zodiac showing the overlap of the circuit of the earth's celestial pole around the pole of the ecliptic, indicating different dates in the past.

of the precession of the equinoxes as well as three important historical dates.

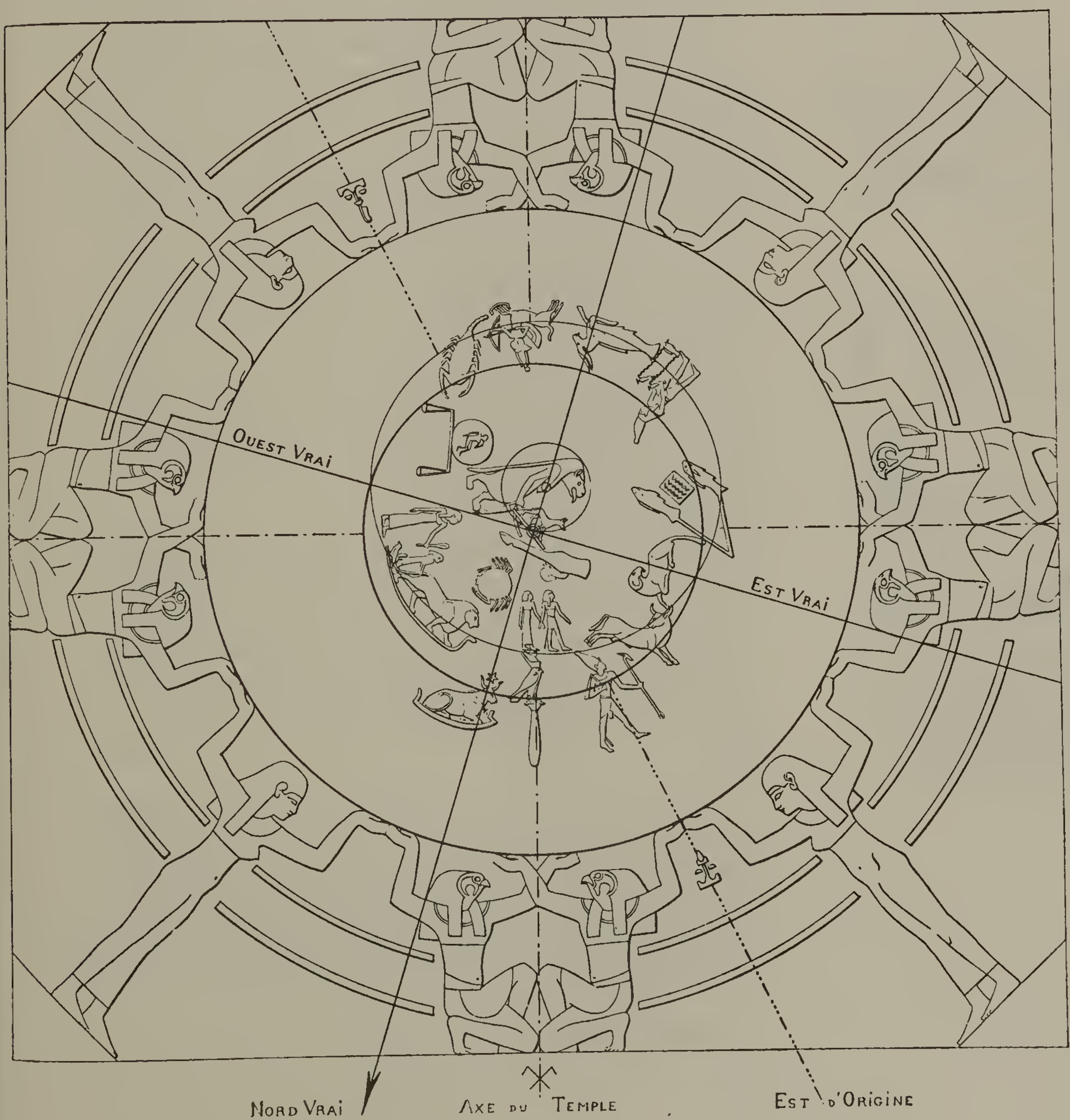
The zodiac is about 8 feet across, carved in relief on hard stone. The constellations are arranged in a spiral and the symbolic figures are marching counterclockwise in the diurnal direction of the stars as seen from the earth. Recognizable mythological figures for the constellations near the pole are a jackal for the Little Bear, an ox-leg for the Great Bear, and a hippopotamus for Drago. Sirius is depicted as a cow in a boat with a star between her horns.

The zodiac is in a circle at the center of which is our

The inner circle of spiraling figures shows the zodiacal constellations such as Gemini (the Twins hand in hand) and Taurus (the Bull) circling around our celestial north pole correctly situated in the Jackal (or Little Bear) which in turn circles around the celestial north pole of the ecliptic, situated in the breast of the Hippopotamus or Drago. Schwaller's lines show that the zodiac of Dendera correctly indicated earlier historical dates when different constellations appeared in the east at the equinox.

north pole. This circle is in a square oriented with the walls of the temple—or about 17° east of north. Our north pole is correctly located in the constellation of the jackal, or Little Bear, as it was at the time when the zodiac was carved, sometime about the first century B.C. But the zodiac also shows the pole of the ecliptic, located in the breast of the hippopotamus, or constellation of Drago.

To Schwaller this explains the spiral formation of the constellations. The mythological figures representing the constellations are entwined in two circles—one around the north pole and one around the pole of the ecliptic. Where these two circles intersect marks the point of the equinox, or due east. The zodiac thus becomes a calendar going back to remote antiquity.



A line due east, which runs between the end of the Ram and the beginning of Pisces, indicates the time when the temple was rebuilt, about 100 B.C. An earlier east line runs right through the Ram, indicating a date about 1600 B.C., at the height of the Amonian domination, during the Twelfth Dynasty.

A special hieroglyph on the ring of the zodiac indicates an equinoctial line running through the end of Gemini and the beginning of Taurus—the date of the founding of the empire of Menes and the beginning of the cult of the Bull and the adoption of the new calendar, sometime in the third or fourth millennium B.C.

In other Egyptian charts of the constellations there appears the figure of a hawk-headed man holding in his outstretched arms a line which ends against the figure of the ox-leg, representing the constellation of the Great Bear.

Hawk-headed man holding a spear (pointing at the Great Bear constellation) indicates the meridian through the pole of the ecliptic, according to Stecchini.

According to Zaba this line held by the hawk-headed man indicates the meridian through our north pole. But Professor Livio Stecchini points out that Zaba did not notice that this line always ends at a very specific position, at times with an arrow point, which divides the seven stars of the Great Bear into four and three. This line, says Stecchini, does not indicate the meridian passing through the north pole, but the meridian passing through the pole of the ecliptic. In Stecchini's opinion, the ancient Egyptians not only understood the precession of the axis of the earth but considered the true meridian the one passing through the pole of the ecliptic of the solar system. Lockyer added that the Babylonians had distinguished the pole of the equator from the pole of the ecliptic, naming the former Bil and the latter Anu.

The evidence leaves little doubt that the ancient Egyptians knew there were two poles in the sky, a north pole, which shifted round a fixed pole, or "open hole" in the heavens; they also knew that this slow circling brought about the precession of the equinoxes. That the phenomenon of the precession was the matrix from which a thousand myths were developed is abundantly illustrated by the work of Giorgio de Santillana and Hertha von Dechend in *Hamlet's Mill.**

There is no doubt in Santillana's mind that the ancient Egyptians were aware of the precession. In his preface to a recent reprint of *The Dawn of Astronomy,* Santillana, then professor of the history and philosophy of science at MIT, remarked that "when a stellar temple is oriented so accurately that it requires several reconstructions at intervals

* Published by Gambit Inc., Boston, 1969.

of a few centuries, which involve each time the rebuilding of its narrow alignment on a star," and "when zodiacs, like that of Dendera, are deliberately depicted in the appearance they would have had centuries before, as if to date the changes," it is not reasonable to suppose the Egyptians were unaware of the precession of the equinoxes.

Santillana was even more forceful in his condemnation of modern archeological scholars who refuse to accept the idea that the phenomenon of the precession was known in Egypt thousands of years before it was *re*discovered by Hipparchus. In *Hamlet's Mill,* Santillana accuses the scholars of having "cultivated a pristine ignorance of astronomical thought, some of them actually ignorant of the precession itself."

The precession was considered the basic mechanism of the universe by the Egyptians, controlling not only astronomical phenomena but all human and biological development.

Since the beginning of history, the spring equinox has moved through Taurus, Aries and Pisces, or almost one-quarter of a whole cycle. Santillana points out that the Copernican system, which for us explains the precession as the wobble of the earth's axis, has stripped the phenomenon of its awesomeness:

"But *if,* as it appeared once, it was the mysteriously ordained behavior of the heavenly sphere, or the cosmos as a whole, then who could escape astrological emotion? For the precession took on an overpowering significance. It became the vast impenetrable pattern of fate itself, with one world-age succeeding another, as the invisible pointer of the equinox slid along the signs, each age bringing with it the rise and downfall of astral configurations and rulerships, with their earthly consequences."

XIV. GEODETIC AND GEOGRAPHIC LANDMARK

The strongest evidence that the ancient Egyptians were capable of accurate astronomical observations comes from the fields of geodesy and geography, sciences whose object is to determine the size and shape of the earth, and to locate landmarks upon it. Until the development of radio and laser beams, coordinates of latitude and longitude with which to locate a spot on this planet could only be obtained by means of accurate astronomical sightings. When a temple or observatory or the remains of a city are found in a geographical location, either of latitude or longitude, or both, specifically related to other established locations, it is clear that its founders must have been able to make the required astronomical observations.

Professor Stecchini—who obtained his doctorate at Harvard in the science of classical mensuration—has now established that the ancient Egyptians not only developed an advanced system of astronomy and mathematics, but an equally advanced system of geography and geodesy.

From ancient hieroglyphs, hitherto neglected, Stecchini has been able to show that from the earliest dynasties in the third millennium B.C., the Egyptians could measure latitude to within a few hundred feet and do almost as well with longitude—a feat which was not repeated on this planet until the eighteenth century of our era.

The ancient texts and hieroglyphs vindicate Jomard in full, and show that at least as early as the unification of Egypt (ca. 2800 B.C.) the ancient Egyptians knew the length of the circumference of the earth very precisely, the length of their country almost to the cubit, and the geographical coordinates of all the main points in their realm from the equator to the Mediterranean. To do so the Egyptians must have been able to make astronomical observations with almost the exactness afforded by the modern telescope and chronometer.

From a twenty-year study of the mathematical and astronomical data contained in the cuneiform tablets of the ancient Sumerians and Babylonians, Stecchini has derived the evidence that astronomical observations of great

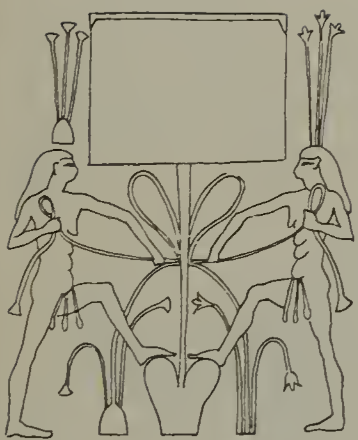
accuracy could be, and were, performed in Mesopotamia as well as Egypt in the third millennium B.C.

From his analysis of the pyramids and stepped ziggurats of the Middle East, Stecchini has demonstrated that they not only incorporate the basic techniques for projecting and mapping the hemisphere of the heavens but for mapping the terrestrial hemisphere; they also reveal a high level of mathematics, capable of resolving and simplifying the problems of trigonometry.

Stecchini points out that Herodotus, who has been ridiculed by scholars for his reported dimensions of Egypt, and accused of having lied about his travels there, turns out to have described ancient Egypt with great accuracy in terms of meridians and parallels carefully worked out by ancient Egyptian astronomers.

Stecchini found a glyph carved on the thrones of virtually all the Pharaohs since the Fourth Dynasty which contained geodetic data and hence astronomical data of extraordinary subtlety, enabling him to determine that the Egyptians used three figures for the tropic of Cancer: a simplified one of 24°, a precise one of 23° 51′, and one of 24° 06′ required for observing the sun's shadow at the summer solstice.

The sophistication of the ancients is demonstrated by the fact that they placed their observatory near Syene on the island of Elephantine, 15′—or half a diameter of the sun—north of the actual tropic because they understood that it was not the center of the sun but its outer rim which had to be observed.



The most important Egyptian text deciphered by Stecchini was a set of three identical hieroglyphs on the back of standard Egyptian measuring rulers found at the temple of Amon at Thebes, the geodetic center of Egypt since the Middle Kingdom. These, says Stecchini, give the clue to the exact dimensions of ancient Egypt.

Ludwig Borchardt, an eminent German Egyptologist, who first published the texts in an article in *Janus* in Vienna in 1921, assumed a *priori* that the figures could not refer to actual latitudes computed astronomically, and did

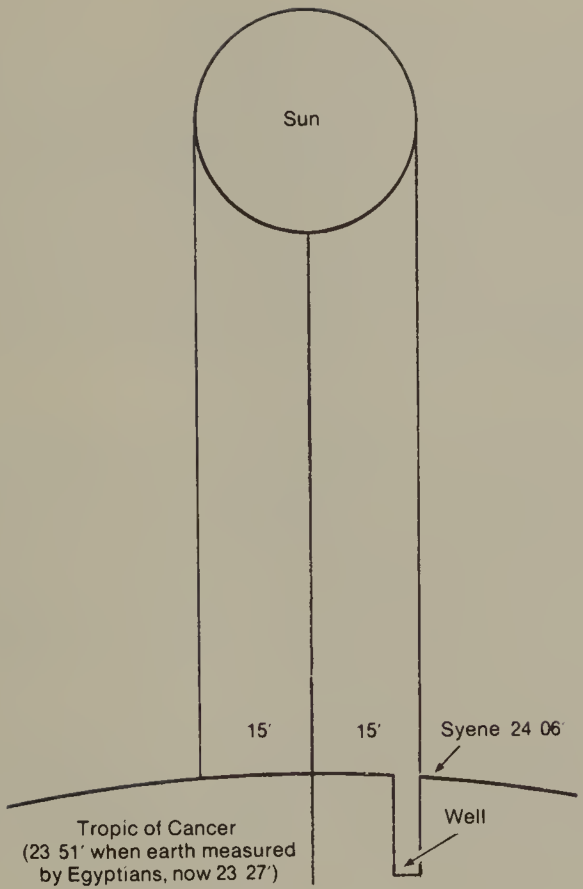
Knotted ropes beneath Pharaoh's throne are used to symbolize the union of Lower and Upper Egypt at the thirtieth parallel, where the apex of the Delta crosses the prime meridian of Egypt, just north of the Great Pyramid.

Three pairs of short horizontal lines at the bottom of the picture are symbols of three distinct values given by the ancient Egyptians to the tropic of Cancer, basic to the geodetic mensuration of Egypt. The central one of these three lines represented the conventional latitude of the tropic at 24°; the lower line represented the actual latitude at 23° 51′; and the upper line a latitude of 24° 6′, which was 15′ north of the true tropic, at Syene, where astronomical observations were made.

not even bother to test them: "One must absolutely exclude the possibility that the ancients may have measured by degrees." Succeeding Egyptologists also failed to compare the texts with actual parallels and meridians. Stecchini found them to apply with astonishing precision.

The texts—which for stylistic reasons have been assigned to the Old Kingdom (third millennium B.C.)—state the length of Egypt to be 20 *atur* from Behdet on the Mediterranean to Pi-Hapy (the apex of the Delta just north of the Pyramid of Cheops) and another 86 *atur* south to the First Cataract of the Nile.

This means that 106 *atur* would span an arc of 7° 30′ from the Mediterranean to Syene. From a composite of texts and geographic evidence an *atur* is the equivalent of 15,000 royal cubits or 17,000 of Jomard's cubits of .4618 meter. This would make Egypt from Behdet at 31° 30′ to Syene at 24° 00′ a length of 1,800,000 of Jomard's cubits, or 831,240 meters. The *Smithsonian Geographical Tables* give the distance from 31° 30′, to 24° 00′ as 831,002 meters. Computing from the third millennium B.C. text, the mean length of a degree of latitude in Egypt would be 110.832 meters. The modern estimate is 110.800 meters.

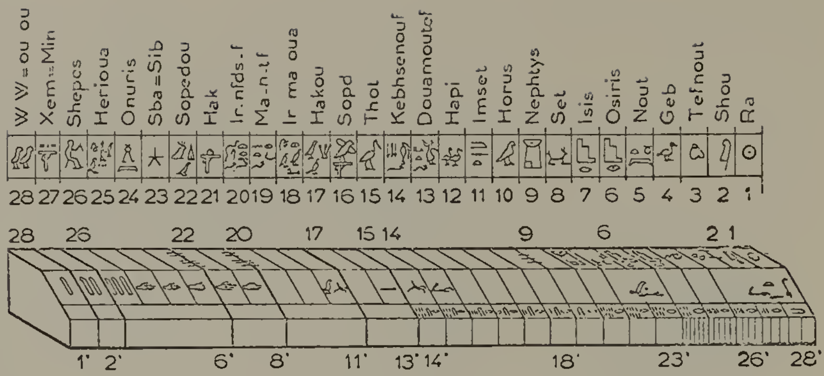


To observe the exact moment the sun fills a well without shadow as it reaches its farthest point north, at the summer solstice, the observation would have to be made under the northern rim of the sun, 15′ further north than the line of the tropic.

When the tropic was at 23° 51′, the ancient Egyptians observed it at Syene at 24° 06′.

Today the tropic is at 23° 27′. By establishing the moment of solstice at the tropic, the ancient astronomers were able correctly to compute the circumference of the earth by the use of deep wells and obelisks.

The island of Elephantine in the Nile near Syene, where the ancient Egyptians had an astronomical observatory and a nilometer to gauge the flood of the Nile.



Royal Egyptian cubit of Memphis. It was divided into 7 palms of 4 fingers each, for a total of 28. The basic unit from which this cubit is derived is the foot of 300 millimeters. One and a half of these feet made a cubit of 450 millimeters, divided into 6 palms of 4 fingers, for a total of 24 fingers. The royal cubit was obtained by the addition of one extra palm, for a total of 7, or 28 fingers, the equivalent of 525 millimeters.

Stecchini points out that a septenary unit was common to Mesopotamia, Egypt and Greece, because it allowed simple solutions to problems of practical measurement. With a π of 22/7, it was simpler to have a septenary cubit; a square of side 7 was considered to have a diagonal of 10, and a square of 10 as having a semi-diagonal of 7.

According to Stecchini, once the Egyptians were in possession of the true proportions of their country, they devised a means of simplifying their geodetic data into a geography that was easily committed to memory without recourse to portable maps, using such obvious natural landmarks as the cataracts on the Nile and the extremities of the Nile Delta as geodetic points for rectangles and triangles with easily remembered angles.

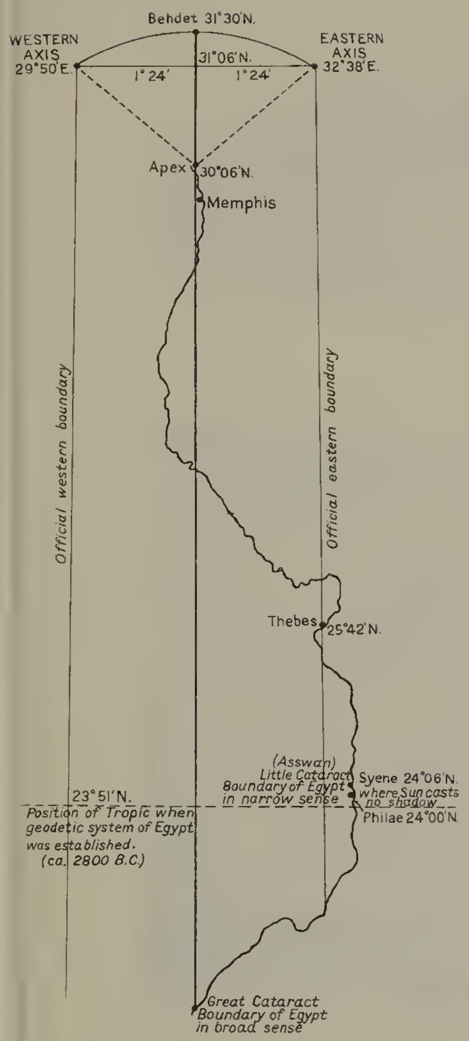
The prime meridian of Egypt was made to split the country longitudinally precisely in half, running from Behdet on the Mediterranean, right through an island in the Nile just northeast of the Great Pyramid, all the way to where it crossed the Nile again at the Second Cataract.*

To simplify the dimensions of Northern Egypt, the Egyptian geographers accurately marked it as a triangle exactly 1° deep, with its apex where the Nile splits (just north of the Pyramid of Cheops), fanning out 1° 24′ east and west to where its widest branches flow into the sea. This became an actual Δ-shaped delta, whose angles were designated by the shadows cast by the northeast and northwest corners of the Great Pyramid.

Southern Egypt was made to run precisely 6° to the First Cataract of Aswan on the tropic of Cancer. Two lines drawn parallel to the prime meridian, starting at the side mouths of the Nile in the Delta, running to the tropic, made a simple rectangle of Lower and Upper Egypt.

Stecchini says that when this particular geodetic system of ancient Egypt was established, the tropic of Cancer was at 23° 51′, which corresponds to a place on the Nile just south of the First Cataract called Parembole in Hellenistic times. On the island of Elephantine—15′ farther north—was the famous "well," whose bottom was said to be completely

* Close to the Mediterranean the meridian may have been marked by a northern pyramid. In 1800 the French Expedition saw the remains of a pyramid near Benha in the Delta, but its superstructure has since disappeared.



The first cataract, near Syene on the Upper Nile, was fabled to have been a land of the deaf because of the constant roaring of the waters over the outcroppings of granite.

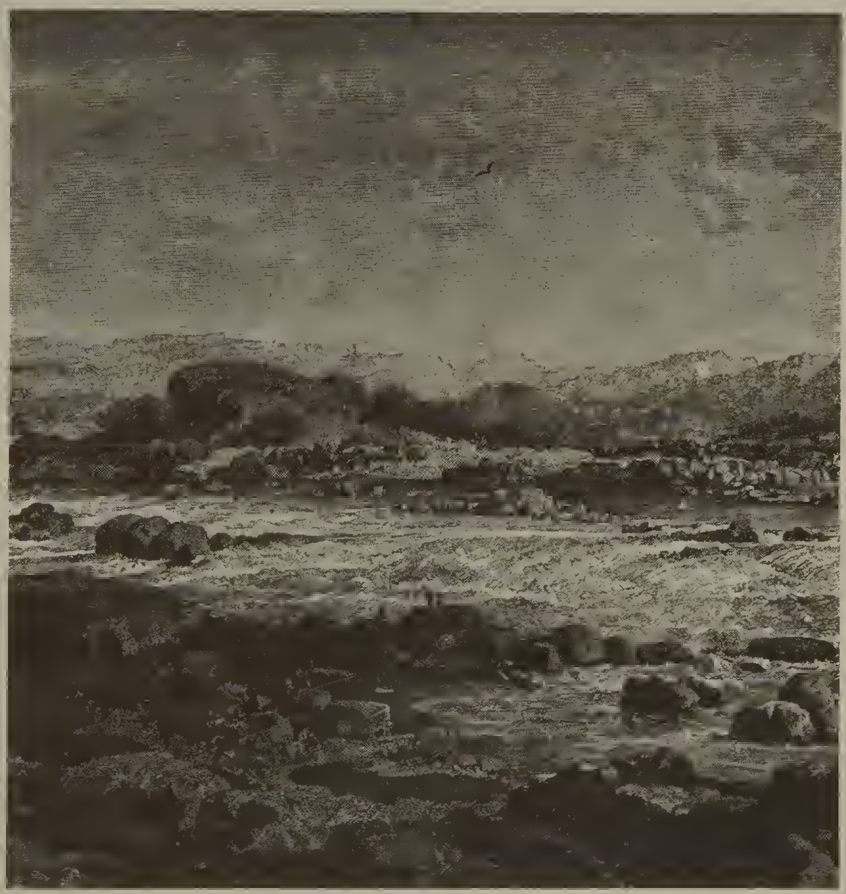
This ancient boundary of Southern Egypt was the source of the hard pink granite from which the monolith beams of the King's Chamber were chiseled, as well as the many great obelisks, weighing as much as a thousand tons, which were set up in Egypt as sundials and geodetic markers.

illumined once a year when the sun stood directly overhead at the solstice.

Were it possible to reconstruct exactly when the tropic was at 23° 51′ it would give a firm date for the establishment of the ancient system of geography; unfortunately no astronomer has yet been able to calculate mathematically the exact rate at which the tropic has moved since ancient times to its present 23° 27′. Schwaller de Lubicz figures it was at Elephantine between 2500 and 3000 B.C.

Cities and temples, says Stecchini, were deliberately built at distances in round figures and simple fractions from the tropic or the prime meridian. The predynastic capital of Egypt was set near the mouth of the Nile at Behdet, right on the prime meridian, at 31° 30′. This gave a length to Egypt of 1,800,000 geographic cubits. Memphis, the first capital of united Egypt, was again laid out on the prime meridian and at 29° 51′, precisely 6° north of the tropic. The northern limit of the Two Kingdoms was set at 31° 6′, and the country was measured by a newer unit, the royal cubit, of which there were 1,500,000 in the length of Egypt.

The geodetic point determining the location of Memphis was called Sokar after the god of orientation (whose name and location are preserved in the present village of Saqqara),



Omphaloi, or "navels," used as geodetic markers.

Geodetic omphalos found by Reisner in the great temple of Amon.

which is exactly on the main axis of the meridian of Egypt, in the necropolis of Memphis.

As each of these geodetic centers was a political as well as a geographical "navel" of the world, an omphalos, or stone navel, was placed there to represent the northern hemisphere from equator to pole, marked out with meridians and parallels, showing the direction and distance of other such navels. In Thebes the stone omphalos was placed in the main room of the temple of Amon, where the meridian and parallel actually cross.

To obtain such precision in their geodesy, says Stecchini, the ancients must have made remarkable astronomical observations.

For the ancient Egyptians to have laid out an absolutely straight meridian of 30° of latitude from the Mediterranean to the equator, over 2000 miles, and drawn two more, equidistant, east and west, as boundaries of the country, must have required an enormous amount of personnel and careful astronomical sightings. Even more sophisticated was their method of establishing longitude, as reconstructed by Stecchini.

With the aid of an elementary system of telegraphy, consisting of a series of beacons, the Egyptians, says Stecchini, were able to note what star was at its zenith at a certain moment, and flash the data, via a string of flares, to other observers so many degrees to east and west.*

H. G. Wood, author of *Ideal Metrology,* assumes that if the Great Pyramid was originally an observatory, signal stations east and west of it once existed which are now in ruins or altogether lost. Wood quotes a Dr. Lieder's description of a little pyramid far to the west in the Libyan desert which could once be seen from the top of the Great Pyramid as the sun went down, but is now lost.

Traveling farther afield, the ancient geographer could establish his longitude with great precision on the basis of accurate tables of the nightly transit of celestial bodies as observed at the Pyramid.†

Fragmented data obtained from such accurate tables, says Stecchini, percolated to the Alexandrine Greeks such as Eratosthenes and Ptolemy, who mixed the accurate data with the inaccurately estimated coordinates of their own period, creating a hodgepodge of good and bad geography. It was not possible to disentangle and correct their work until the development of the chronometer in the eighteenth century of our era.

Because of the advanced geodetic and geographic science of the Egyptians, Egypt became the geodetic center of the known world. Other countries located their shrines and capital cities in terms of the Egyptian meridian "zero," including such capitals as Nimrod, Sardis, Susa, Persepolis, and, apparently, even the ancient Chinese capital of An-Yang.

All of these localities, says Stecchini, were set and oriented on the basis of the most exact sightings. The same applies to the centers of worship of the Jews, the Greeks, and the Arabs.

According to Hebrew historians the original Jewish center of worship was not Jerusalem, but Mount Gerizim, a strictly geodetic point 4° east of the main axis of Egypt. It was only moved to Jerusalem after 980 B.C.

The two great oracular centers of Greece—Delphi and Dodona—were also geodetic markers according to Stecchini.

* Fires such as were lighted by the Druids at the moment of the midsummer solstice may have been the origin of the "midsummer fires" and the Beltane fires of May Day, described in *The Golden Bough.*

† Because every observable star comes to the meridian of every place on the globe once in 24 hours, the interval which elapses between the same star coming upon the meridian of two different places is the difference in longitude of the two places.

Delphi is 7° and Dodona 8° north of Behdet, the northernmost part of Egypt, on the prime meridian of Egypt.

The Moselm shrine of Mecca is 10° east of the western meridian of Egypt and 10° south of Behdet. According to Stecchini the sacred black stone of the Kaaba was originally part of a set of four, placed in what he calls a pyramidical triangle from which the trigonometric functions of the shrine could be derived.

Islamic tradition stresses the point that the Kaaba was originally a geodetic center. The essential element of the Kaaba consisted of four stones marking a square with diagonals running north-south and east-west. The diagonal north-south with the northeast and southeast sides formed what the Egyptians called a pyramid. The angle formed by the diagonal with the southeast side was 36°, from which Stecchini concludes that the trigonometric functions of the shrine were measured along the northeast side.

The northwest side of the building of the Kaaba is completed by a semicircular wall: according to tradition this semicircular wall existed since the very beginning. Most likely, this was used, says Stecchini, as a sighting device.

To make a map projection of the northern hemisphere, the ancient Egyptians found a simple mathematical and geometrical means of reducing the curved surface of the globe to a flat surface suitable for mapping, and with a minimum of distortion: they used the stepped pyramid, or ziggurat, each face of which could represent a 90° quadrant of the hemisphere, and each level of which could represent a mappable zone between two parallels of latitude.

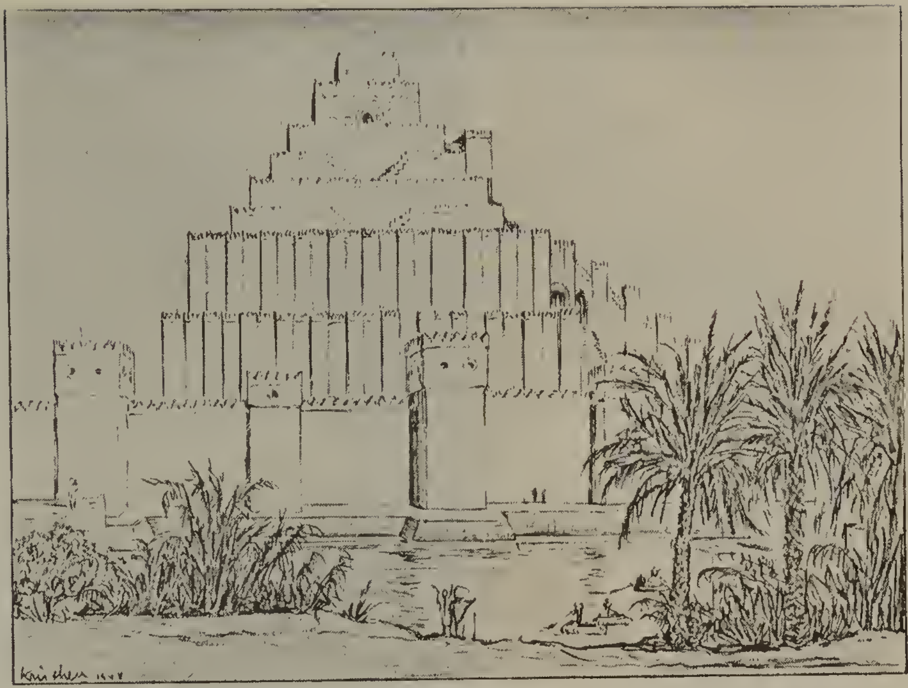
Professor Maspero describes the ziggurats of Mesopotamia as "miniature reproductions of the arrangement of the universe." Professor C. P. S. Menon in his *Early Astronomy and Cosmology* says of the ziggurats: "We can deduce that the shape of the Earth, which appears to have served as a model for the temples, was a terraced pyramid with corners pointing to the South, West, North and East."

Ziggurats at Ur, Uruk, and Babylon reached a height of three hundred feet. The ziggurat of Nabu at Barsipki was called the "House of the Seven Bonds of Heaven and Earth" and was in seven stages said to have been painted in seven "Planetary colors."

The sophistication of the ancients, says Stecchini, is illustrated by the ziggurats of Babylon. These stepped "Towers of Babel," long a mystery to mankind, turn out to incorporate a series of Mercator projections, several thousand years before the advent of the Flemish cartographer.

For the purpose of mapping, the northern hemisphere was reduced to a series of flat surfaces represented by the

Reconstruction of Babylonian stepped pyramid or ziggurat. According to H. G. Wood, the ziggurat of Jupiter Belus at Babylon had an ideal basis in the number 360. In his *Ideal Metrology* it is described as a seven-staged pyramid in which each of the six upper stages is 360 inches shorter than the one next below it; the base side was 3,600 inches, and the total height of the structure was 3,600 inches. According to Wood, the entire system of ancient Babylonian metrology appears to have been derived from 360 × 360 × 100, or 12,960,000.



faces of the stepped ziggurat. The area between the equator and the pole was divided into seven bands or "zones" as the Greeks called them, each diminishing in width to correspond to the shrinking degree of longitude. The base line represented the equator, the first step the thirtieth parallel. Thus, each façade represented a 90° quadrant of hemisphere.

Stecchini says the limits of these four quadrants were established with great precision. Egyptian texts, Greek mythology (including the *Argonautica* and the *Odyssey*), and Greek and Roman writers from Herodotus onward unanimously agree in setting this western limit of the Mediterranean quadrant at 9° 54′ East. Another limit, says Stecchini, was known as the Golden Chersonnesos, that is to say, the peninsula of Malaya at meridian 99° 54′ East at a point where the equator cuts the western coast of the island of Sumatra.

Cuneiform tablets indicate that each level of the ziggurats had a specific area corresponding to standard units of land measure.

Nineteenth-century authors illustrated the ziggurats as astronomical observatories, with bearded Babylonians gazing from the battlements; but John Taylor maintained that such high terraces afforded no better vantage than the ground.

On the other hand, a square or tubular shaft of several hundred cubits, built into their interiors, would have made first-rate telescopes for observing the skies. In Mexico the Pyramid of Xochicalco near Cuernavaca contains a tubular well down which the sun shines perpendicularly without a shadow on a specific day of the year.

Nineteenth-century idea of Babylonian astronomers atop a ziggurat, published by the French astronomer Camille Flammarion.

Sir John Herschel pointed out that "from the bottom of deep narrow pits, such as a well, or the shaft of a mine, such bright stars as pass the zenith may even be discerned by the naked eye."

John Taylor indicated the reference in Ezekiel (XXIX: 10 and XXX: 6) to a "Tower of Syene," suggesting that perhaps the famous well at Syene was inside a sighting tower.

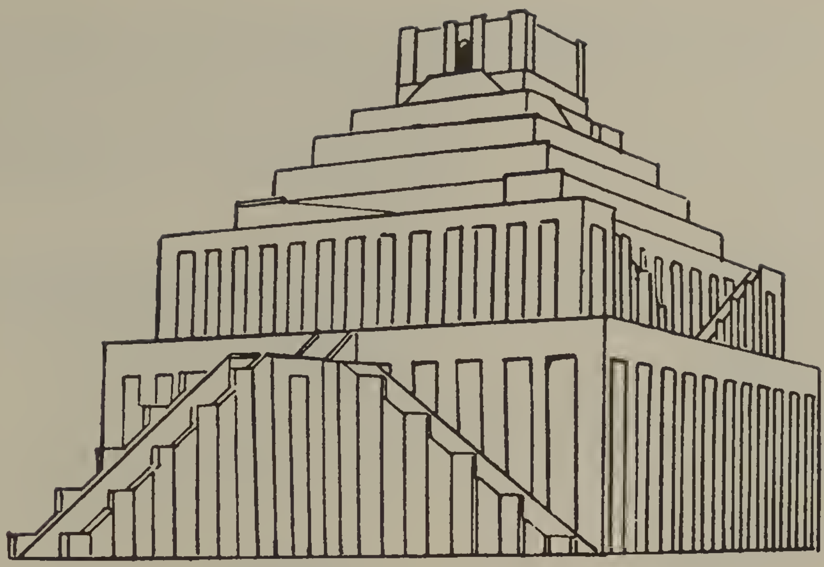
Reconstructing the ziggurat of Babylon on the basis of the cuneiform text known as the Smith tablet, Stecchini established that it rose in seven diminishing steps, each face of which was smaller than the one below it. For mapping, this allows meridians to cross the parallels at right angles, as in Mercator's projection, but avoids his distortion by shrinking each rectangular face in proportion to the shrinking degree of longitude as it approached the pole.

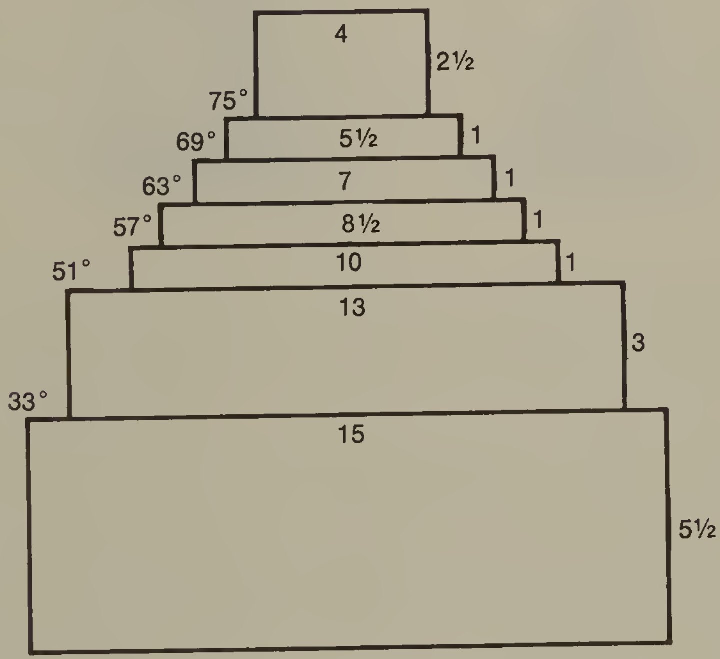
The ziggurat of Babylon, says Stecchini, would have been perfect trigonometrically if the height of the first three steps had been as originally conceived: 30, 48 and 55 1/2 degrees. But the Babylonians raised the first step to 33°, the approximate parallel of Babylon.

The cuneiform description of the ziggurat, known as the Smith tablet, specifically indicates that each level of the ziggurat has an area corresponding to standard units of land surface. Particularly important in Mesopotamian land surveying was the square with a side of 60 double cubits—the surface of the third step.

The slope angles at various heights also give important angles, such as $\sqrt{5}-1$, which is also incorporated into the Great Pyramid. Such triangles, and the number $\sqrt{5}-1$ (in common practice taken as the magic series 1–2–3) were fundamental in the operations of land surveying.

The third, fourth and fifth steps of the ziggurat make triangles with sides related as the Pythagorean 3–4–5 triangle.





In the original design, says Stecchini, the first step of the ziggurat was intended to represent the thirtieth parallel, but in Mesopotamia it was raised to 33°, the approximate latitude of Babylon. Thereafter the Babylonians made each step rise in units of 6° of latitude. This made it possible for them to obtain an easily remembered cosine value for each step by simply dividing its length by two thirds.

As the Babylonians liked to count by sixes, with a hexagesimal ana sexagesimal system, the steps of the ziggurat rose in multiples of 6°. Further to simplify their accounting, the degree of parallel represented by each step could be obtained by multiplying the height of each step by 6; e.g., $6 \times 5\ 1/2$ (first step) $= 33°$.

The system gave the Babylonians an extremely simple way of remembering the trigonometric value of each parallel.

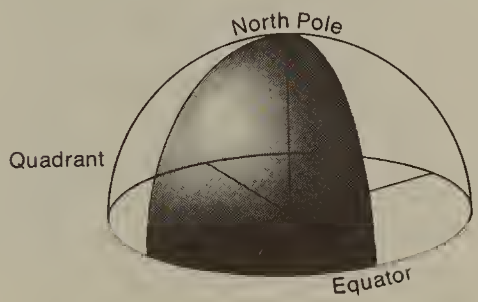
All they had to do was divide the length of each step by .666 (or 2/3). Thus, 2/3 of 15 (width of first step) is 10.000, which is the cosine value of the equator. Thereafter the operation produced a simple progression: 8.666, 6.666, 4.666, 3.666, 2.666 for the cosine value of the angles indicated by each step.

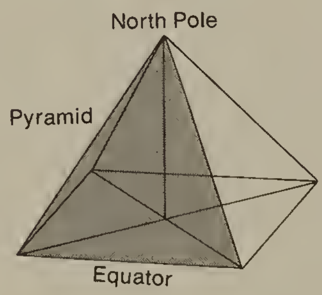
The top step, says Stecchini, was rectangular instead of square, because the average of its sides gives 2.5833, which is the cosine of 75° 01′.

XV. THE GOLDEN SECTION

In the Great Pyramid the Egyptians produced a system of map projection even more sophisticated than the one incorporated in the ziggurats.

The apex of the Pyramid corresponds to the pole, the perimeter to the equator, both in proper scale. This fact was inherent in Jomard's conclusions, but got lost in the babble of cubits.

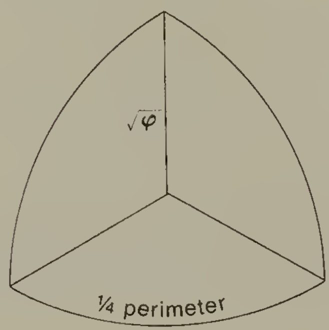


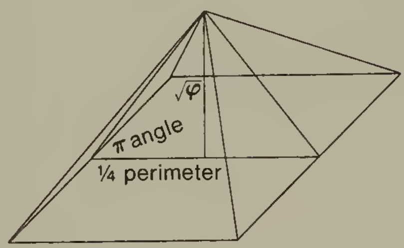


Each flat face of the Pyramid was designed to represent one curved quarter of the northern hemisphere, or spherical quadrant of 90°.

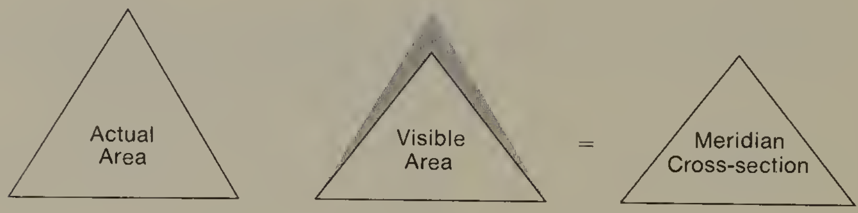
To project a spherical quadrant onto a flat triangle correctly, the arc, or base, of the quadrant must be the same length as the base of the triangle, and both must have the same height. This happens to be the case *only* with a cross section or meridian bisection of the Great Pyramid, whose slope angle gives the π relation between height and base.

John Taylor intuitively suspected something of the sort, but was unable fully to formulate it.



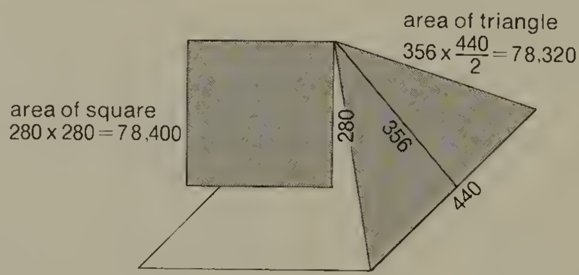


The subtlety of the Pyramid's projection lies in the fact that when viewed from the side, the laws of perspective reduce the actual area of a face (mathematically oversized) to the correct size for the projection, which is the Pyramid's *cross section.*



What the viewer saw, and sees, with the aid of perspective is the correct triangle.

The key to the geometrical and mathematical secret of the Pyramid, so long a puzzle to mankind, was actually handed to Herodotus by the temple priests when they informed him that the Pyramid was designed in such a way that the area of each of its faces was equal to the square of its height.



This interesting observation reveals that the Pyramid was designed to incorporate not only the π proportion but another and even more useful constant proportion, known in the Renaissance as the Golden Section, designated in modern times by the Greek letter φ (pronounced *phi*), or 1.618.*

φ, like π, cannot be worked out arithmetically; but it can easily be obtained with nothing more than a compass and a straightedge.

With the incorporation of the Golden Section, the Great Pyramid provides an effective system for translating spherical areas into flat ones.

Anyone who is not anxious to follow the simplified mathematics in this chapter may more simply skip to the following chapter—which contains the answer to the riddle. But he will miss some odd conceits about the relation of

* If the 356 cubits of the Pyramid's apothem are divided by half the base, or 220 cubits, the result is 89/55, or 1.618.

mathematics to the cosmos and to the creative function of life as embodied in the science of the builders of the Pyramid. The pharaonic Egyptians, says Schwaller de Lubicz, considered φ not as a number, but as a symbol of the creative function, or of reproduction in an endless series: to them it represented "the fire of life, the male action of sperm, the *logos* of the gospel of St. John."

The Golden Section, or φ, is obtained by dividing a line

at a point *C*

in such a way that the whole line

is longer than the first part

in the same proportion as the first part

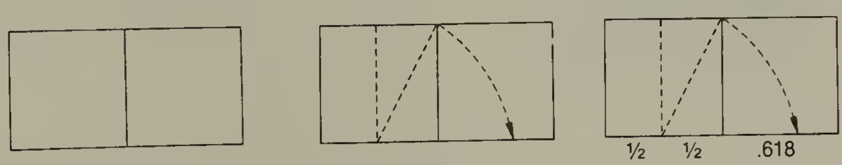
is longer than the remainder.

This will mean that $\frac{AB}{AC} = \frac{AC}{CB} = 1.618.$

This equation, which appears so simple, turns out to be loaded with meaning. Plato in his *Timaeus* went so far as to consider it, and the resulting Golden Section proportion, the most binding of all mathematical relations, and makes it the key to the physics of the cosmos.

In the Great Pyramid the rectangular floor of the King's Chamber (which consists of two equal squares, or a 1×2 rectangle) also serves to illustrate and to obtain the Golden Section.

If you split one of two squares in half and swing the diagonal down to the base, the point where the diagonal touches the base will be φ, or 1.618 in relation to the side of the square, which is 1.*

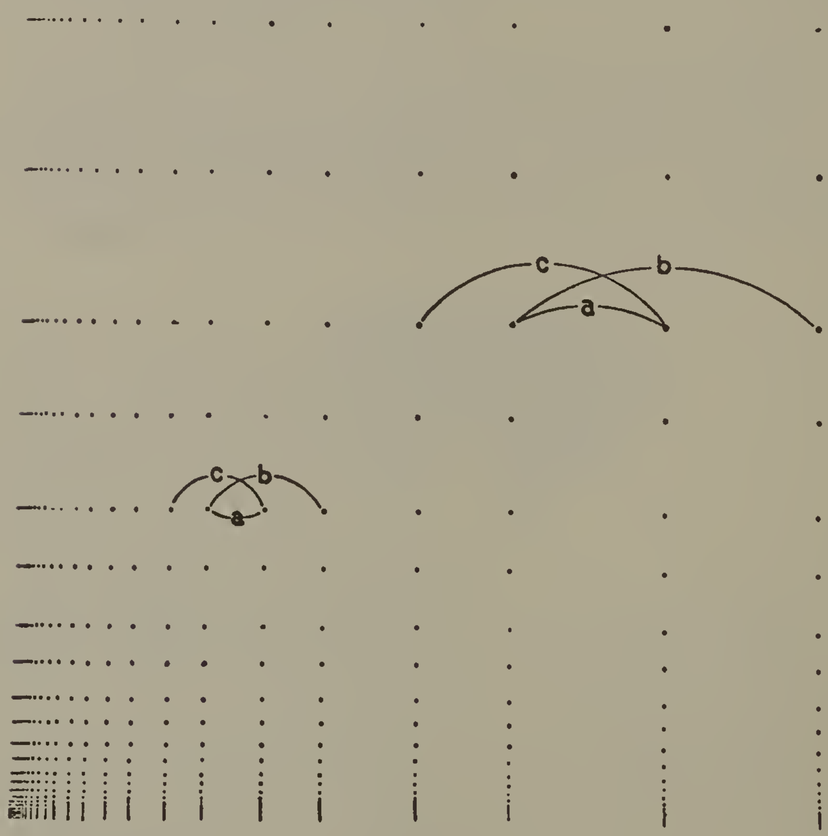


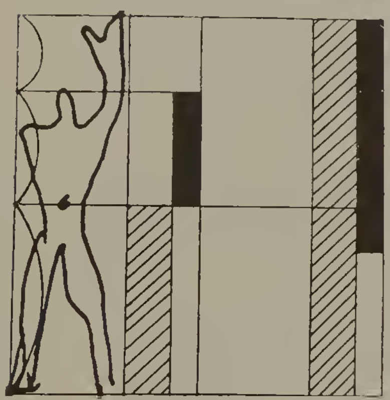
* Pythagoras' theorem will also show that the value of φ will be $1/2 + \sqrt{5}/2$, or 1.618, and that $\varphi - 1$ will be .618.

The odd, if not unique, mathematical fact that $\varphi + 1 = \varphi^2$ and that $1 + 1/\varphi = \varphi$ leads to an additive series, known as a Fibonacci series, in which each new number is the sum of the previous two: 1-2-3-5-8-13-21-34-55-89 . . . etc., and their ratio comes closer and closer to φ.*

In Egypt Fibonacci got wind of the additive series and popularized its mystical quality by bringing to Europe the story of the "rabbit problem," or how to find the number of rabbits born in one year, starting with an original pair. Assuming the rabbits to be enclosed by a wall and that every month they produce a pair of rabbits, and that each new pair in turn produce another pair each month, the answer could be obtained by the additive series 1-2-3-5-8-13-21. . . . In this case it is 377 pairs of rabbits.

This mathematical grid, based on the Golden Section, was to become the backbone of the architectural system developed by the great French architect Le Corbusier for his construction of anything from the United Nations building in New York to the closets in a bathroom.

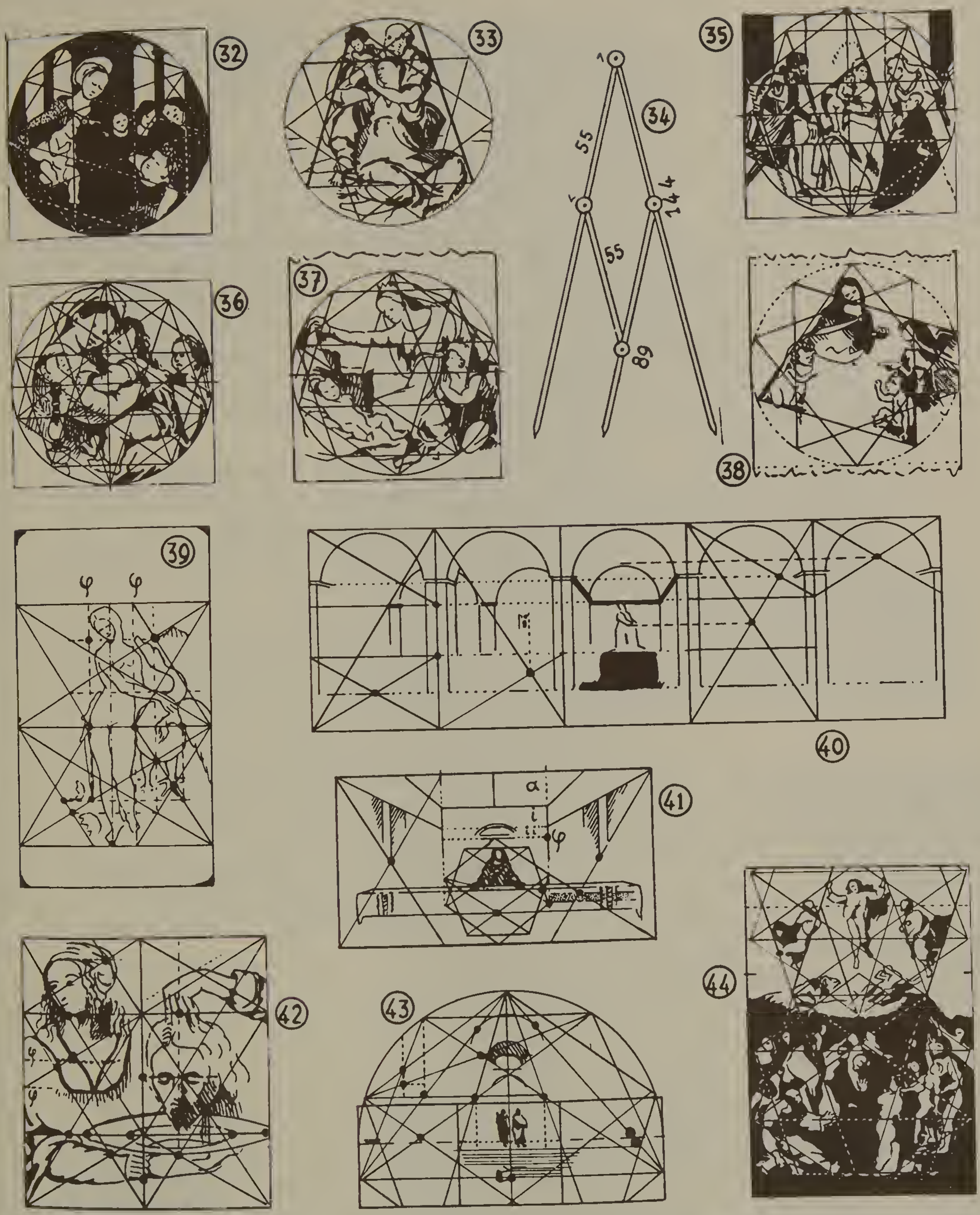




Le Corbusier's "modulor" based on the φ relation in the human body.

The Fibonacci series can be visualized geometrically as a mathematical grid growing larger (or smaller) in which each new unit always bears the relation of φ to its predecessors and successors.

* Leonardo Bigollo Fibonacci, known as Leonardo da Pisa, was perhaps the greatest mathematician of the Middle Ages. Born in 1179, he traveled to Algiers with his father, who acted as consul for the Pisan merchants. From the Arabs Fibonacci learnt the Hindu system of numerals from 1 to 9, which he is credited with having introduced to Europe, where calculations were still being made by the clumsy means of Roman numerals and Greek letters.



Funk-Hellet's analysis of (32) Mainardi, (33) Michelangelo, (34) Golden Section compass: note 55/89 relation, (35) Veronese, (37), (42), (43) Raphael, (38), (39), (41) Leonardo da Vinci, (40) Fra Lippo Lippi.

In the Renaissance the φ proportion, or Golden Section, as it was called by Leonardo da Vinci, served as the hermetic structure on which some of the great masterpieces were composed. Leonardo illustrated a book on the Golden Section for Luca Pacioli, known as "the monk drunk on beauty," which was published in Venice in 1509.

Funk-Hellet has analyzed the φ proportion in a score of masterpieces, including Titian's *Presentation of the Virgin,* Luini's *Sleep of the Infant Jesus,* and Veronese's *The Wedding at Cana.*

The conclusion that the Egyptians of the Old Kingdom were acquainted with both the Fibonacci series and the Golden Section, says Stecchini, is so startling in relation to current assumptions about the level of Egyptian mathematics that it could hardly have been accepted on the basis of Herodotus' statement alone, or on the fact that the φ proportion happens to be incorporated in the Great Pyramid. But the many measurements made by Professor Jean Philippe Lauer, says Stecchini, definitely prove the occurrence of the Golden Section throughout the architecture of the Old Kingdom.

Professor Lauer, for many years the architect for the Egyptian Department of Antiquities, has made thousands of measurements of ancient Egyptian buildings.

Schwaller de Lubicz also found graphic evidence that the pharaonic Egyptians had worked out a direct relation between π and φ in that $\pi = \varphi^2 \times 6/5$.*

In the tomb of Rameses IX there is a strange figure of a royal mummy with one arm raised and an erect phallus. The mummy is lying at the hypotenuse of a sacred 3–4–5 right-angled triangle indicated by a snake.

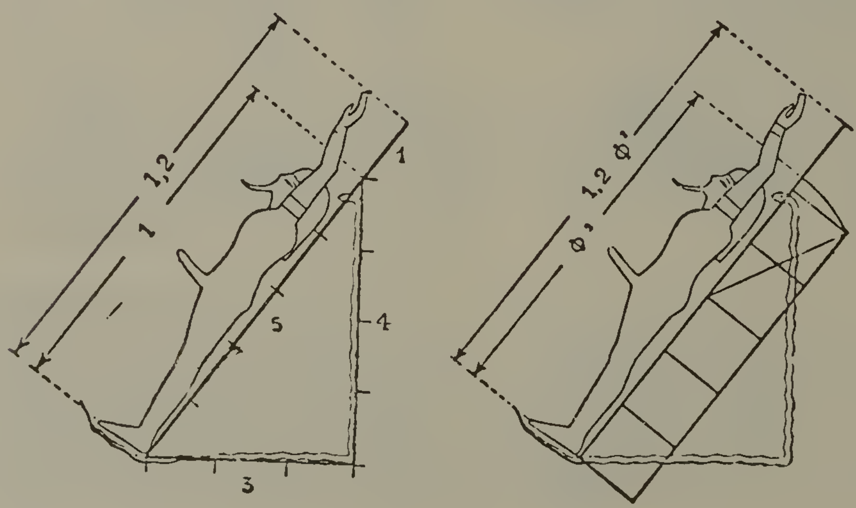
The length of the body, says Schwaller, is clearly 5 cubits and that of the upright arm is one more cubit, for a total of 6. At the same time the body is divided by the phallus in the proportion of 1 and φ, for a total of φ^2.

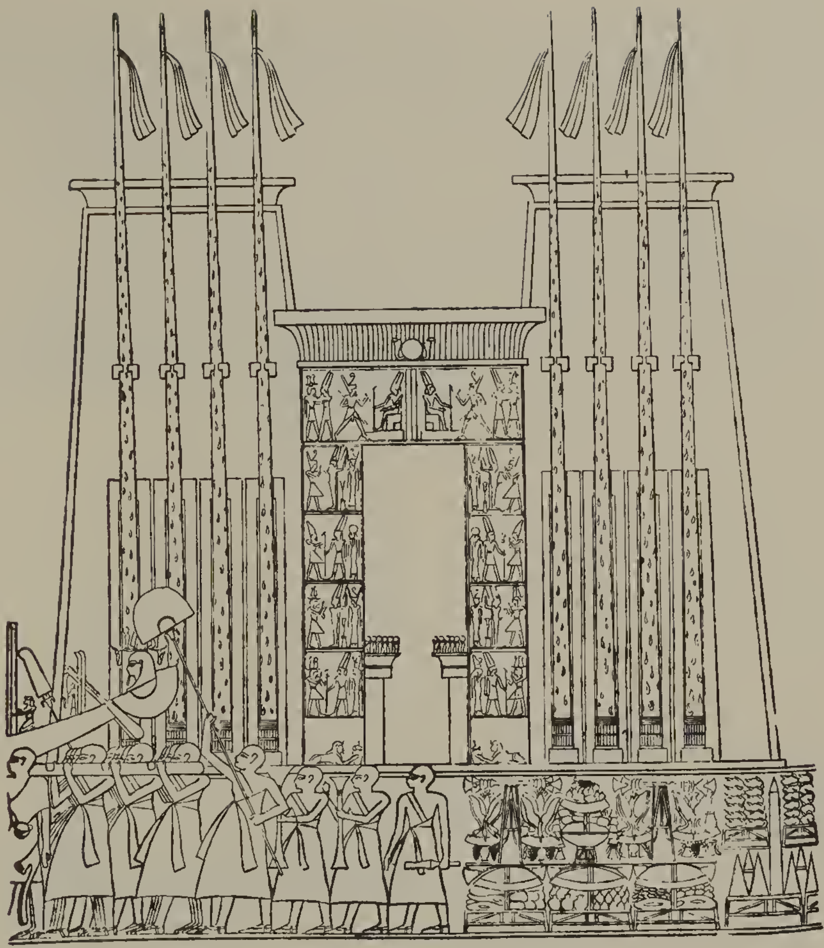
This, says Schwaller, makes the outstretched arm give a value for π of 6/5 of the body, or φ^2, which is 3.1416.

On the east side of the temple of Luxor, Schwaller also

* $2.618 \times 6/5 = 3.1416$.

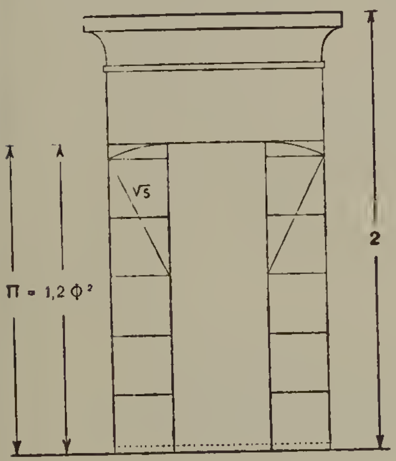
Egyptian king as the hypotenuse of a sacred 3–4–5 triangle formed by a snake.
Schwaller de Lubicz shows the king as φ^2, split into a $\varphi + 1$ proportion by the phallus. The king's raised arm gives a 6/5, or $1.2 \times \varphi^2$, proportion, which is exactly 3.1416, or π.





Priests exiting from third pylon of the Great Temple of Karnak bearing the king's barque.

Schwaller de Lubicz shows how the value of π correct to four decimals, or 3.1416, was incorporated into the great gate whose basic measurement was 1×2.



found a relief depicting a cortege of priests exiting from the great temple of Karnak, carrying the king's "solar barque." Schwaller points out that if the width of the gate of the temple, from outside wall to outside wall, is taken as 1, its full height will be 2, and the doorway $\varphi^2 \times 1.2$, or 3.1416; again the value of π, correct to four decimals.

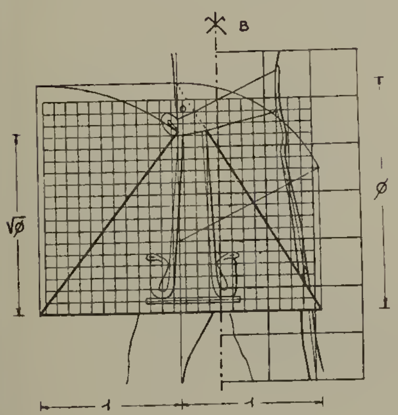
En passant, Schwaller notes the curious coincidence that the Greeks should have adopted for the relation of diameter to circumference the symbol of π, which looks just like the Egyptians' doorway.

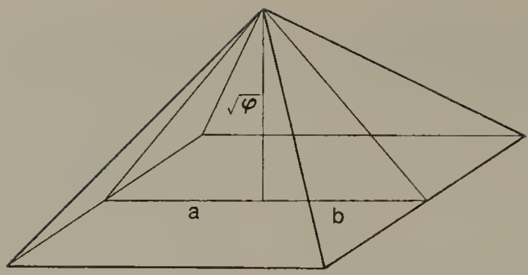
Even more extraordinary is Schwaller's resolution of the symbolic meaning of the triangular loincloth worn by the Pharaohs. Schwaller checked several score of these royal napkins for hermetic significance and found that they invariably gave two angles whose values were respectively φ and $\sqrt{\varphi}$.

Because of the location on the body of the royal napkin—similar to the Masonic apron of today—its phallic character, says Schwaller, was unmistakable.

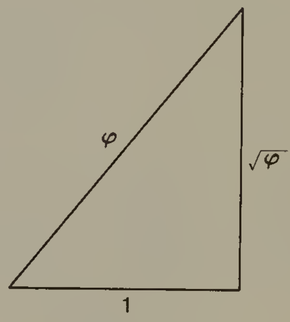
In the Great Pyramid the φ relation is found in the triangle formed by the height, the half base, and the apothem; that is to say, in the basic *cross section* of the structure.

Schwaller de Lubicz measured scores of triangular royal napkins and found that lower angles were invariably φ and $\sqrt{\varphi}$.

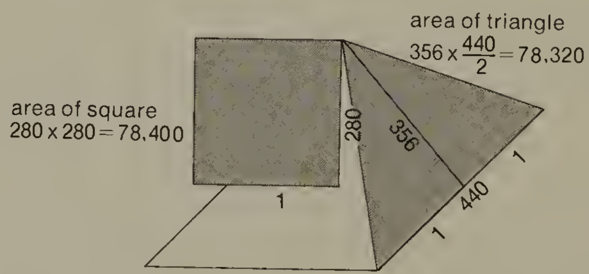




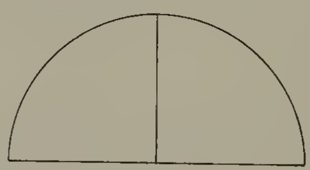
These proportions create a relation between the sides of the triangle such that if the half base is 1, the apothem is φ and the height is $\sqrt{\varphi}$.

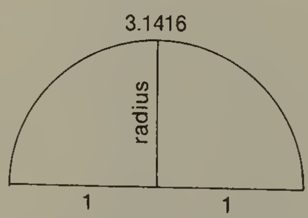


This relation shows Herodotus' report to be indeed correct, in that the square on the height of the Pyramid is $\sqrt{\varphi} \times \sqrt{\varphi} = \varphi$, and the areas of the face $1 \times \varphi = \varphi$.



The simplicity of the system incorporated in the Pyramid makes child's play of the complexities of mathematical map projection. All one need understand is that π is the unchanging value which links a straight diameter to a curved circumference.*

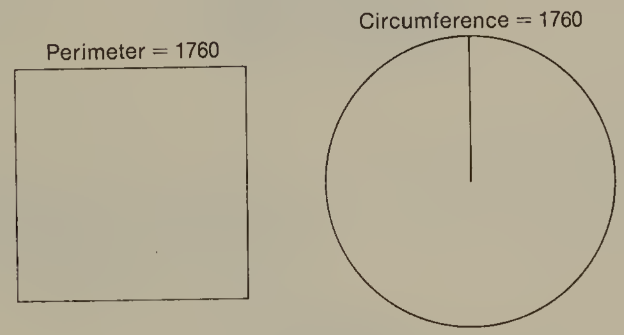




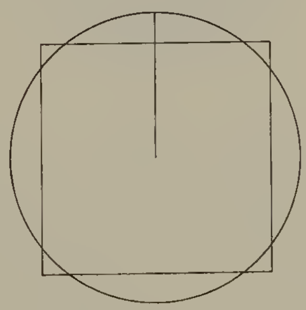
* π times the diameter of a circle will equal its circumference. π times one-half the diameter squared will equal the area of the circle.

Although the squaring of a circle is an insoluble problem if you use the irrational number of π, it is nevertheless practically resolvable as a function of the Golden Number φ. Because $\pi/2 = 2/\sqrt{\varphi}$ to within a thousandth part, π can usefully be taken as $4/\sqrt{\varphi}$.*

The Pyramid is so designed that for all practical purposes it accomplishes the squaring of the circle. The Pyramid's base is a square whose perimeter is equal to the circumference of a circle whose radius is the Pyramid's height.†



Superimpose the square on the circle and you get not only an interesting but an extremely useful diagram consisting of the perimeter of the Pyramid and the circumference of the circle it represents.



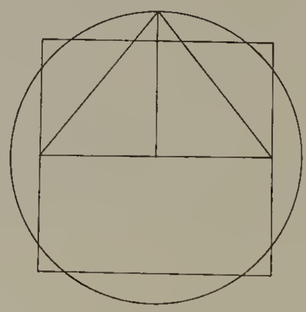
* The following examples are included for the sake of those who might doubt the mathematics; they are not essential to the narrative.

Because π also equals $\varphi^2 \times 6/5$, it is possible to use the Fibonacci series to obtain an accurate relation for the diameter of a circle to its circumference without recourse to π. In the Fibonacci series of 21–34–55, if 21 is taken as the diameter of a circle, its circumference will be $55 \times 6/5$, or 66, accurate to one-thousandth part, giving the Great Pyramid value for π of 22/7, or 3.14285.

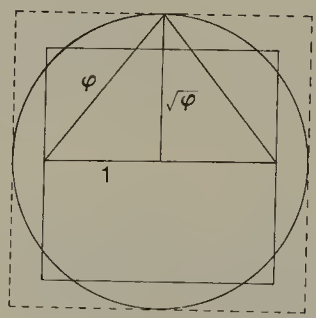
Higher numbers in the Fibonacci series provide increasingly finer values in whole numbers accurate to one ten-thousandth part. Prolonging the series, which goes . . . 89–144–233–377–610 . . . a diameter of 144 gives a circumference of $377 \times 6/5$, with a value for π of 3.1415; a diameter of 233 gives a circumference of $610 \times 6/5$, with a value for π of 3.1416; and so on.

† Four times the base of 440 cubits equals 1760 square cubits. The height of 280 cubits $\times\ 2\pi$, or twice 22/7, equals 1760 square cubits.

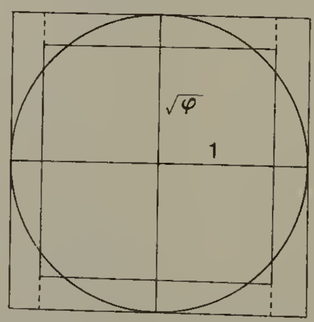
Three more lines will provide the mathematically correct cross section of the Pyramid of Cheops.



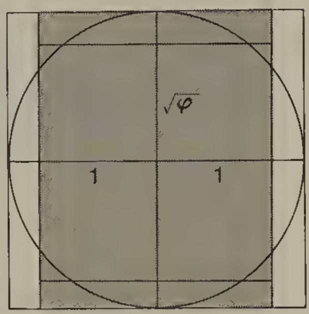
By simply enclosing the diagram in another square, and inserting the φ relationship as it exists in the Pyramid, a key is obtained for readily translating spherical surfaces into flat ones of equal area.



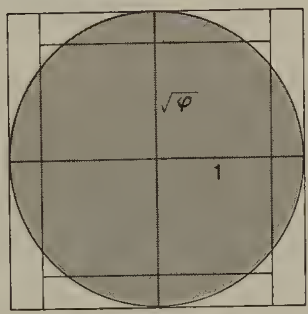
To obtain a rectangle equal in area to the basic circle, two sides of the smaller square need merely be prolonged till they touch the sides of the larger square.



The area of the rectangle is its length times its width, or $2\sqrt{\varphi} \times 2$, which is $4\sqrt{\varphi}$.

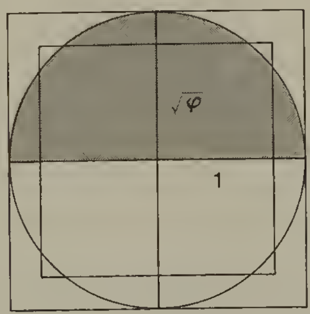


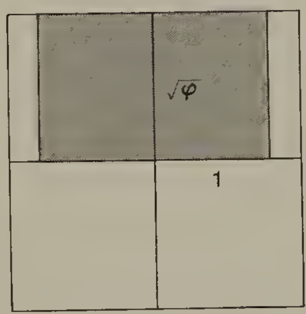
The area of the circle is πr^2, or $\pi\varphi$ in this case, the radius being $\sqrt{\varphi}$. But since $\pi = 4/\sqrt{\varphi}$, the area is also $4\sqrt{\varphi}$, the same as the rectangle.



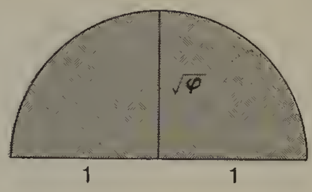
Thanks to the Pyramid's structure it is thus possible, with virtually no mathematics, to draw a rectangle (from the base of the Pyramid and twice its height) which will be equal in area to a circle on its height. This leads directly to being able to draw a rectangle or triangle equal to a spherical quadrant, resolving the main problem of the map maker with the same simplicity.

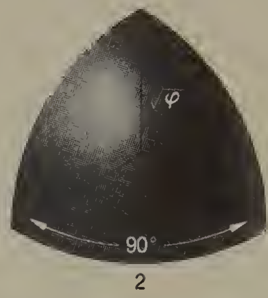
As the whole circle equals the whole rectangle, half the circle is equal to half the rectangle.



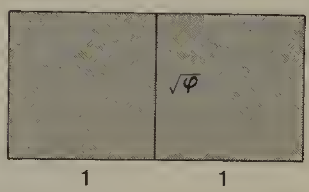


But half a flat circle is also mathematically rigorously equal in area to the spherical surface of a quadrant of 90°.





Thus a rectangle of height $\sqrt{\varphi}$ and a base of 2 is equal to a quadrant of height $\sqrt{\varphi}$ and an arc of 2.



Area = $2\sqrt{\varphi}$

Area = $2\sqrt{\varphi}$

It is thus possible to translate a spherical quadrant of 90° of longitude onto a flat Mercator surface of equal area or onto an undistorted triangle of exactly half that area.

With the Pyramid, the ancient Egyptians had not only squared the circle but effectively cubed the sphere.

XVI. SCIENTIFIC SURVEY GIVES GEOGRAPHICAL PROOF

That the Pyramid of Cheops was intended to represent a geographical rendition of the northern hemisphere was indicated repeatedly in the ancient texts, as Jomard had noted. From a careful analysis of classic Greek authors, Stecchini narrowed the sources of information on the Pyramid —other than Herodotus—down to a single Greek writer, Agatharchides of Cnidus, a peripatetic philosopher who was guardian to the king of Egypt at the end of the second century B.C.

Agatharchides reported that the length of one side of the base of the Pyramid corresponded to 1/8 minute of degree, and the apothem to 1/10 of a minute.

Jomard had hit upon this information and used it to find an almost exact solution: his apothem of 184.722 meters multiplied by 10 gave a minute of 1847.22 meters, which is almost precisely the length of a minute of latitude at the twenty-ninth parallel. This led Jomard to assume that the builders of the Pyramid had chosen to use the mean latitude value for all Egypt, which he figured to be 27° 40′.

What Jomard could not know was that the most ancient geodetic center of Egypt had been placed at 27°45′, precisely halfway between Syene on the Tropic, and Behdet on the coast of the Delta. He could not have known this because the site of the new capital of the young pharaoh Akhnaten called Akhtaten or "Resting point of Aten" had not yet been discovered near the modern Tell el-Amarna, nor had the young Champollion yet deciphered the hieroglyphs.

A stone text found in the ruins of Tell el-Amarna relates to the foundation of the capital. One of the surviving copies is about twenty-five feet high. It gives the length of the new capital as being limited by two boundary stones meticulously set "for eternity" at the extraordinary distance of 6 *atur,* 3/4 of a stadium and four geographic cubits. This indicates an intended accuracy of one in ten thousand. As Stecchini interprets the text, it not only specifically indicates 27° 45′ as the ancient geodetic center of Egypt, but gives the length of the *average* degree of latitude between the equator and the pole to be 240,715 cubits of 111,136.7 meters. The modern estimate is 111,134.1 meters.

As Stecchini points out, Akhnaten's geodetic reform was a return to the predynastic system of computing the length of Egypt in geographic cubits rather than royal cubits.

Had Jomard been able to measure all four sides of the base of the Pyramid with the precision of modern surveyors, he would have realized that the ancient Egyptians intended—quite logically—for the *base* of the Pyramid to indicate the value of a degree at the equator (where they apparently considered the earth to be a true circle and a degree of latitude to be equal to a degree of longitude).

Up until the time of World War I there still remained considerable doubt as to the actual lengths of the four sides of the base of the Pyramid. Petrie had encountered great difficulty in delimiting the exact position of the corners, from which several blocks had been removed. But in 1925, Ludwig Borchardt, then director of the German Institute of Archeology in Cairo, asked to borrow the instruments of the Government of Egypt in order to make a new survey of the Great Pyramid. Borchardt hoped that a really accurate set of measurements might at last separate the strands of fact from fiction in the matter of the geometry of the Great Pyramid.

The Egyptian government agreed to make the survey on condition that Borchardt first clear all the remaining debris from around the base. When this was accomplished, an engineer named J. H. Cole was employed to make a thoroughly scientific survey. Cole used an extensive sounding of the foundations, and was finally able to ascertain to within millimeters the original position of each of the four corners.*

* These were published in *Determination of the Exact Size and Orientation of the Great Pyramid of Giza* (Survey of Egypt, paper 58). Cole gives 230.215 meters (± 6 millimeters) for the south side; 230.454 meters (± 10 millimeters at the west end and ± 30 millimeters at the east end) for the north side; 230.391 for the east side; and 230.253 for the west side.

Stecchini surmises that the apparent discrepancies of a few inches in the lengths of the four base lines might not have been errors on the part of builders who could set casing stones with the precision of a modern optician and dig a descending passage of over 350 feet with a mere 1/4 inch error in azimuth, but *intentional variants* for a definite purpose.

Were the difference in length of the sides to be explained not as the result of imprecision, but as intended skill, it would be possible to explain the lack of squareness in the angles of the base of the Pyramid. In Stecchini's opinion, the Pyramid's sides may have been deliberately planned with angles differing from a right angle in multiples of 15″ in order to correspond to a second time in the apparent motion of the stars.

Ludwig Borchardt's measurements of the angles of the base of the Great Pyramid.

If the base of the perimeter is intended to be 1/8 minute of degree, twice the perimeter will equal one minute.

Cole's mean figure for twice the perimeter is 1,842.91 meters. The modern figure for a minute of latitude at the equator is 1,842.9 meters.

From the figures it is evident that the ancient Egyptians knew that a degree of latitude is shortest at the equator and lengthens as it approaches the pole.

Schwaller de Lubicz arrived at the same conclusion by noting that the Egyptians counted a minute of arc as being 1000 brasses, or 1000 fathoms of 6 feet. According to Schwaller the brasse was a strictly geodetic measure that varied between 1.843 meters and 1.862 meters, depending upon the degree of latitude at which it was figured. The concordance is remarkable in that a minute of latitude is 1,842.9 meters at the equator, and 1,861.65 at the pole.

Stecchini's analysis of the ancient texts also helps resolve the problem of the apothem of the Pyramid which was said to be 1/10 of a minute, or 600 feet.

Agatharchides of Cnidus reported that the Pyramid of Cheops was topped by a pyramidion, or capstone, of four cubits which could be included in a calculation or excluded depending on the problem to be resolved. Like the obelisks, most pyramids were capped by a pyramidion of precious metal that would sparkle in the first rays of sunlight.

Pyramidion, or capstone, from the pyramid of Amenemhet III (1849–1801 B.C.) at Dashur. It is of polished black granite with winged sun disk of gold and carved hieroglyphs.

Discounting 4 royal cubits for the pyramidion leaves an apothem of 352 cubits of .525 meter each, and solves the whole riddle of the cubits in the Pyramid.

It gives an apothem of 600 geographic feet of .308 meter, or 400 cubits of .462 meter. It also gives an apothem of 500 remen, 220 megalithic yards, 320 *pyk belady* cubits, 100 brasses, 60 decapodes, 40 cannes, 10 short schoenia, 6 plethra, or 1 stadium. It is one tenth of a minute of latitude measured at the parallel of the Great Pyramid.

Jomard had been lucky when he found 600 feet to the apothem of the Pyramid. He had measured short, not knowing about the pyramidion, and come up with a very close 184.72—which was derided by his colleagues.

Six hundred feet of .308 meter is 184.8 meters. The modern estimate of 1/10 minute of latitude at the parallel of the Great Pyramid is 184.75.

But Jomard had been absolutely right when he said he found 500 old Egyptian cubits of .4618 meter in the base of the Pyramid, and 400 larger *pyk belady* cubits of .5773 meter. These cubits are based on what Stecchini found to be the oldest foot in antiquity, the geographic foot which was still used in classical Greece and which survived in Europe down to our Middle Ages: in Egypt it was still common when Jomard arrived. Stecchini found evidence of this foot in temples in Mesopotamia in the preliterate era as early as 3500 B.C. The same geographic foot forms the edge of a cube or *artaba* which was the standard unit of grain measure in the Near East down to the Persian Empire.

It is now clear that the minute differences that appear in this foot in Persia, Greece, Mesopotamia and Egypt are due to the fact it was computed astronomically, varying a mere fraction of a millimeter depending on the latitude at which it was measured.

The façade of the Parthenon is 100 geographic feet of .3082765 meter, or 1 second of arc at the latitude of Athens, which is 37° 58′. At the equator a foot is a millimeter less, or only .30715 meter; at the mean latitude of Egypt, at 27° 45′, it is .307795. At the latitude of the Great Pyramid it is what Jomard found it to be: .3079. One and one-half of these feet made a geographic cubit of .4618, the same cubit Jomard found in current use when he arrived in Egypt, and which had been current since the time of Al Mamun (by means of which the Arabs could have correctly computed the circumference of the earth).

If you divide the earth into 360 degrees, and again into 60 minutes of 60 seconds, the result is one second of arc, or 100 geographical feet. Translated into meters by multiplying by .308 the result is 39,916.8 kilometers, which is within one quarter of one percent of our modern earth circumference of 40,000 km. By Akhnaten's average degree it was an even closer 40,009.32 kilometers.

Taylor had come within a hair of resolving the problem when he correctly postulated that the builders of the Pyramid had taken a great circle of 360 degrees and divided it first into 60 minutes and then into 60 seconds for a total of 1,296,000 seconds of arc.

Searching for a unit among the ancient measures that would fit this total, Taylor came up with what he called the short Greek foot, or Ptolemaic foot, which was 1.0101 of an English foot. One hundred of the Ptolemaic feet to a second of arc gave an earth circumference of 129,600,000 Ptolemaic feet, or 130,908,960 English feet, which was a bare one thousandth short of the estimate of the earth's circumference in Taylor's day.

Taylor's Ptolemaic foot was, of course, none other than Jomard's foot of .3079, from which was derived the cubit of .4618 meter, 500 of which fit the base of the Pyramid.

But Taylor couldn't make the sums come out because he was using the base computed by Le Père and Coutelle, which was about six feet too long, and into which neither the Ptolemaic foot nor the cubit would fit.

For lack of Cole's precise survey, poor Taylor, who was hot on the scent, was obliged to discard Jomard's thesis that 500 cubits of .4618 fit the base of the Pyramid along with the idea that it was intended to represent 1/8 minute, or 1/480 of a geographical degree. That Taylor was loath to do so is clear from his comment that he was sure that "it is in this direction, if any, that we may hope to find a satisfactory answer to the question: why was the Great Pyramid built?"

Instead, Taylor pursued the confusing idea that the Pyramid had been intended to indicate a polar axis for the earth of 500,000,000 Pyramid inches, and that the Egyptians had measured the base of the Pyramid in units to fit a solar year of 365.2322 days.

Piazzi Smyth, who also sensed there was truth in Taylor's probings, followed him into this apparent cul-de-sac.*

* Even so Taylor and Smyth may have been on the track of a solution. Taylor suggested that the circumference of the earth had been measured in Ptolemaic feet and common cubits, whereas the *polar* axis had been measured in inches and sacred cubits. In his recent *Historical Metrology,* Algernon Berriman supports Taylor's hypothesis by showing that whereas a "sacred" cubit of 25.064 inches is the ten millionth part of the earth's polar radius, a "royal" cubit of 20.6265 inches is a fraction of the circumference of the earth in that it is 206,265 sexigesimal seconds of arc: in other words the radius laid along a circumference of 1,296,000 seconds becomes a radian of 206,265 seconds.

Why Taylor, Smyth, Petrie and Davidson could not, or would not, avail themselves of Jomard's figures is a mystery. The twenty-one volumes of the *Description de l'Egypte* are bulky, hard to come by, and harder to handle (they are in leatherbound folio and double [Atlantic] folio, weighing as much as fifty pounds), and the information is scattered, without an index, through hundreds of pages of text, mixed with thousands of incongruous or irrelevant facts and figures; but the hard facts and figures are there; and Jomard's handling of them is lucid.

More surprising is the dogged determination of Egyptologists and writers on the Pyramid to continue to overlook or deny these facts. Even so eminent an Egyptologist as Jean Philippe Lauer, architect for the Egyptian Department of Antiquities, who certainly had ready access to *Description de l'Egypte* (his father was a curator of the Biblioteque Nationale) continued to dispute Jomard's conclusions even as late as after World War II.

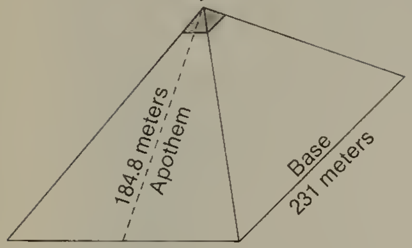
In his book *Le Problème des pyramides,* Lauer writes: "We must recognize that all this pretty hypothesis rests on inexact data. The cubit of .462 meters derived by Jomard from the base and the apothem of the Pyramid appears to be as hypothetical as that of Piazzi Smyth."

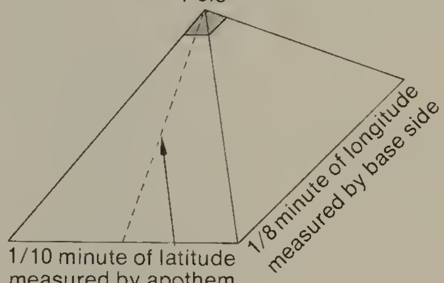
Ironically, the Director of the Department of Egyptian Antiquities, M. Etienne Drioton, who wrote the preface to Lauer's book, complained that it is because of their opposition to such theories as Jomard's that Egyptologists are being treated like "naif, blind, refractory dabblers in science whose quiet routines have been disturbed!"

That Jomard's cubit of .4618 or .462 meter is incorporated 500 times in the base of the Great Pyramid and 400 times in the apothem is no longer a matter of debate. Thanks to Cole it is a simple matter of multiplication. Even the confusing report of the Roman historian Pliny that the base of the Pyramid measured 833 1/3 feet and its apothem 666 2/3 feet becomes easily resolvable. The incongruity is rational when it is realized that Pliny's foot was simply 9/10 of a geographic foot. In other words, 833 1/3 of Pliny's feet turn out to be 750 geographic feet, or 500 geographic cubits.

The 500 cubits base is equal to 230.3625 meters (almost exactly Cole's figure) if measured by a geographic cubit computed at the equator, and 230.925 (almost exactly Jomard's figure) if measured by a cubit computed at the parallel of the Great Pyramid. The difference in cubits—which amounts to a fraction of a millimeter—makes no difference whatsoever to the relative values of the other units. For the sake of clarity the accompanying chart uses a cubit of .462 and a foot of .308.

Ancient Units of Measure Contained in the Great Pyramid in Round Numbers or Exact Fractions





The units of measure, from the short foot of .300 meter, through the various cubits, brasses, megalithic yards, parasangs, and miles, all fit perfectly in either round numbers or exact fractions into the base and apothem of the Great Pyramid because they are *all* fractions of a correct geographical degree of latitude or longitude at the equator. The Great Pyramid is thus a true standard of measure and a scale model of the northern hemisphere.

Apothem	Base
616 Egyptian feet of .300 meter	770 Egyptian feet
600 Greek or geographic feet of .308 meter	750 Greek feet
500 remen of .3696 meter	625 remen
400 geographic cubits of .462 meter	500 geographic cubits
352 royal cubits of .525 meter	440 royal cubits
320 *pyk belady* of .5775 meter	400 *pyk belady*
275 megalithic yards of .84 meter	220 megalithic yards
100 brasses or fathoms of 1.848 meters	125 brasses or fathoms
60 decapodes or rods of 10 feet	75 decapodes
40 rods of 15 feet	50 rods of 15 feet
6 plethra	7.5 plethra
1 stadium of 600 feet (.308)	1 1/4 stadium
1/10 of a mile, or angular minute	1/8 mile or minute
1/600 of a geographic degree	1/480 of a degree

Agatharchides was quite right when he quoted ancient Egyptian sources as saying that the base of the Pyramid was intended to be 1/8 minute of degree at the equator. 500 of Jomard's cubits multiplied by 8 for a minute, by 60 for a degree and 360 for a circumference, equal 86,400,000 cubits.

Relation of the Ancient Egyptian Foot (of .308 meter) and Multiples Thereof to the Circumference of the Earth

In the circumference there are			129,600,000 feet
There are 360 degrees		of	360,000 ft.
3,600	great Egyptian schoene	of	36,000 ft.
21,600	miles	of	6,000 ft.
216,000	stadia	of	600 ft.
1,296,000	plethra	of	100 ft.
2,160,000	schoenia	of	60 ft.
8,640,000	cannes	of	15 ft. (1) cubit
12,960,000	decapodes	of	10 ft.
21,600,000	brasses or ogyie	of	6 ft.
86,400,000	cubits	of	1 1/2 ft.
129,600,000	feet	of	1 ft.
518,400,000	palms	of	1/4 ft.
2,073,600,000	fingers	of	1/16 ft.

Obelisks outside the temple of Amon-Ra at Karnak which was oriented to the solstice. By measuring their shadow at the solstice it was possible to extrapolate the meridian circumference of the planet.

This reveals the source of the Egyptian cubit and foot. There are 86,400 seconds in a day of twenty-four hours, or the time it takes the earth to revolve on its axis. So the distance traveled by the earth at the equator in one second is exacly 1000 of Jomard's cubits.

The builders of the Great Pyramid gave its base a length corresponding to the distance the earth rotates in 1/2 a second. This makes the cubit and the foot doubly earth commensurate: the cubit was equal to 1/1000 of a second of time, the foot to 1/100 second of arc.

How could the ancient observers have established this fact? To compute the polar circumference of the earth the ancients used the sun and the shadows cast by obelisks. To compute the equatorial circumference they observed the passage of stars across fixed points such as obelisks. For the polar circumference they needed merely to measure the distance between two obelisks a few miles apart and the difference in the length of the shadows of the obelisks.

There was no need to measure such a vast distance as separated Alexandria from Syene. The difference in latitude, and hence the fraction of arc separating any two meridian obelisks, can be obtained by the relation of the obelisk's shadow to its height *when measured at the moment of the solstice or equinox.*

To obtain the equatorial circumference, an observer at the base of an obelisk at the thirtieth parallel could signal the appearance on the eastern horizon of a zenith star to an observer at a measured distance in the western desert where the tip of the obelisk would be on the horizon. Noting the interval of time between the signal from the first observer and the moment the star appeared on *his* horizon (and knowing the earth moves through 1,296,000 seconds of arc in 86,400 seconds of time), the observer could figure the equatorial circumference of the earth. At the thirtieth parallel it would vary from the equator by the cosine value of 30° or $\sqrt{3/2}$.

It was thus simply a matter of deciding what *unit of measure* to use in computing these lengths. An observer looking up at the Grand Gallery from a point far enough back to subtend an angle of 2° at the opening, could then note the time it took a star on the celestial equator to cross the opening. He would then possess the necessary data to relate the width of the Grand Gallery to the circumference of the earth.

From the figures it is evident that the ancient astronomers took the earth's daily rotation on its axis as a unit of time and made 1000 cubits the distance traveled by the earth in a second of time.

With a series of obelisks they could physically measure minutes and seconds of meridian arc, along a meridian and extrapolate the distorted distance to the pole.

From many scattered texts Stecchini has deduced that the Egyptians had worked out a simplified method of computing the change in each degree from equator to pole by means of an additive and subtractive series. The geographic cubit was also ideal in that it gave an admirable length for Egypt of 1,800,000 cubits. From Behdet to Syene is 7 1/2 degrees, or 1/48th of the earth's circumference of 86,400,000 cubits.

These cold facts should settle one whole facet of the mystery of the Great Pyramid. Clearly the ancient Egyptians knew the shape of the earth to a degree not confirmed till the eighteenth century when it was established that Newton was correct in his theory that the planet was somewhat flattened at the poles, and they knew the size of tne earth to a degree not matched till the middle of the nineteenth century when it was first remeasured with comparable accuracy by the German geodesist Friedrich Wilhelm Bessel. It is equally evident that they could divide a day into 24 hours of 60 minutes and 60 seconds, and produce a unit of measure that was earth commensurate—just as Taylor, Smyth and Jomard had surmised.

So now that Cinderella's foot has been found to fit her lost slipper without pinching or effort, to go on lengthening and shortening the carbuncled feet of her ugly sisters would indeed be like M. Drioton's naif, blind and refractory dabblers in science. On the other hand, a little cooperative effort by experts on ancient Egypt and Sumeria might help bring to light many more fascinating details of the early history of science.

Sexagesimal, Decimal and Quaternary Relations of Ancient Egyptian Units of Measure

60 palms	= 1 canne
60 feet	= 1 short schoenion
60 decapodes	= 1 stadium
60 short schoenia	= 1 Hebraic mile
60 plethra	= 1 Egyptian mile or minute of degree
60 stadia	= 1 grand schoenion
60 Egyptian miles	= 1 degree or moira
60 grand schoenia	= 1 sexagesime
60 sexagesimes	= 1 circumference of the globe
10 Egyptian feet	= 1 decapode
10 Egyptian cubits	= 1 canne or Egyptian pole
10 orgyie or brasses	= 1 short schoenion
10 decapodes	= 1 plethron
10 cannes	= 1 side of land unit of 100 cubits (aroura?)
10 short schoenia	= 1 stadium
10 stadia	= 1 Egyptian mile
10 grand schoenia	= 1 degree of longitude
4 fingers	= 1 palm
4 palms	= 1 foot
4 cubits	= 1 orgyie or brasse
4 cannes	= 1 short schoenion
4 sides of 100 cubits (aroura?)	= 1 stadium

Number of Greek or geographic feet of .308 meters.

In circumference of world	360,000 × 360
In a geographical degree	360,000
In a long schoene	36,000
In a geographical minute (or mile)	6,000
In a stadium	600
In a brasse	6
In a cubit (geographical)	1 1/2

Geodetic Values Incorporated in the Dimensions of the Great Pyramid

	Base	Perimeter	Apothem
Egyptian foot of .300 meter	770	3080	616
Greek or geographic foot of .308 meter	750	3000	600
Greek or geographic cubit of .462 meter	500	2000	400
Royal Egyptian cubit of .525 meter	440	1760	352
Pyk belady cubit of .5775 meter	400	1600	320
Megalithic yards of .84 meter	275	1100	220
Brasse of 6 geographic feet (1.848 meters)	125	500	100
Decapodes of 10 geographic feet	75	300	60
Plethra	7.5	30	6
Stadium of 600 geographic feet	1 1/4	5	1
Miles or minute of degree	1/8	1/2	1/10
Parasangs	1/24	1/6	1/30
Long schoene	1/48	1/12	1/60
Geographical degree	1/480	1/120	1/600

XVII. DECLINE OF ANCIENT KNOWLEDGE

What remains a mystery is how all the advanced science of the ancient Egyptians could have been lost for so many centuries.

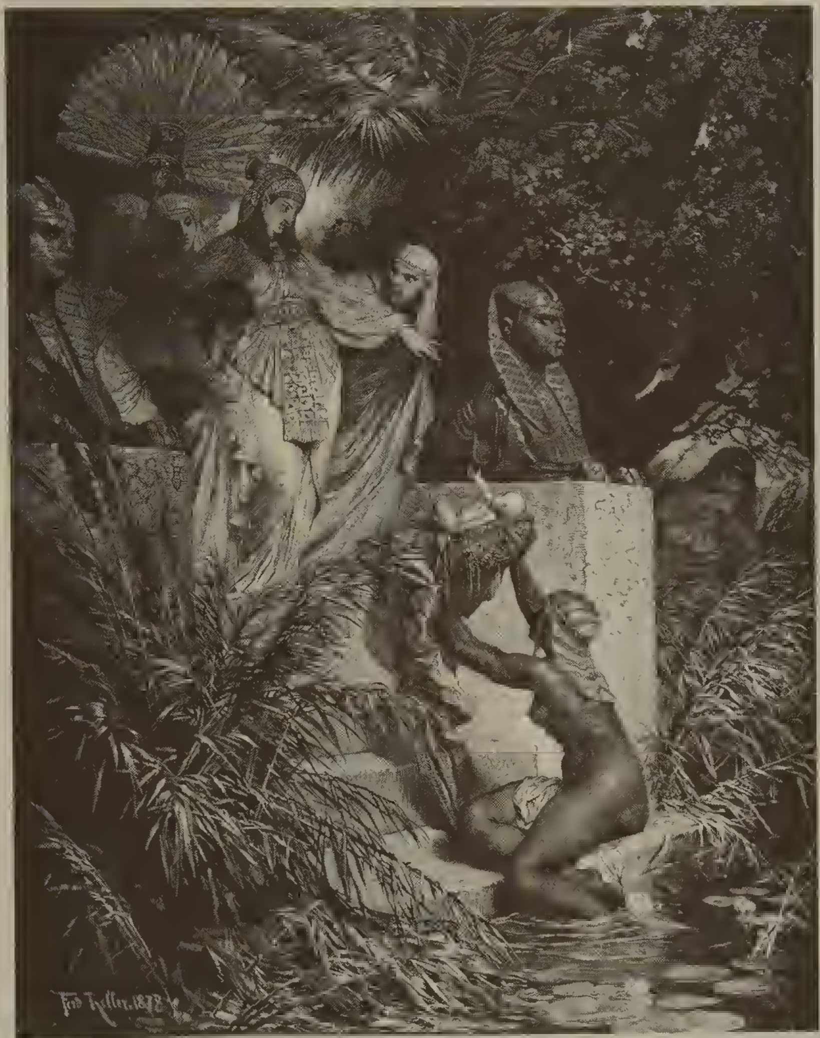
In his reconstruction of preclassic geographical data, Stecchini has traced an advanced science of geography based on accurate astronomical tables which were kept up to date all the way down to the beginning of the first millennium B.C. He has established that the later Babylonians still had excellent maps for their area of the world between the thirtieth and thirty-sixth parallels, made in segments of 6° of latitude by 7° 12′ of longitude, which gave them perfect squares because of the diminished length of a degree of longitude between those parallels.

This same system, says Stecchini, was in use as late as the reign of Darius the Great of Persia, whose empire, centered on the arbitrary geodetic point of Persepolis, ran precisely 3 units of 7° 12′ east of the Egyptian meridian and three units of 7° 12′ west of the Indian border.

But errors were already creeping into the geography because of a lack of direct observation of celestial phenomena and because of the reliance by geographers on ancient astronomical data that were no longer up to date.

As an explanation for this regression of geographic science, especially during the Hellenistic period, and thereafter almost to modern times, Stecchini suggests that when Alexander the Great destroyed Persepolis in the fourth century B.C. he may have exterminated the Egyptian geographers imported by the Persians to do their figuring, and that when he dismantled the center of Egyptian science at Heliopolis in order to build his own capital at Alexandria, he may have compounded the damage.* The destructions of Persepolis and Heliopolis were considered by Alexander

* Heliopolis, the On of the Bible, was considered the greatest university in the world. It had existed since much earlier times under the domination of the priests, of whom there were said to be 13,000 in the time of Rameses III, 1225 B.C. More than 200 years earlier, Moses was instructed at Heliopolis "in all the wisdom of the Egyptians," which included physics, arithmetic, geometry, astronomy, medicine, chemistry, geology, meteorology and music.



Romantic nineteenth-century depiction of Moses being found in the bullrushes.

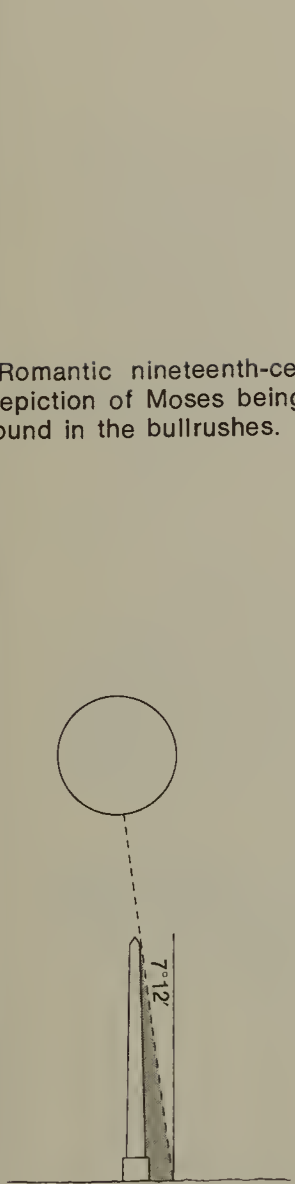
essential in order to destroy the geographic, and therefore the political, basis of the older empires.

Stecchini's evidence shows that far from being the great innovators of geographical knowledge, the Alexandrine geographers of the next half millennium, such as Eratosthenes, Hipparchus and Ptolemy were mainly handling and mishandling traditional data of an advanced science that preceded them, and which they only understood in part.

Current scholarship keeps repeating that the circumference of the earth was first measured by Eratosthenes, the Greek who was put in charge of the library of Alexandria, but it is clear that Eratosthenes merely cited old Egyptian information about the circumference of the earth without really understanding it.

Eratosthenes claimed to have found that a degree of latitude was 700 stadia. This, says Stecchini, was nothing but the traditional Egyptian datum of 14 *atur* to 50 stadia.

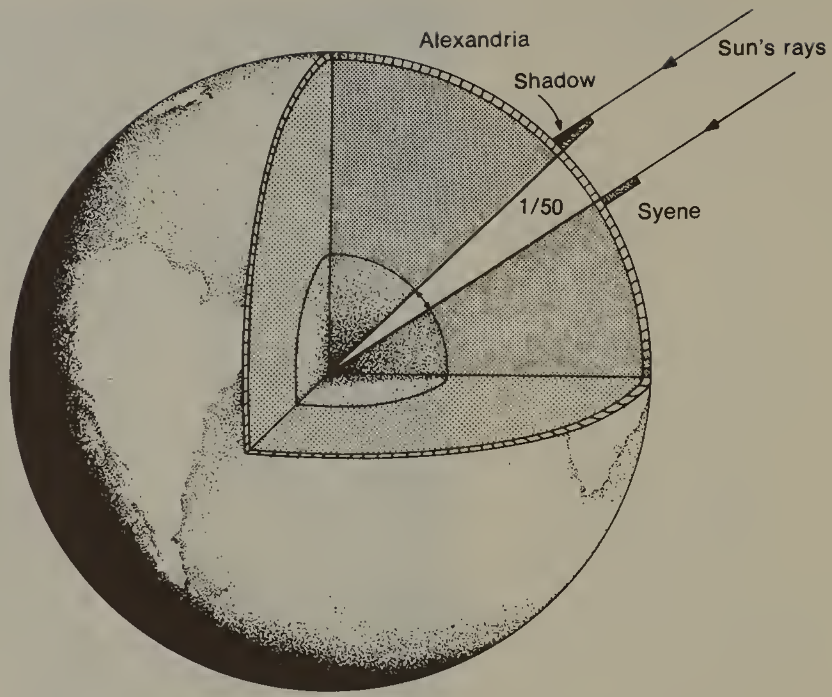
Eratosthenes also claimed to have found by observation that when the sun does not cast a shadow at the southern limit of Egypt, it casts a shadow of 7° 12′ at Alexandria.



Gnomon at Alexandria at summer solstice.

Eratosthenes is said to have measured the circumference of the earth by noting the angle of the sun's rays at Alexandria at the summer solstice, the day he knew the sun would be directly overhead at Syene on the tropic of Cancer.

Finding a shadow angle of 7° 12′ at Alexandria, he deduced the distance from Alexandria to Syene to be 7° 12′ of the 360° circumference of the globe. As 360/7° 12′ = 50, Eratosthenes multiplied the 5000 stadia he believed to separate Alexandria from Syene by 50 and got a figure of 250,000 stadia for the circumference of the earth. Because his various errors canceled out, he was credited with a scientific answer.



In reality Eratosthenes had read the old Egyptian data (then more than 2000 years old) to the effect that the tropic was at latitude 23° 51′ and that the sun did not cast any shadow at Elephantine. What he did not know, and could not measure, was that by his time the tropic had shifted to 23° 45′. Nor did Eratosthenes understand the necessity of adjusting his figures according to the apparent semi diameter of the sun; he believed Alexandria to be 7° 12′ north of 23° 51′; he even claimed that Alexandria was on the same meridian as Elephantine, whereas they are apart by about 3°, or 200 miles of longitude.

Furthermore, Eratosthenes used the "great cubit" of Babylon (532.702 millimeters) to obtain his stadium, instead of the more ancient royal cubit of the Egyptians of 525 millimeters, unaware that the first step taken by the Assyrians when they conquered Egypt in the seventh century B.C. was to substitute their own Mesopotamian cubit for the Egyptian one in order to manifest their own dominion.

On the basis of his research into ancient geography, Stecchini is now convinced that there existed on this planet a people with an advanced mathematical and astronomical science several millennia before classic Greece.

XVIII. WHO BUILT THE PYRAMID? WHEN? AND HOW?

It would be satisfactory to be able to describe the method by which the Great Pyramid was put together, by whom, and when.

But the builders, whoever they may have been, left no description of their method. No one has even found a *later* Egyptian report of how the first pyramids were built. It is only on the basis of shrewd guessing that Egyptologists estimate the stepped pyramid of Saqqara to be the oldest of the Egyptian pyramids and attribute its construction to the legendary architect Imhotep in the reign of King Zoser of the Third Dynasty.

The stepped pyramid of Medûm, which was the first stepped structure to be converted to a true pyramid, is attributed to Cheops' father Sneferu on similarly sketchy evidence; the same goes for the bent pyramid of Dashur.

Lacking solid history, the Arabs (and the Jews) of the Middle East proliferated legend. The most ancient tradition about the Great Pyramid is that it was erected to memorialize a tremendous cataclysm in the planetary system which affected the globe with fire and flooding.

Arab authors recount that the pyramids were built before the deluge by a king who had a vision that the world would be turned upside down, and that the stars would fall from the sky. According to these Arab sources, the king placed in the pyramids accounts of all he had learnt from the wisest men of the times, including the secrets of astronomy, complete with tables of the stars, geometry, and physics, treatises on precious stones, and certain machines, including celestial spheres and terrestrial globes. They also speak of "malleable glass."

The earliest Jewish reports—other than the vague reference in the Bible to "pillars of stone"—is in Josephus, who says the Sethites were inventors of a wisdom which dealt with celestial bodies and their order in the heavens, and that to preserve their wisdom for all mankind they built two monuments—one brick, the other stone—the stone one being still extant in Egypt in Josephus' time, during the first century after Christ.

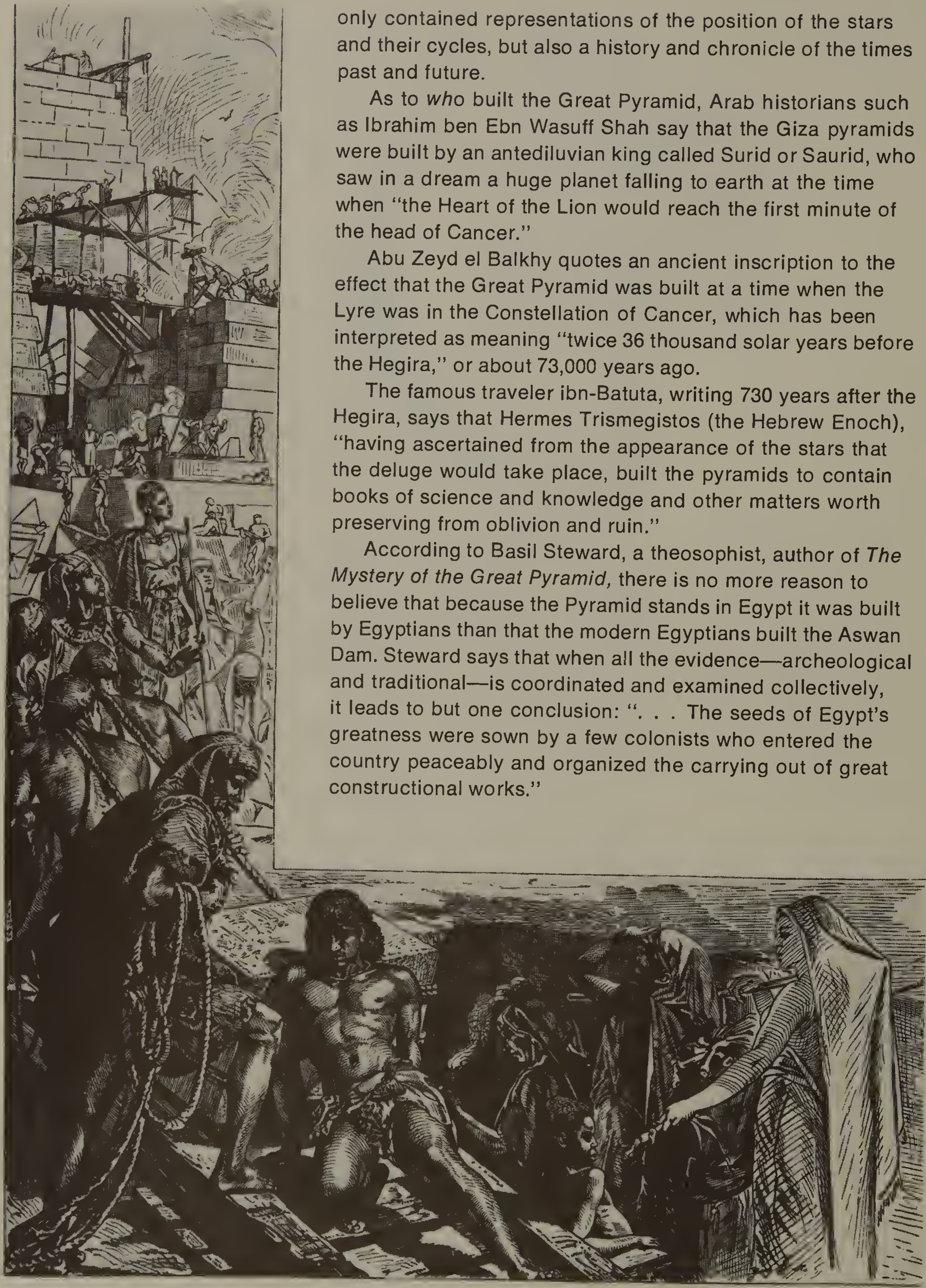
The Arab legends maintain that the Great Pyramid not only contained representations of the position of the stars and their cycles, but also a history and chronicle of the times past and future.

As to *who* built the Great Pyramid, Arab historians such as Ibrahim ben Ebn Wasuff Shah say that the Giza pyramids were built by an antediluvian king called Surid or Saurid, who saw in a dream a huge planet falling to earth at the time when "the Heart of the Lion would reach the first minute of the head of Cancer."

Abu Zeyd el Balkhy quotes an ancient inscription to the effect that the Great Pyramid was built at a time when the Lyre was in the Constellation of Cancer, which has been interpreted as meaning "twice 36 thousand solar years before the Hegira," or about 73,000 years ago.

The famous traveler ibn-Batuta, writing 730 years after the Hegira, says that Hermes Trismegistos (the Hebrew Enoch), "having ascertained from the appearance of the stars that the deluge would take place, built the pyramids to contain books of science and knowledge and other matters worth preserving from oblivion and ruin."

According to Basil Steward, a theosophist, author of *The Mystery of the Great Pyramid,* there is no more reason to believe that because the Pyramid stands in Egypt it was built by Egyptians than that the modern Egyptians built the Aswan Dam. Steward says that when all the evidence—archeological and traditional—is coordinated and examined collectively, it leads to but one conclusion: ". . . The seeds of Egypt's greatness were sown by a few colonists who entered the country peaceably and organized the carrying out of great constructional works."



Sir George Cornewall Lewis, in *An Historical Survey of the Astronomy of the Ancients,* complained of the arbitrary dating used by Egyptologists which he compared to "the manipulation of the balance-sheet of an insolvent company by a dexterous accountant (who, by transfers of capital to income, by suppression or transposition of items, and by the alteration of bad into good debts, can convert a deficiecy into a surplus)." Lewis pointed out that Baron Bunsen and Dr. Lepsius, both eminent Egyptologists, separated the dates of the figure Sesostris by no less than 3793 years, and asked: "What would we think if a new school of writers on the history of France, entitling themselves Francologists, were to arise in which one of the leading critics were to deny that Louis XIV lived in the seventeenth century, and were to identify him with Hercules, or Romulus . . . or Charlemagne."

The only major historian of ancient Egypt was Manetho, a priest, who wrote a history of Egypt for Ptolemy II, but it was lost. Only scraps of it, translated by authors who lived about six hundred years after his death, have survived. His list of dynasties, checked and modified, forms the framework on which the history of Egypt has been reconstructed. But very little detail is known concerning the political history of the first two dynasties, other than the nearly twenty names of Pharaohs listed by Manetho.

Most Egyptologists consider the First Dynasty to have started with Menes about 2900 B.C., and the Fourth, consisting of Sneferu, Cheops, Didoufri, Kephren, and Mykerinos, to have lasted about 120 years from 2680 to 2560 B.C., as the Old Kingdom.

There followed a first intermediate period, a Middle Kingdom from 2052 to 1785 B.C., a second intermediate period, and a New Kingdom from 1580 to 1085 B.C. Post Empire Dynasties XXI to XXVI follow down to 525 B.C.

According to Steward the colonists were probably a band of Asiatic or Euphratean travelers with a very advanced scientific and mathematical knowledge, who entered Egypt and organized the erection of the Great Pyramid, on completion of which they left the country, taking their knowledge with them.

As Steward puts it, the plans for the Great Pyramid were in existence a long time before the actual construction commenced, and were the design of a single individual "who belonged to the Adamic White civilization endowed with moral, scientific and cultural attainments far in advance of all other contemporary civilizations."

Petrie substantiates this theory to the extent that he believes: "the exquisite workmanship often found in the early period (of Egyptian architecture) did not so much depend upon a large school of widespread ability, as on a few men far above their fellows." Referring to the phenomenal accuracy of the work embodied in the Great Pyramid, Petrie says, "It was limited to the skill of one man."

Recent Soviet authors postulate that the Egyptians may have come from Indonesia when their civilization was devastated some ten to twelve thousand years ago as a result of some cosmic catastrophe such as the falling of an asteroid.

According to Peter Kolosimo in *Terra Senza Tempo,* published in Milan in 1969, the Russians have recently brought to light some fascinating secrets of Egyptian archeology.

The Russians are said to have found astrònomical maps of surprising correctness, with the position of the stars as they were many thousands of years ago. The Russians are also reported to have dug up several objects, many not yet identified, including crystal lenses, perfectly spherical, of great precision, possibly used as telescopes. Kolosimo says similar lenses have been found in Iraq and central Australia, but that they can only be ground today with a special abrasive made of oxide of cerium which can only be produced electrically.*

As to the actual dates of construction of the Great Pyramid, apart from the statement that it was built 300 years before the Flood, the legends add little. Egyptologists who worked out that the Fourth Dynasty must have reigned between 2720 and 2560 B.C. believe the Great Pyramid was commenced in 2644; others believe that its construction was begun in 2200 and that 30 to 56 years were required to

* Several attempts to check these data with Soviet academicians have so far been without result.

To Egyptologists Imhotep (above) was a national hero in the reign of King Zoser (below). Imhotep as designer of the stepped pyramid of Saqqara was considered not ony the world's greatest architect but a sage, magician, high priest, medical doctor, diplomat, economist, and poet.

complete it. Still others place the building of the Pyramid a thousand years earlier.

As for the method employed by the builders, the record is equally bleak. I. E. S. Edwards of the Egyptian Department of the British Museum, who spent a lifetime going over the available evidence, points out in his scholarly treatise on the pyramids written in the 1930s that little or no light is thrown on the subject by extant Egyptian records, either written or pictorial.

The result is a congeries of conflicting theories not only about when but about how the Great Pyramid was built.

Nevertheless Egyptologists are in general agreement that the first step required on the Giza plateau was to clear the sand and gravel down to bedrock, then produce a leveled base by removing protuberances and filling in depressions.

R. L. Engelbach, a pupil of Petrie, and for many years Keeper of the Cairo Museum, believes that to obtain a true level the Egyptians surrounded the four sides of the area with low banks of mud from the Nile which they filled with water and through which they cut a network of trenches. The degree of their success is attested by Cole's survey, which found the base rock of the thirteen acre perimeter to be less than 1 inch out of level.

Into the base rock a row of fine rectangular, white limestone slabs were carefully fitted as a pavement on which to lay the first row of casing stones.

When it came to drawing the first straight side, Borchardt and Lauer agree, the correct orientation must have been obtained by means of repeated observations of the rising and setting of circumpolar stars, of which the most likely was alpha Draconis.

The next step would have been to fix the large limestone corner blocks into the rock base so as to form the square corners for the laying of the first rows of casing stones.

Archeologists have had little trouble establishing that most of the limestone blocks for the construction of the Pyramid must have been obtained from the deep Mokattam quarries a few miles across the Nile on the Arabian side of the river, though many of the blocks may have been obtained directly from the Giza hills.

On some of the blocks the names of the quarry gangs were daubed in red ochre, such as "Boat Gang" or "Vigorous Gang."

The nearest source for the 70-ton granite monoliths used to protect the King's Chamber is the Aswan quarry, near Syene about 500 miles up the Nile; from there they were presumably floated downstream on a series of reed barges.

W. Emery has shown that as early as the First Dynasty

The limestone blocks with which the Pyramid is built appear to have been mostly quarried on the spot, or across the Nile in the Mokattam hills about 20 miles away, or from the Turah and Maura quarries opposite Memphis. The 22 acres of casing stones are from the same quarries.

The granite blocks for the Pyramid are believed to have come from Aswan, near the First Cataract, where they were quarried from the face of the rock about a mile from the right bank of the Nile.

Hillsides were hollowed out to provide uniform limestone blocks for the outer casing of the Pyramid.

Limestone was quarried in layers from the top down.

The Aswan granite quarries were 500 miles south of the Great Pyramid.

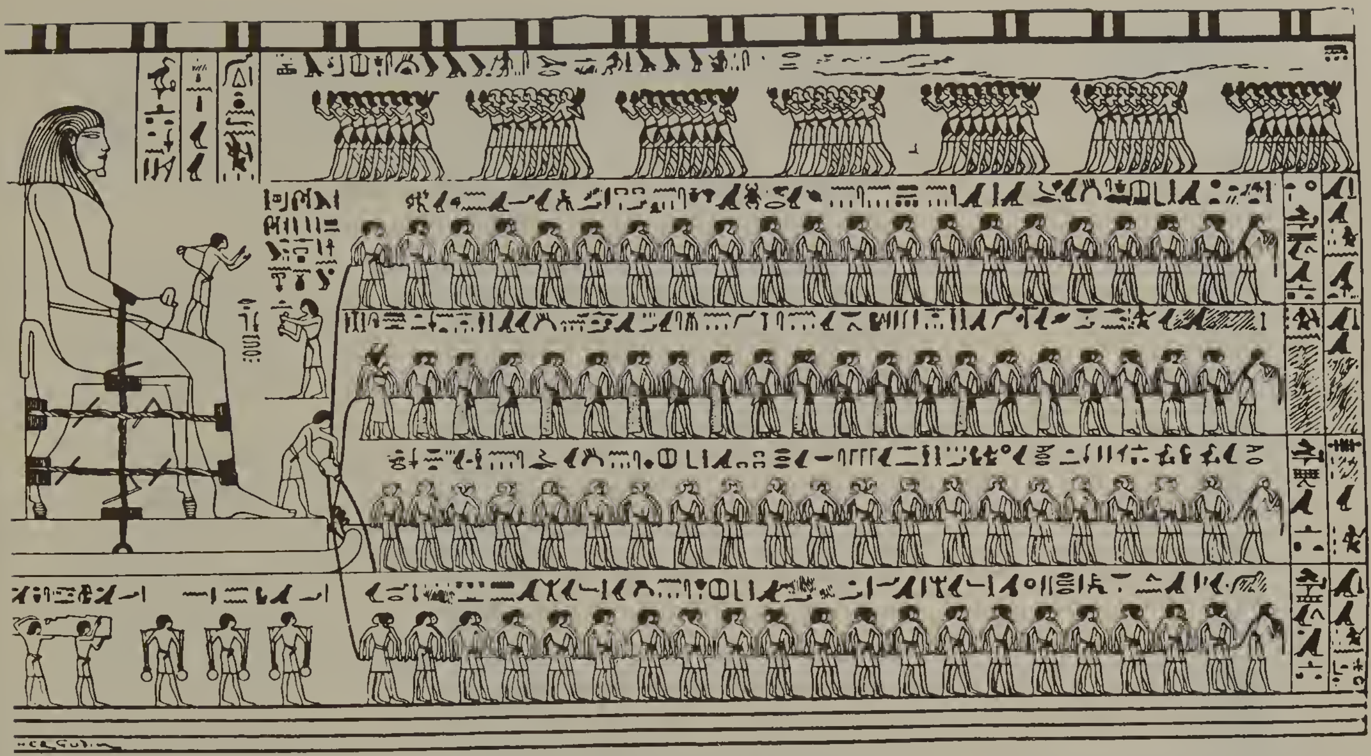
Egyptologists conjecture that in order to cut the stone blocks, the ancient Egyptians must have had some method of tempering bronze unknown in modern times. To cut and finish hieroglyphs and other ornaments would require a tool with an extremely hard-tempered edge.

Few iron tools have been found, probably because of the rapid oxidation of iron in Egypt, where the soil is especially nitrous.

the Egyptians possessed excellent copper tools, including saws and chisels, with which to cut any kind cf limestone, and that their technique of working and polishing granite was developed to a truly remarkable art. As an abrasive material in their sawing operations they are believed to have used moistened quartz sand.

To quarry the rock from the hillside, the Egyptians developed a variety of systems, traces of which can still be found on the Mokattam range. Tunnels were dug several hundred feet into the rock, shelves were cut out between the roof and the block to be detached, then a line was chipped away vertically with a wooden mallet and a copper chisel, which must have been highly tempered by some method unknown today. Wedges were inserted which were moistened till they expanded to crack the rock. Sometimes fires were built along the grooved lines, and water poured on the heated stone to obtain a clear fracture.

The only historical description of the manner in which the limestone blocks were taken to the Pyramid is by Herodotus, who claims that he was informed in Egypt that it took twenty years to build the Pyramid and that levies numbering a hundred thousand men were employed for periods of three months to transport stone from the quarries. Herodotus says that to transport the rough blocks from the edge of the Nile up to the top of the Giza plateau, a great causeway was built, which required ten years to complete. The causeway was said to be 3000 feet long and 60 feet wide, of polished stone, over which sleds could pull the heavy stones.



Several score Egyptians transporting a colossal statue with men harnessed in double rank. Note the timekeeper standing on the statue's knee, and a man pouring liquid on runners to decrease friction.

Commander F. M. Barber, an American naval attaché who was stationed in Egypt at the end of the last century and wrote an informed booklet entitled *Mechanical Triumphs of the Ancient Egyptians,* figured that if the causeway had to rise to a height of 120 feet above the Nile, it would have had an incline of 1 foot in 25, which he considered a very easy grade for a greased stoneway.

Barber estimated that it would take a force of 900 men harnessed in double rank on four draft ropes to drag a 60-ton monolith up such an incline. On the causeway the men would cover a space 225 feet long by 16 feet wide, which Barber considered a sufficiently compact and manageable force.

Barber says that such a force would have no trouble dragging the stone, especially if they were drilled to pull together; he concludes that for this reason men and not animals are pictured hauling wrought stones: men could be drilled to march in absolute cadence to a song or time-keeping instrument. A "one-two-three, surge," says Barber, produces a momentary force represented by nearly the weight of the whole mass of men, or several times their ordinary pulling force. Also, vacancies in the ranks caused by sickness could be filled without materially affecting the drill of the remainder. Cattle could never be so well organized.

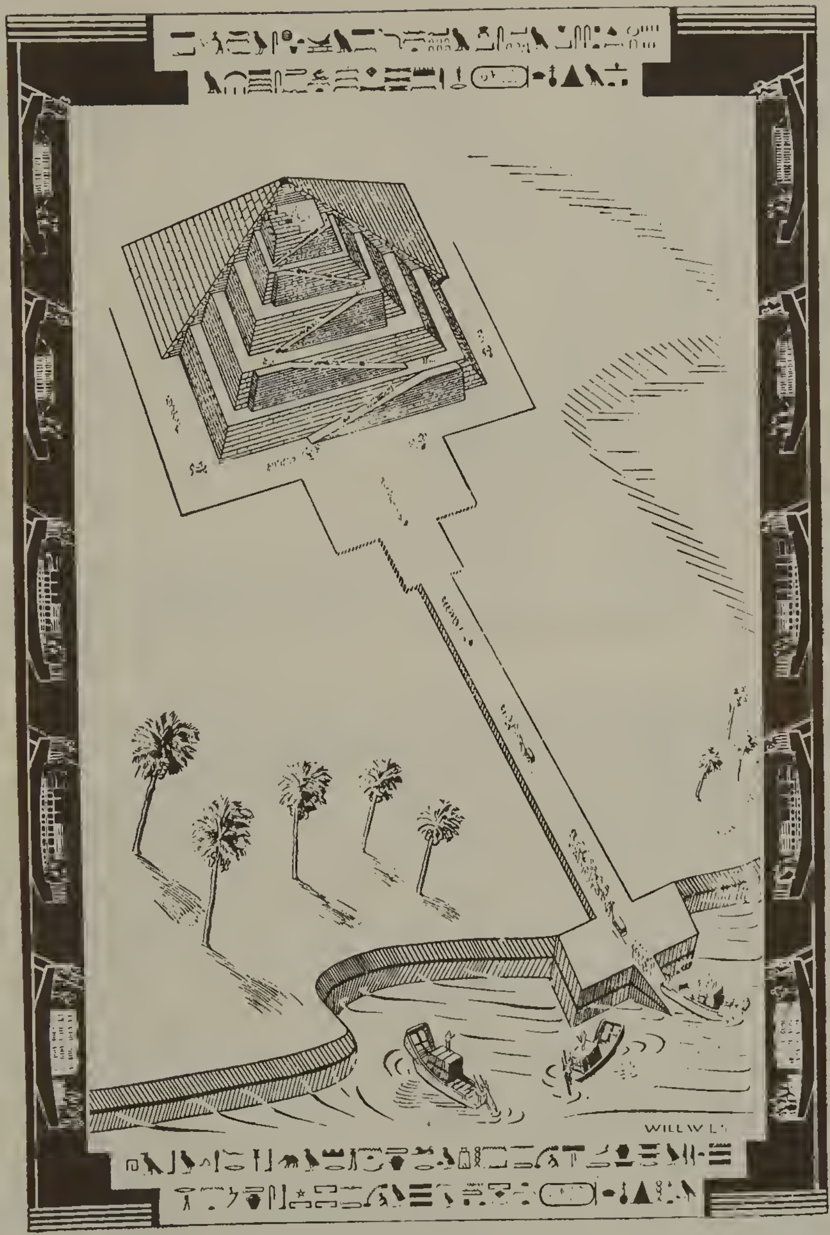
Pictures show Egyptians hauling stone in the manner described by Barber and include a special artisan pouring some sort of grease on the sled runners to reduce friction.

Other Egyptologists have suggested that owing to the great quantity of supplies necessary for building Cheops' pyramid, it was likely that several ramps led from the valley up to the Giza plateau, but very few remains of such possible causeways can now be observed because of modern excavations and the widespread tourist layout.

According to the French scholar E. Amélineau, considerable remains of an inclined plane leading to the pyramid of Kephren still existed at the end of the eighteenth century; and remains of a causeway leading to the pyramid of Mykerinos are still visible today.

The Egyptian archeologist Selim Hassan says that at the edge of the Giza plateau there is a considerable surface composed of large limestone blocks which run in a northeasterly direction and descend to a little less than half the height of the plateau. He believes they may have been part of a construction ramp which was demolished when the Great Pyramid was completed.

Causeway to the pyramid of Kephren.



W. W. Lucker's reconstruction of a pyramid and its causeway to the Nile.

Ahmed Fakhry, another Egyptian archeologist, says that remains of a southern supply ramp composed of rubble mixed with mud still exists a short distance from the south side of the main causeway.

As to how the Great Pyramid was actually constructed, there are differing opinions among Egyptologists. Herodotus reported that the upper portion of the Pyramid was finished first, then the middle, and finally the part nearest the ground. This has been interpreted as meaning that the finished outer casing stones were placed in position against the nucleus starting from the top, presumably by means of a ramp that was removed as the builders worked downward; this would have required four ramps, one against each face.

Herodotus maintains the casing blocks were lifted from the ground, step by step, on pieces of wood, with a machine

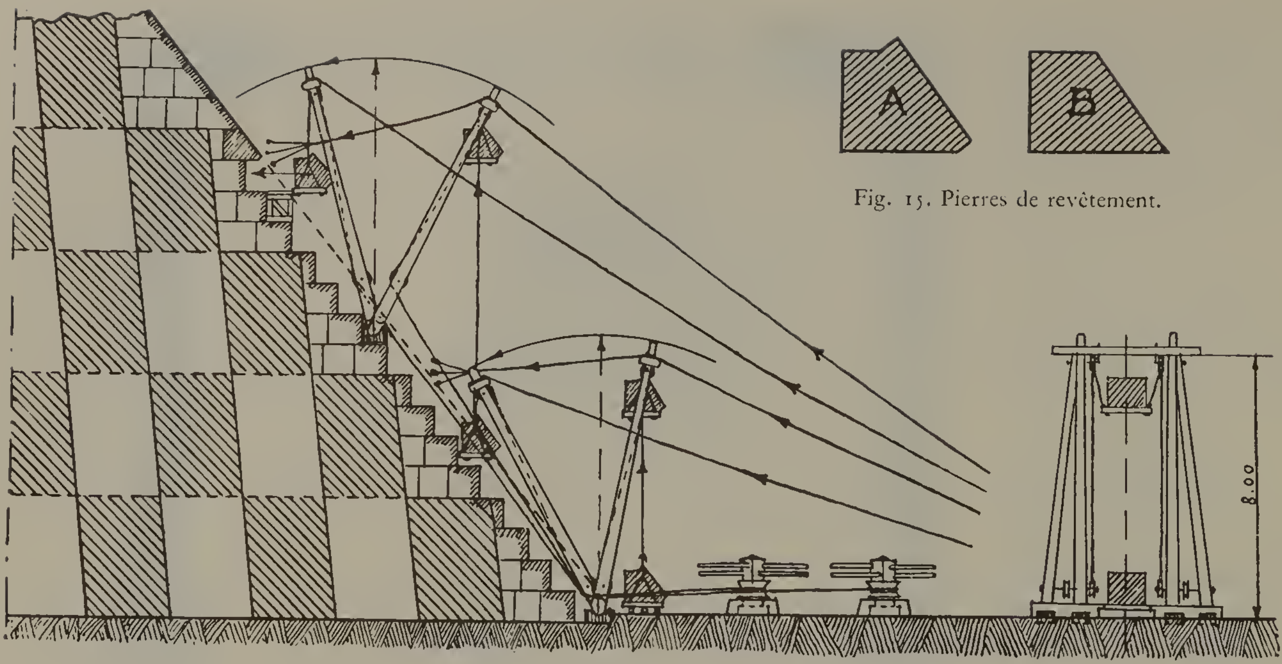


Fig. 15. Pierres de revêtement.

Machine for raising casing stones, as described by Herodotus and reconstructed by H. Straub-Roessler.
A and B are Lauer's indication of how casing stones may have been fitted.

which he does not adequately describe. Cotsworth figures that if the stones had had to be rocked to the top as reported by Herodotus, it would have taken about a month to get each of the final ones up to the summit.

Barber maintains that steel cranes or derricks would have been required to swing such great stones as are found in the Pyramid, and that for lack of such equipment the Egyptians would have had to construct a ramp in order to raise the heavy stones to the required level. Remains of such ramps have been found at the pyramid of Amenemhet at Lisht and also at Medûm. Aerial photographs indicate substantial remains of ramps under the sand at Dashur.

Petrie thinks the casing stones were placed in position at the same time as the core, starting from the bottom and going up course by course. He estimates that about 500 blocks were brought over from the quarries each day and laid in place. As the lower courses contain as many as 50,000 blocks, it would have taken over three months to lay each of these courses.

Petrie says the transporting was done during the three months of inundation, when a vast labor force was available and when advantage could be taken of the flood waters to float the blocks from the quarries downstream and across five miles of swollen Nile. Petrie suggests that even if no more than eight men could work together on an average block of 40 cubic feet weighing about 2 1/2 tons, they could have transported ten such blocks to the Pyramid in three months, taking two weeks to bring the blocks down the causeway from the quarry, a day or two with good wind to ferry the blocks down the Nile, and six weeks to raise them to the required position on the Pyramid. By November the men would be at liberty to return to their usual occupations when the land was again accessible.

Petrie estimated the Great Pyramid to contain about 2,300,000 stones weighing 2 1/2 tons apiece and averaging 50 × 50 × 28 inches. If eight men could bring ten stones in three months, 100,000 men could bring 125,000 stones each season, or the required total in the twenty years reported by Herodotus.

Edwards says there can be little doubt that in addition to the 100,000 men levied for the purpose of transporting the blocks to the Pyramid, many others were engaged in building the Pyramid. These men, says Edwards, consisted of skilled masons and an attendant body of laborers, continually employed throughout the year preparing and laying the blocks and erecting or dismantling the ramps. Presumably these workers could have been housed in the buildings found

Aerial photograph showing ramp under the sand leading to the pyramid of Dashur.

Romanticized modern drawing of barges being rowed down the Nile toward the Giza pyramids.

by Petrie west of Kephren's pyramid, where about 4000 at a time could have lived in barracks.

Petrie figures that 40,000 skilled workers living permanently on the spot could easily cut and finish the 120,000 blocks needed each year; a party of four men would have a whole month to handle each block.

Petrie believes the masons finished and laid the casing and some of the core masonry, course by course, on the ground, before raising them. He found horizontal lines carved on the casing stones and on the core stones showing just how they were to be fitted. He believes that skilled masons planned all the work throughout the year and that at flood time gangs of unskilled workmen raised the finished stones to their indicated positions.

Petrie says the casing stones were dressed by very fine picking or adzing and were moved into position from the *inside,* whereas the core was filled in afterward.

Maragioglio and Rinaldi, two Italian scholars who recently made extensive measurements of the pyramids of Giza which they incorporated into four carefully illustrated quarto volumes entitled *L'Architettura delle Piramidi Menefite,* agree that the casing and the nucleus were built up at the same time; they think the casing blocks were slid into place by means of a thin layer of very liquid mortar that served as a lubricant as well as a filler and binder; they also think the casing blocks were levered into position from the back and sides so as not to show marks or chips on the front.

Ballard believes it would have been impossible to place the finished blocks without damaging their fine edges; he thinks the roughly scabbed blocks were put in place and finished off with the aid of templates.

In support of Petrie, I. E. S. Edwards points out that because the lowest course of casing stones lies on the smooth pavement of Turah limestone which projects a couple of feet beyond the Pyramid base, it would have been impossible to lay the casing stones from the *outer* side without damaging the fringe of the pavement which was to remain exposed; nor could they have been dressed *after* being put in position without damaging the pavement.

The fact that some of the limestone slabs of the foundation pavement are seen to be laid *beneath* the nucleus blocks also indicates the nucleus was filled in after the casing blocks had been placed in position.

Petrie believes the casing blocks were placed side by side on the ground and worked so that the back, sides and bottom would fit perfectly when put in place. The only thing left to do on the spot would have been the leveling of the upper faces.

According to the architect Rex Engelbach and the engineer Somers Clarke, authors of *Ancient Egyptian Masonry,* in order to render the sides of the casing blocks perfectly equal they were placed side by side in the yard and a saw was passed between them. However, Maragioglio and Rinaldi could find no trace of saw marks on the vertical sides of any of the remaining blocks.

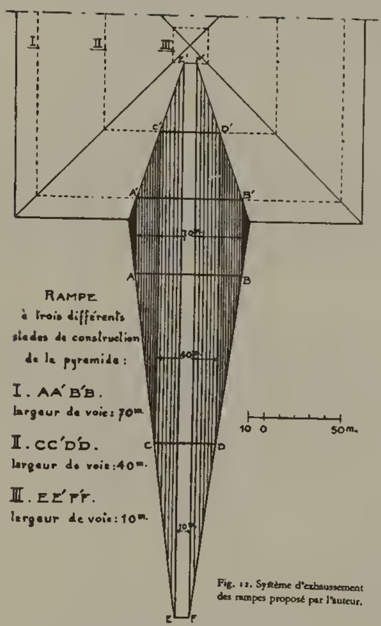
Petrie claimed to have found traces of red ochre on some of the stone faces which had not been perfectly dressed. From this he deduced that the dressing was done by degrees —as a dentist shapes a tooth—the control being made with facing plates covered with ochre.

In any case, the arrangement of casing blocks must have been worked out in detail well in advance of placement so as to assure a variance in the width and height of the backing stones from level to level, so as to prevent the vertical joints from coinciding.

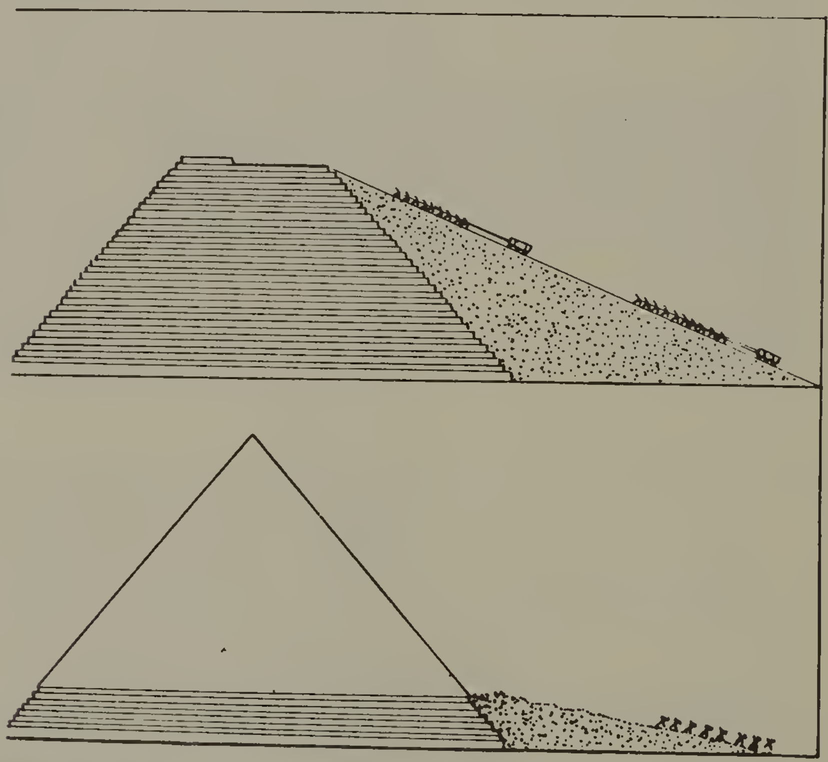
All the stones presently visible in the Pyramid are backing stones specially cut to dovetail and fit behind the outer casing. They are well dressed and squared, but made with fossilized limestone instead of the pure white.

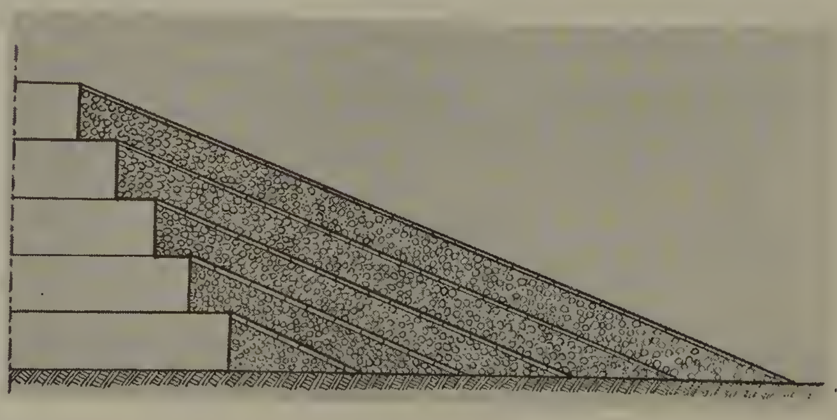
Behind them the nucleus consists of less well-dressed and roughly faced blocks of greatly varying sizes, for easier construction, and to insure that break joints did not coincide in either sense. They are held together by a mortar composed of sand, lime and crushed red pottery, which gives it a slightly pinkish color.

Maragioglio and Rinaldi attribute the concavity of the sides of the visible backing blocks to a means of preventing the facing courses from sliding, especially in the middle, by wedging the backing stones together at the center. On the north side the concavity has been measured as .94 meter. Maragioglio and Rinaldi believe the casing faces may also have been slightly concave, if only for esthetic reasons, as the optic aberration would thus be corrected, the Pyramid edges would appear sharper, the faces flatter; also,



Lauer's idea of how the ramp would grow wider and narrower.





Various methods of building ramps.

any errors in dressing the faces could be more easily distinguished.

Slight variations in the angle of the outer faces of casing fragments found in the rubble at the Pyramid's base may be explained by such a surface concavity.

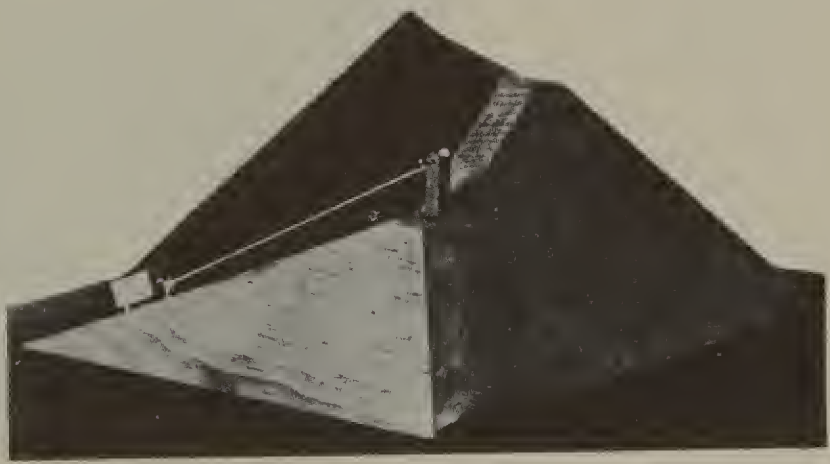
To raise each course of casing stones and nucleus all the way up the Pyramid, Petrie believes a ramp was constructed against one face, and he estimates that its volume would have had to be at least equivalent to that of the Pyramid itself.

Barber points out that to carry an inclined plane to the top of the Pyramid at a grade of one in ten, it would have been necessary to start the ramp 6000 feet away in the Nile valley at a point over 1600 feet before the commencement of Herodotus' causeway. Furthermore, says Barber, there would always have been four times as much work to do on the inclined plane as on the Pyramid.

In order to carry the ramp to the top of the Pyramid, Barber estimates that some 75,000,000 cubic feet of Nile bricks would have been necessary, or four times the number of cubic feet of stone still required to finish the Pyramid. With each additional course of masonry the ramp would grow higher and longer, but it would also grow narrower as the Pyramid narrowed at the top. According to Pliny such ramps were composed of niter and salt which could later be dissolved with water, but the idea seems fanciful as it would have required an ocean.

In *Natural History* of November, 1970, Olaf Tellefsen, an engineer, suggests that the Great Pyramid could have been erected with only a few thousand men using a simple piece of machinery consisting of a sturdy wooden arm balanced with counterweights on a fulcrum fixed to wooden skids—much like the machine drawn by the German engineer L. Croon.

This, says Tellefsen, would have done away with the need



for huge ramps postulated by Egyptologists on the basis of archaeological remains. According to Tellefsen, there was not enough manpower in ancient Egypt to build such ramps beyond the halfway mark of the Pyramid. Egyptologists countered, a little acidly, that from that point on the ramps narrowed rapidly, and that there appeared to be little evidence for Tellefsen's contention.

Cotsworth believes the Egyptians used a more ingenious system for raising the stones by taking advantage of the building itself as a ramp, dragging the stones up the Pyramid's own spiraling outer wall. This would enable the builders to fill in the core as they went up and finish the casing as they came down. Cotsworth says he watched a modern Egyptian peasant build a pigeon house by just this method.

The system has the added advantage that if the south wall of the Pyramid were completed first, the rest of the work could have been carried out in its shade rather than in the broiling sun.

But with or without the broiling sun, if one takes into account the problems of quarrying, roughing out, transporting over two million core stones, and finishing some 115,000 enormous casing stones to a precision of 1/100 inch, then raising, manipulating and mortaring them into their correct

place in a unified polished structure, one must agree with Antoniadi that the mind boggles at the enormity of the effort.

According to Barber's well-trained naval mind, it must have required the organizing capacity of a genius to plan all the work, to lay it out, to provide for emergencies and accidents, to see that the men in the quarries, on the boats and sleds, and in the masons' and smithies' shops were all continuously and usefully employed, that the means of transportation was ample, that the commissariat did not fail, that the water supply was ample and conveniently disposed, and that the sick reliefs were on hand.

Barber points out that public works were essential to keep this population employed and fed during the floods. August Mencken presumes that no less than 150,000 women and children also had to be housed, fed, and policed in nearby settlements. Judging from the texts and the paintings dealing with the subject of forced labor, Barber figures a large portion of the duty of the standing army of 400,000 men must have been that of guards.

Cotsworth says that in the rainless climate of Egypt no housing was needed for the natives who were accustomed to surviving on grain and water, and that the desert provides better sanitation than was available in Victorian England.

The waste chips of the masons were thrown over the

In 1950 the Museum of Science in Boston built a model to the scale of 1:120 showing how they believed the pyramids of Giza to have been constructed with slanting side ramps, three up and one down.

Dows Durham, curator of Egyptian art at the Museum of Fine Arts in Boston, responsible for the technical details, disagreed with the theory of long ramps because every time the building rose a few feet the ramp would become unusable until it was raised and extended.

Durham conceived the side ramps as being about 10 feet wide, or sufficient to handle a sledge with a double row of men to drag the stones over wet timbers for reducing friction. However, turning the corners would not have been easy.

cliffs of the Giza hill on both the north and the south sides, where they formed banks stretching out a hundred yards, occupying a space almost half the bulk of the Pyramid. The slopes formed an angle of rest of about 40°, showing the different qualities of refuse thrown away on different days, varying from large chips to mere sweepings.

In pits which had recently been made in part of the heap close to the edge of the cliff, Petrie noted layers of desert flint and sand showing when a piece of desert ground had been cleared to get more space for working. Among the rubbish he found pieces of workmen's water jars and food vessels, chips of wood and charcoal, and even a piece of ancient string.*

The only report on the daily cost of building the Pyramid is given by Herodotus, who says that an interpreter told him the daily sum spent on radishes, onions and garlic for the workmen was inscribed in Egyptian characters on the base of the Pyramid. But the report sounds apocryphal, as does the one passed on by Herodotus to the effect that Cheops became so broke during the operation that he prostituted his daughter by placing her in a chamber and charging each visitor the equivalent of a finished limestone block for her favors.

Kingsland figured that to position an estimated 2,300,000 blocks in a period of 20 years, or 7300 workdays, would have meant placing 315 stones each day, or 26 stones an hour working 12 hours a day.

Mencken, who has such disdain for the mathematical and astronomical knowledge of the ancient Egyptians, considers it remarkable that they were able to solve some of their problems of construction unless they had "more knowledge, better instruments, and far more ingenuity than is generally believed."

Kingsland wonders what means of illumination the Egyptians used while digging down to the subterranean pit and what method they used for getting air to the diggers. He finds it difficult to resist the conclusion that the Egyptians must have had tools and appliances of which we are totally ignorant, and must have employed methods which today would be termed occult.

Some of their solutions may have been no more arcane than Lockyer's suggestion that with one movable mirror and several fixed ones, sunlight could have been reflected to any part of the interior of the Pyramid.

Though legend attributes to the priests of Heliopolis the

* It would be helpful if more fragments could be excavated and carbon-tested.

knack of being able to cause tempests and levitate rocks that a thousand men could not move, most Egyptologists argue strenuously against the possibility of sophisticated instruments such as laser beams for cutting surfaces, or ground-effect or antigravity machines for raising weights, insisting that the job was accomplished with nothing but primitive appliances and unlimited manpower. Nevertheless the conscientiously academic Edwards fudges the issue by saying: "Cheops, who may have been a megalomaniac, could never, during a reign of about twenty-three years, have erected a building of the size and durability of the Great Pyramid if technical advances had not enabled his masons to handle stones of very considerable weight and dimensions."

Petrie is more specific and gives substance to the hypothesis of unknown methods, pointing out that in the pyramid of Kephren there is a granite portcullis weighing about 2 tons which is in such a position in a narrow passage that only 6 or 8 men could work on it at once. As it would take a force of 40 to 60 men to manipulate such as a mass, Petrie concludes that the Egyptians must have had some more efficient means which remains unknown to us.

Although the Danish engineer Tons Brunés has demonstrated how a block as large as the beams of the King's Chamber could be comfortably raised by a single man with the dexterous use of balancing and wedges, Petrie is convinced that ancient builders possessed some more efficient means of raising and setting stones than mere rollers, levers, ramps and manual hauling.

But perhaps the most puzzling riddle of the Pyramid, requiring an intellectual game of detection, is the one constituted by the three granite plugs wedged into the end of the Ascending Passage.

XIX. WHY WERE THE PYRAMID PASSAGES PLUGGED? WHEN? AND HOW?

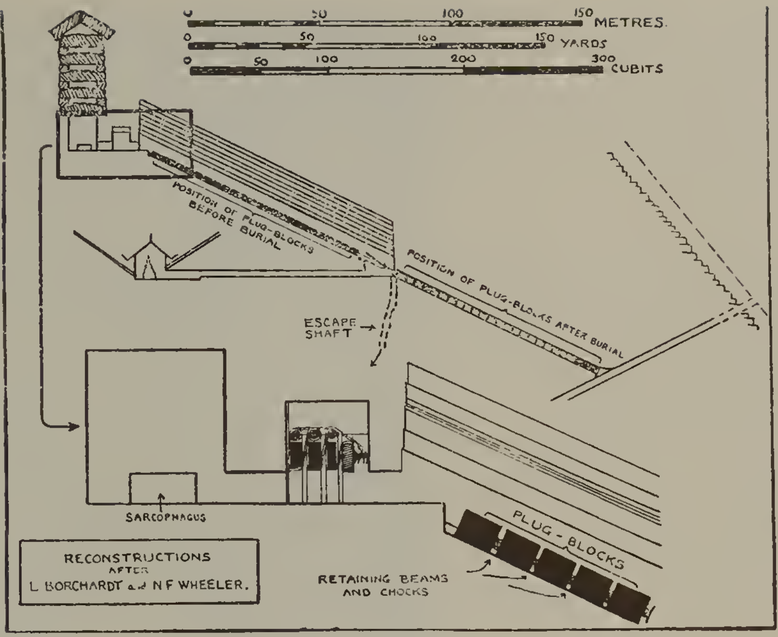
Most Egyptologists conclude that the Pyramid was built as a tomb for some Pharaoh, presumably Cheops. Any mathematical, religious or prophetic theories about the structure they consider to be fanciful, or, at best, coincidental. To Egyptologists the corridors of the Great Pyramid were designed solely as a means of transporting the coffin of the dead Pharaoh to his sarcophagus in the burial chamber, as a means of exiting after the entombment, or as blinds to lead grave robbers away from a hidden chamber.

No other reason is offered for piling up so massive a mound of masonry than to protect the dead Pharaoh from the attention of grave robbers. Oddly, this is the single function which neither the Great Pyramid, nor any of the others, managed to fulfill, there being no reliable report of any body having been found in any of the pyramids, only some fragments of bones whose dates are uncertain.

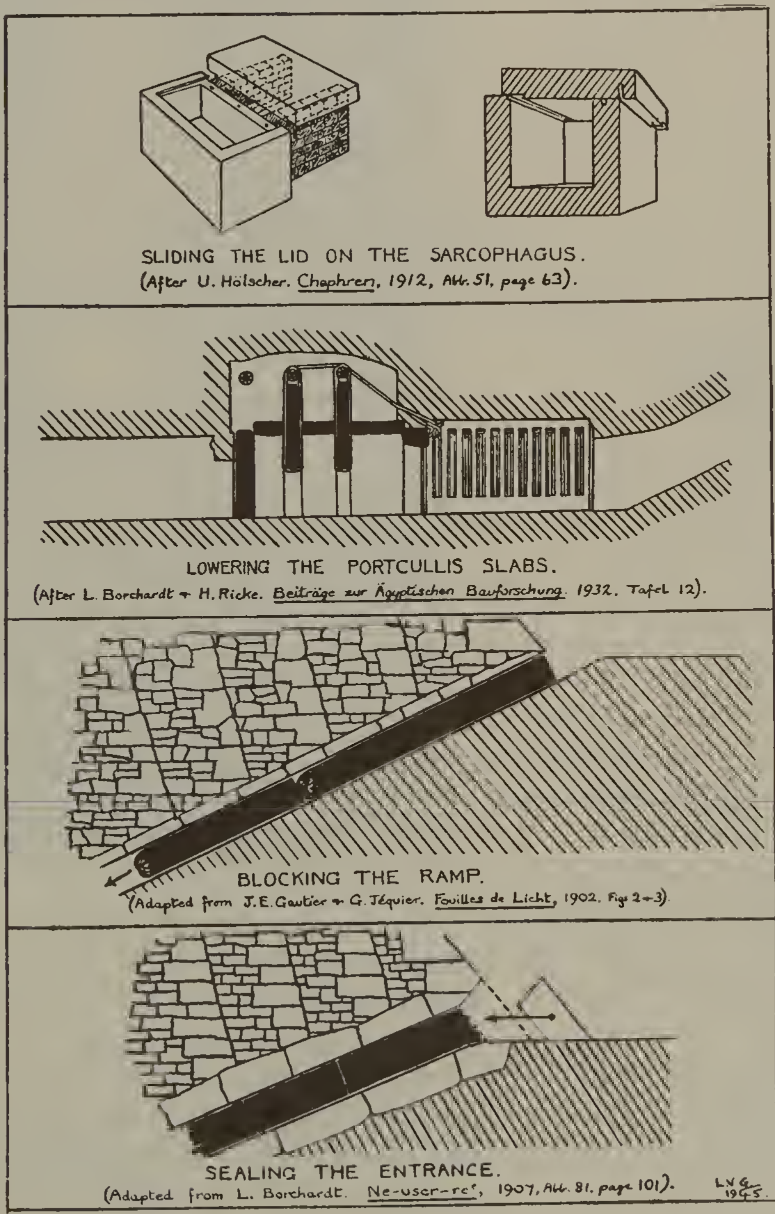
Even the "unplundered" tomb of Cheops' mother, Hetepheres, found in 1925 by the Harvard-Boston Expedition at the bottom of an 85-foot-deep shaft filled with rubble, appeared untouched in 5000 years: yet the sarcophagus was empty and is presumed to have been so placed within the "burial" chamber.

According to the Egyptologists, who include such eminent figures as Petrie and Borchardt, once the body of a Pharaoh had been laid to rest in the Great Pyramid and the burial party had made its exit, the three huge granite blocks, plus several limestone ones, were allowed to slide down the incline between the ramps of the Grand Gallery till they had completely plugged the Ascending Passage.

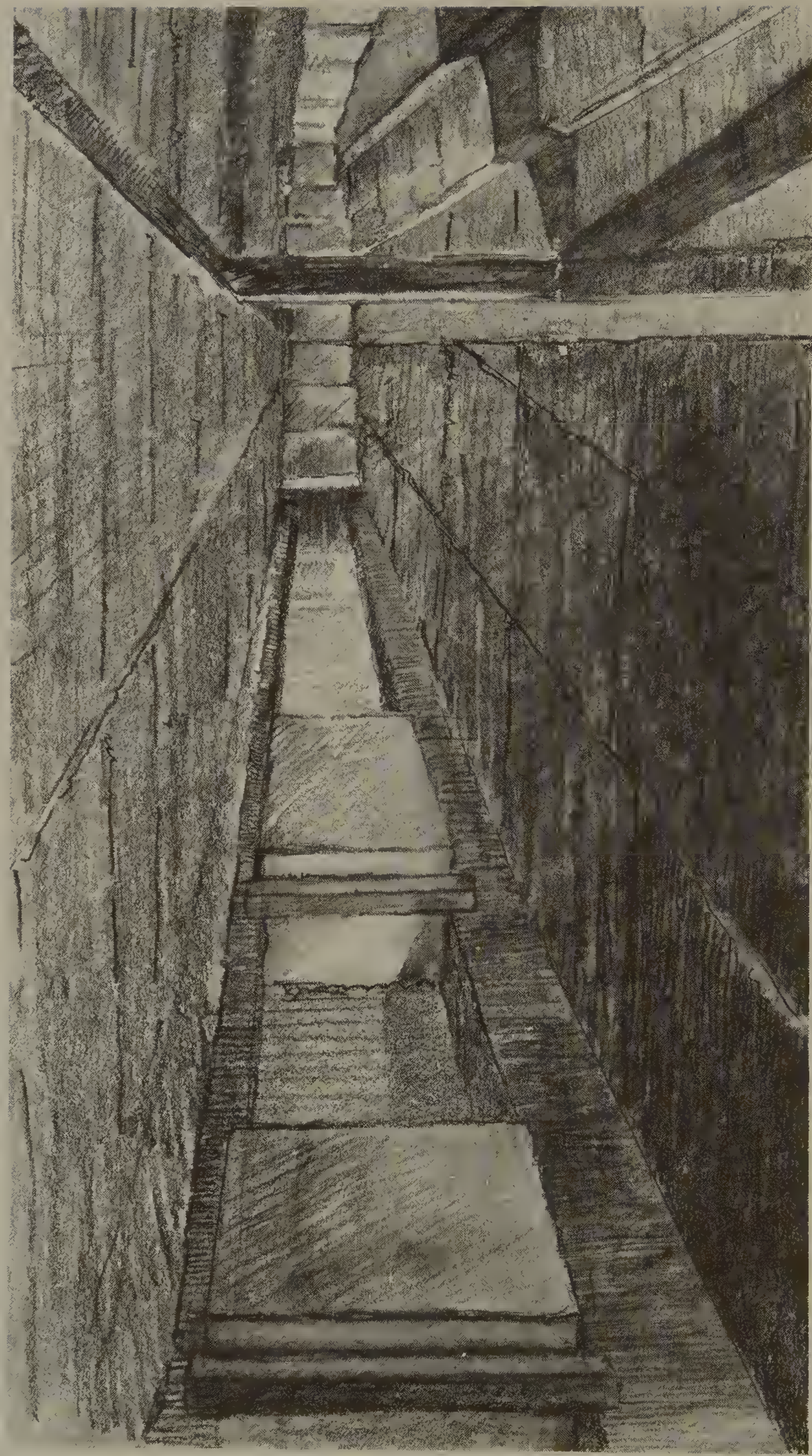
Whether the tripping mechanism could have been operated by remote control from a safe distance below the plugged entrance, or whether the technicians responsible for the tripping device were immured for life, or whether they managed to make their escape down what is known as the "well" are theories supported in different degrees by different Egyptologists.



Method of plugging the Ascending Passage as visualized by Cottrell from the ideas of Borchardt and Wheeler.



Ideas of various Egyptologists of the methods of plugging passages, lowering portcullises and sealing sarcophagi.

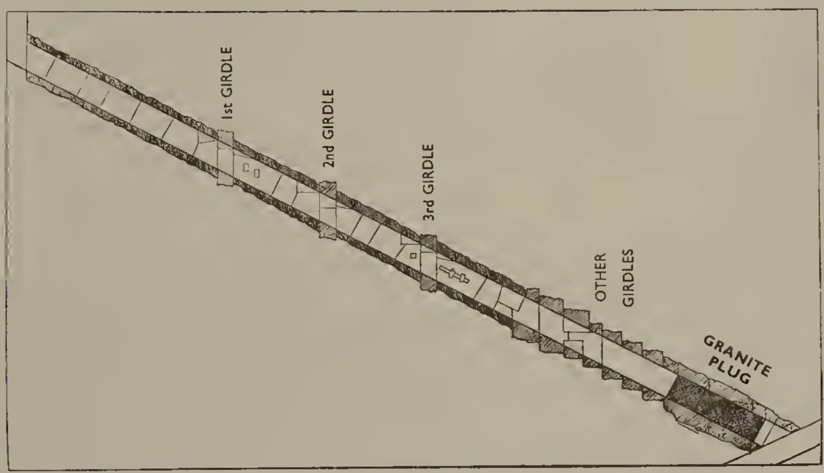


Modern illustration of the granite plugs in the Grand Gallery.

To account for the three granite plugs and the peculiar arrangement of the Pyramid's passages and chambers, Borchardt put forward the theory that the builders started with one plan, but kept changing it as they went along.

Borchardt believes the "original" intention was to bury the dead Pharaoh in the pit carved out of natural rock at the bottom of the Descending Passage, but that this plan was changed. For some unspecified reason, says Borchardt, it was decided to bury the king higher in the body of the Pyramid, which was already several courses high. The pit was therefore left unfinished. An Ascending Passage was carved up through the already laid courses of masonry, and continued as a new passage up to the level of the Queen's Chamber.

While making a careful study of the walls of the Ascending Passage, Borchardt observed that the stones at the lower end were laid approximately parallel with the ground, whereas nearly all those at the upper end were parallel to the gradient of the corridor. From this he deduced that the Pyramid must have already reached a level corresponding to halfway up the as yet nonexistent Ascending Passage before it was decided to use an upper chamber; at that point the Ascending Passage was dug up through the existing level courses; thereafter it was built with blocks parallel to its slope.



Arrangement of girdle stones 10 cubits apart, to tie the Ascending Passage to body of Pyramid, as drawn by Adam Rutherford, director of the Institute of Pyramidology in Great Britain.

Borchardt's theory is supported by Leonard Cottrell, author of a popular book on the pyramids, *Mountains of Pharaoh,* who suggests that when the builders switched plan they got as far as the Queen's Chamber complete with its air channels before they again changed their minds.

Cottrell says a third scheme brought with it the decision to heighten the Ascending Passage into "the magnificently corbeled Grand Gallery," extending it another 160 feet so as to build yet a third chamber, the King's, as the final resting place for the Pharaoh's body.

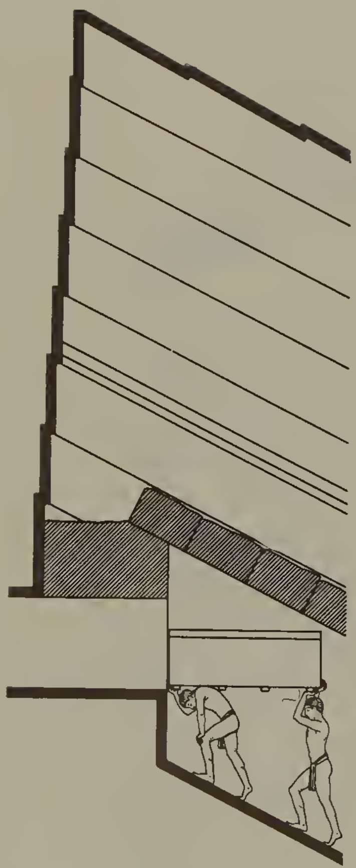
According to Cottrell, the change came about as a sort of afterthought, while the great mass of builders was already in the midst of constructing a building whose base and slopes appeared to have been worked out with such extraordinary precision.

Why the Grand Gallery should have been raised to 28 feet, when less than half that height would have been ample for the bearers and for the storage of the plugs, was not explained by Cottrell.

Borchardt and Cottrell's theory was disputed by Maragioglio and Rinaldi, who point out that the bottom of the Ascending Passage was *intentionally* cut through the lower courses simply as a means of anchoring it to the body of the Pyramid. The Italians say the lower part of the Passage was not dug out of normal masonry or with normal methods, but in masonry especially erected to anchor the end of the Passage, many of the blocks being exceptionally large, laid flat, vertical and edgewise, and of a different quality from the rest of the nucleus, with joints very thin and finely finished; whereas in other areas where the regular nucleus masonry is visible, the joints are wide and coarse.

The object, say Maragioglio and Rinaldi, was to create a bulwark at the juncture of the Ascending and Descending Passages so that the ceiling and floor of the Ascending Passage would not thrust down on the empty space of the Descending Passage. The Italians point out that several monolithic girdle stones are employed at 10-cubit intervals all the way up the Ascending Passage to reinforce its bond with the nucleus of the Pyramid, and prevent its slipping, but that no such girdle stones appear in the Descending Passage, where they are not needed because the whole passage rests against the solid rock of the Giza hill.

Borchardt produced a further refinement to his theory, which not only found few supporters, even among his fellow Egyptologists, but tended to discredit his whole approach to the problem: namely, that the granite and limestone plugs which filled the Ascending Passage could not have been stored on the Grand Gallery floor between the ramps, because they would have provided an "undignified obstacle" for the funeral train to clamber over. As the plugs were too large to be brought in or out of either the Queen's Chamber or the King's, Borchardt theorized that the blocks were raised onto a wooden platform which was fitted into the grooves which appear halfway up the walls of the Gallery.

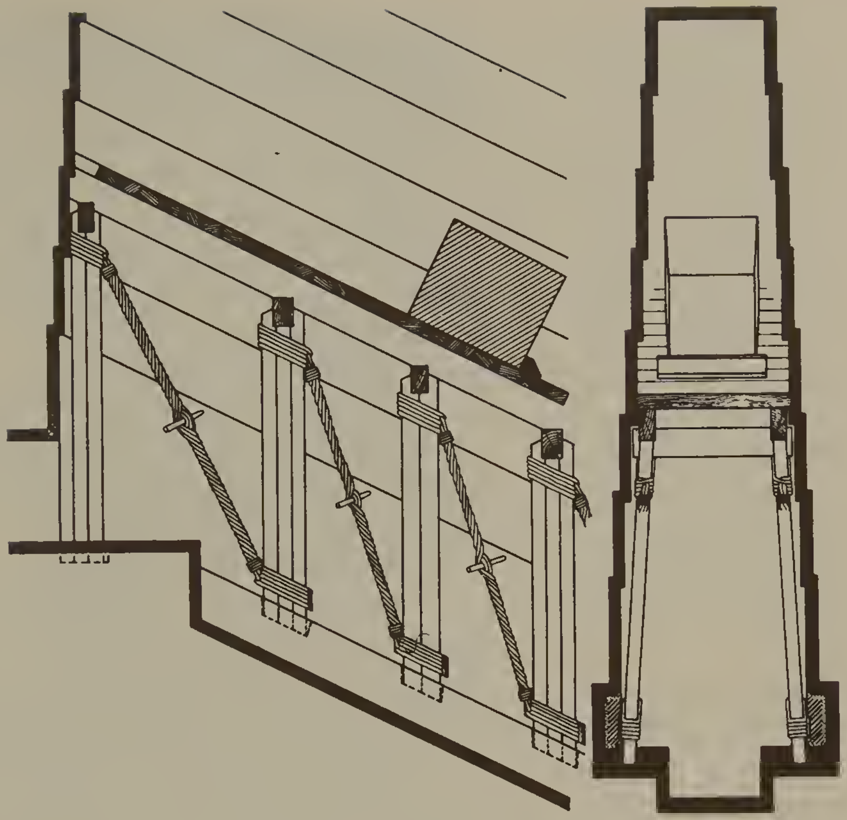


Borchardt's fanciful idea of pallbearers reaching the Great Step at the top of the Grand Gallery, with plug stones supported on a platform above them.

This would have allowed the funeral cortege to move beneath them; though how this would have been any less undignified than having to crawl up the low and narrow Ascending Passage is not explained, nor is it explained how the heavy blocks were brought down from the level of the wooden planking to the level of the pavement on which they were to slide.

That Borchardt's hypothesis is unreasonable, say Maragioglio and Rinaldi, is evident from the fact that few archeologists have paid much attention to it.

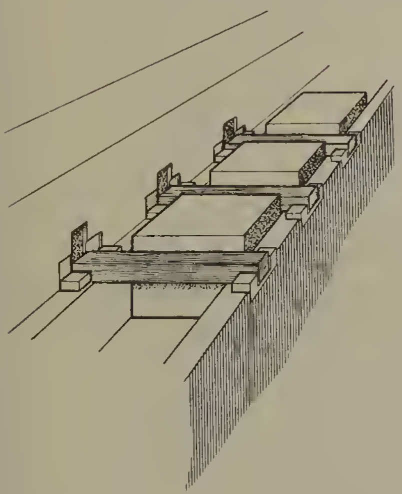
As for the method of triggering the plugs down the Ascending Passage, Cottrell believes the notches in the



Trestle believed by Borchardt to have raised plug stones to a level half the height of the Grand Gallery.

ramp of the Grand Gallery were cut to hold cross beams of wood or limestone to keep each of the massive plugs from prematurely sliding. According to Cottrell, once the funeral cortege had passed, operators standing on the ramps could have released each plug, starting with the bottom one, and allowed them to slide into the Ascending Passage, on the theory that had they all been released simultaneously the momentum and the total weight might have caused damage at the lower end.

The theory raises the question as to what became of the wooden or limestone crosspieces. Had they been made of wood they might conceivably have pulverized and completely disintegrated in the thousands of intervening years. They might also have been carried down the well by the escaping operators, though this would have been something of an ordeal, if indeed possible. The material might also have long since been disposed of by grave robbers. Still, the question is puzzling. Also, why go to all the trouble of plugging the Ascending Passage, only to leave the well shaft as a perfectly simple way for thieves to climb back up to the Grand Gallery? The lower end of the well shaft could have been cleverly concealed; but its whole length could hardly have been plugged or made impassable with fill *after* it had been used as a means of escape.



Goyon's idea of how granite and limestone plugs were held in place by crossbeams fitted into the ramps.

Part or all of the *Descending* Passage could have been plugged and the Pyramid sealed. This would have been the simplest way conclusively to close up *all* the chambers in the Pyramid, making it an almost superhuman job to chisel out 350 feet of solid limestone.

Petrie disputes the notion that the long Descending Passage could have been filled with blocks; and Maragioglio and Rinaldi suggest that traces of the dismantling of such plugs would have been left on the walls of the Descending Passage, which is not the case, with the exception of a few feet beyond the entrance.

The most sophisticated refutation of the theory holds that the Descending Passage may have been purposely left empty and the pit unfinished as a blind to lead any robber who entered by the trap door to believe that no king had been buried in the Pyramid!

As for the well shaft, Maragioglio and Rinaldi have a completely different theory about its function. They do not think it was ever designed as an escape route; they think it was built in from the early stages as a service shaft and to bring air to the lower end of the Descending Passage.

The Italians say the need which led to the building of such a shaft may have arisen shortly after the beginning of the Ascending Passage, most likely as a means of ventilating the lower shaft. They believe the diggers at the bottom of the Descending Passage had difficulty breathing. Plausible at first sight, the theory is open to two objections: as the building went up course by course, above the level of the rock base, there would have been all the air in the world; whereas digging the well shaft *below* rock level, the diggers would have been as cramped and airless digging the well shaft as digging the Descending Passage, at least until the two met at the bottom—by which time the well would no longer have served its ventilating purpose, the digging having been completed.

Such an air vent might conceivably have been useful to bring air to the pit, had the pit been used for any continuing purpose, such as observing the stars.

The Italians also believe that long before any funeral party entered the Grand Gallery, the entire well shaft was filled from the top with debris and loose material. The bottom entrance was then carefully camouflaged, and a stone was mortared into the upper end in the west ramp of the Grand Gallery to seal and hide the shaft from the top. They cite the fact that from classic times till the nineteenth century no one appears to have spotted the bottom entrance to the well shaft.

Maragioglio and Rinaldi agree with Petrie that the Pyramid was violated by thieves or grave robbers soon after it was finished, during the civil wars, which they date between 2270 and 2100 B.C. At this point the theory of the Italians becomes radical. They maintain it was these early despoilers of the Pyramid and not Al Mamun who cut a hole around the granite plugs at the end of the Ascending Passage. These thieves then worked their way up the Ascending Passage, broke through the lowered portcullis, and entered the "crypt." According to the Italians it was these or successive thieves who found the well shaft by noting a difference in the stones at the bottom of the ramp in the Grand Gallery, which they forced in order to clear out the well shaft in search of treasure. The Italians maintain that the marks in the west ramp around the missing stone appear to have been made with a chisel struck from above. They say it would also have been extremely difficult to remove the stone from below in the very restricted passage which leads to the head of the well shaft.

To explain the way the Ascending Passage was plugged, the Italians maintain the tripping mechanism could have been operated by remote control. They point out that it has recently been discovered that in the bent pyramid of Sneferu, the blocks of granite which plug the Descending Passage could *only* have been moved by gravity and not directly levered by workmen, because there *is* no escape route.

The Italians believe the plugs in the Great Pyramid were slid on liquid mortar and that its forced accumulation accounts for the 10 centimeters of empty space between the first and the second granite plug; though they offer no explanation as to what may have become of the mortar, which could hardly have volatilized in the meantime, unless it was some sort of oil and not mortar.

It is also hard to imagine how the antique grave robbers could have immediately found the exact spot halfway down the Descending Passage from which to dig up past the granite plugs if there is any truth in the story of the plug being covered by a prismatic block.

Maragioglio and Rinaldi suggest there was no such block; paradoxically they give credence to the story that Al Mamun's workers heard a heavy block fall—simply because Al Mamun's passage takes a sudden turn to the east in order to break into the Descending Passage.

Another theory which attempts to account for what could have taken place in the plugging of the Pyramid was produced in 1963 by August Mencken, the engineer from Baltimore who has so little regard for the scientific knowledge of the ancient Egyptians. According to Mencken's somewhat farfetched reconstruction of events, when the Great Pyramid had been built up above the ridge of the roof of the King's Chamber, and work was still going on in the Grand Gallery and in the Antechamber, the structure was suddenly shaken by a severe earthquake. It was then, says Mencken, that the ceiling beams of the King's Chamber were cracked, the fissures opened, and, "to the terror of the builders, the triggering device which held the plugs on the floor of the Grand Gallery was sprung and the blocks slid down the Ascending Passage, blocking all exit from the Pyramid."

According to Mencken, the men inside were trapped, but their plight was not desperate. "As soon as the fright and confusion caused by the earthquake had subsided, the men on the outside discovered what had happened to the men on the inside and opened communication with them through the air ducts leading out from the King's Chamber. By the same ducts the trapped men were supplied with food and water."

Mencken figures that to have chipped out the three granite plugs in the restricted space of the Ascending Passage was out of the question, and that to have tunneled around them would have caused irreparable damage to the passageways. Rather than chip out the granite blocks, the Egyptians, says Mencken, decided to dig the well up from the bottom of the Descending Passage all the way to the end of the Grand Gallery.

The trapped men, says Mencken, were informed of what was being done, "and by the time the tunnel reached the opening in the Gallery they had removed the ramp stone." According to this theory an inspection crew was sent to ascertain the damage and examine the King's Chamber ceiling; for this purpose the small tunnel, later known as Davison's, was dug straight through the lowest of the cushioning chambers.

The plugging of the Ascending Passage, says Mencken, put an abrupt stop to all other interior work and made it impossible for the King's Chamber to be used for a burial, either real or token. "So everything above the plug blocks was abandoned and thus ended the first and only attempt of the ancient Egyptians to build elevated chambers."

In criticism of Mencken's theory it may be asked why, if the building had been constructed to just beyond the peak of the King's Chamber, would it not have been easier to remove several blocks from the upper tiers in order to reach the trapped men rather than go through the trouble of boring hundreds of feet up the whole length of the well? Also, if the builders had no further use for the interior of the building, why go to the effort of finishing off the Pyramid and casing it with 22 acres of finely polished limestone?

An entirely different solution to the problem is provided by David Davidson, the structural engineer from Leeds. According to Davidson, the depth and width of the granite plugs which seal the lower end of the Ascending Passage clearly indicate that the plugs must have been built into the passage *at the time the Pyramid masonry had reached the height of the plugs, or 17 courses.*

Davidson, who spent several months in Egypt studying the Pyramid closely, says the half-inch clearance at the sides of the top of the Ascending Passage would *not* be sufficient to insure the granite plugs being slid from the Grand Gallery without jamming.

This raises the question as to why the builders would have bothered to even build the Ascending Passage if they intended to plug it up immediately with three large granite plugs.

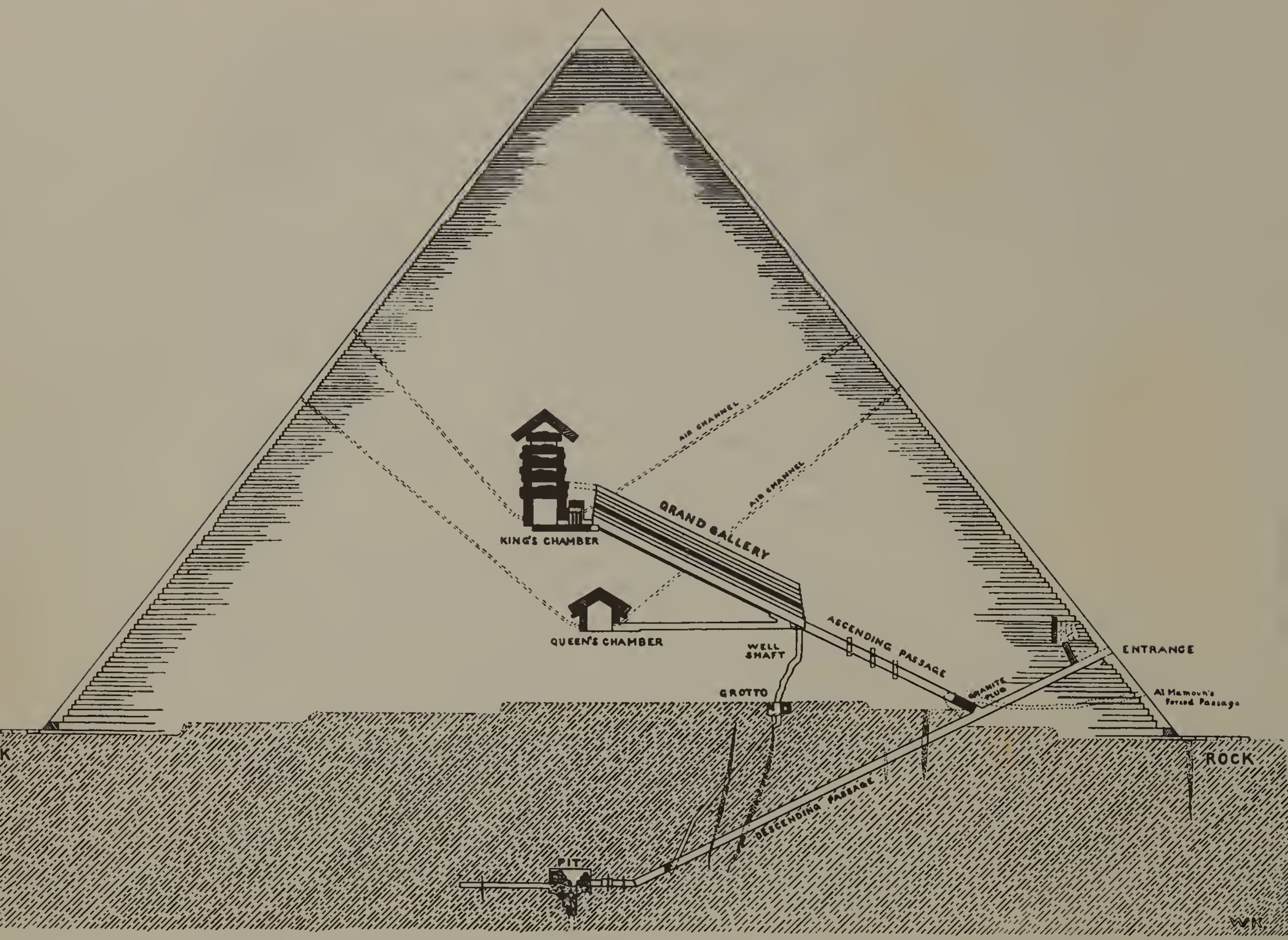
Davidson answers that the inside of the Pyramid was not designed for contemporary use, but was intended to be discovered by people of a much later civilization, rather like our modern time capsules, and that the discoverers would have to break their way in through the series of limestone plugs, much as Al Mamun is reputed to have done.

This raises the question of the presence of the well shaft, which could have led any intrepid explorer straight to the Grand Gallery, bypassing the Ascending Passage. Davidson answers that the well was an afterthought, not planned in the beginning as an escape route after a burial, if for no other reason than because the Pyramid was never intended as a tomb.

Davidson has an ingenious reconstruction of what may have occurred. He maintains that some time not long after the completion of the Pyramid, an earthquake or several disasters severely shook the building. After the disaster the priests or guardians of the Pyramid noted certain subsidence effects on the external surface of the structure, and they decided they must investigate the interior to see if the King's Chamber had collapsed or been badly damaged.

Davidson says this must have happened within a few generations of the completion of the construction, and before precise details and measurements of the internal construction had been lost.

The keepers, says Davidson, entered the Descending Passage and instead of trying to carve their way up through a score or more of limestone plugs in the Ascending Passage, as was later to be done by Al Mamun, they went nearly to the bottom of the Descending Passage and then began to bore a hole upward toward the beginning of the Grand Gallery.



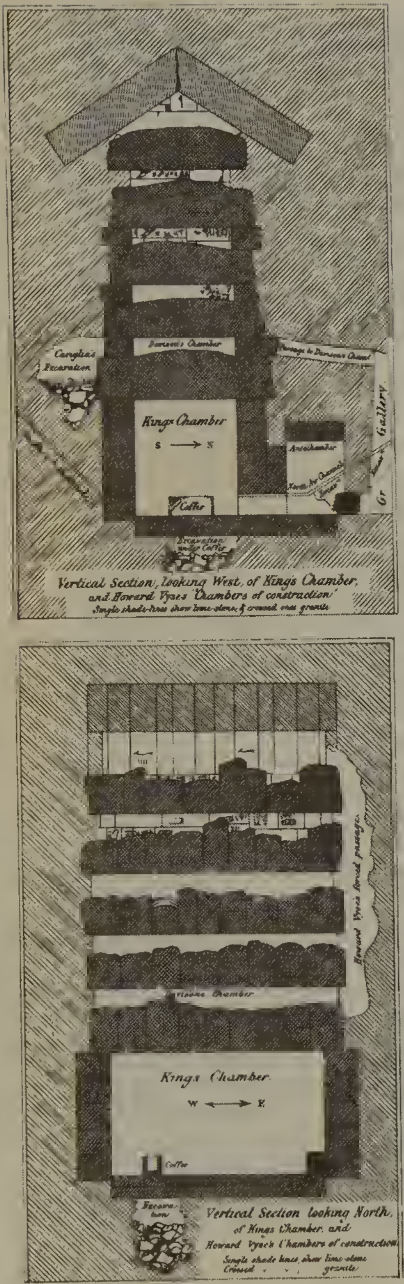
Davidson's rendition of the Great Pyramid passages, showing three large fissures in the natural rock.

Their reason for starting so far down, says Davidson, instead of taking a shorter route past the plugged Ascending Passage, was to cut their way through, and carefully observe, two large fissures that had appeared in the bedrock. A third fissure, present at the time of construction, had already been shored up by the builders.

The problem of the priests, says Davidson, was to determine if the fissuring was severe enough to cause further subsidence.

Digging in a gradual upward slope, says Davidson, the keepers worked their way through both fissures, finding them in not as bad condition as they had expected. At the level of the Grotto the keepers made a staging area for tools, for rest, and for the bypassing of workers and material.

From the Grotto they continued their shaft up toward the commencement of the Grand Gallery. Having somehow made an accurate survey of exactly where they were, they



Davidson's rendering of the way the chambers in the Pyramid are aligned just east of the main east-west axis.

then bored straight up and came out beneath the lowest ramp stone on the west side of the Gallery. To Davidson it is clear from the fractured appearance of the ramp around the well entrance that the stone was forced upward and outward.

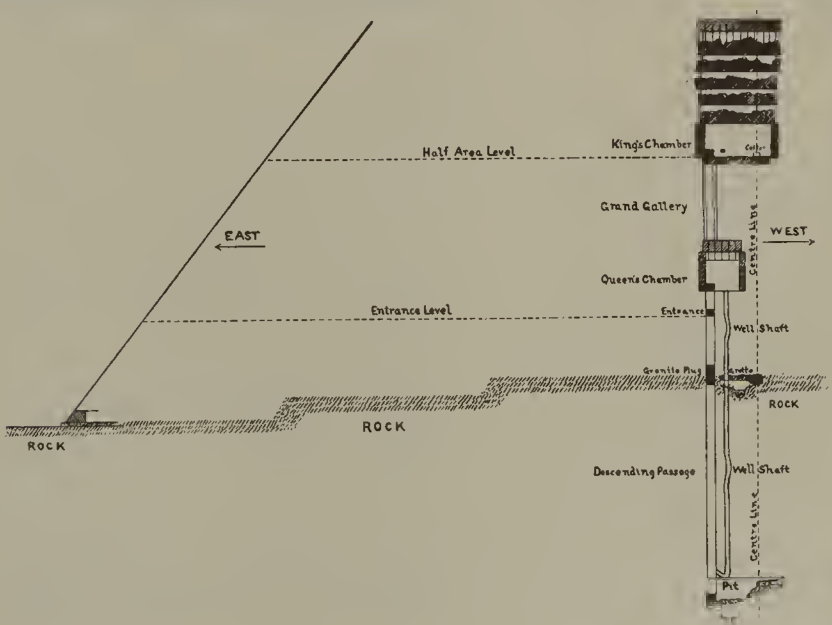
To accomplish such a feat of accurate digging would have meant knowing the precise internal arrangement and measurements of the Pyramid. Anyone boring blindly could have missed the few feet of Grand Gallery and been obliged to bore several hundred more feet through the limestone courses before coming out into daylight. This goes a long way toward discounting the possibility of the well shaft having been dug by either thieves or explorers.

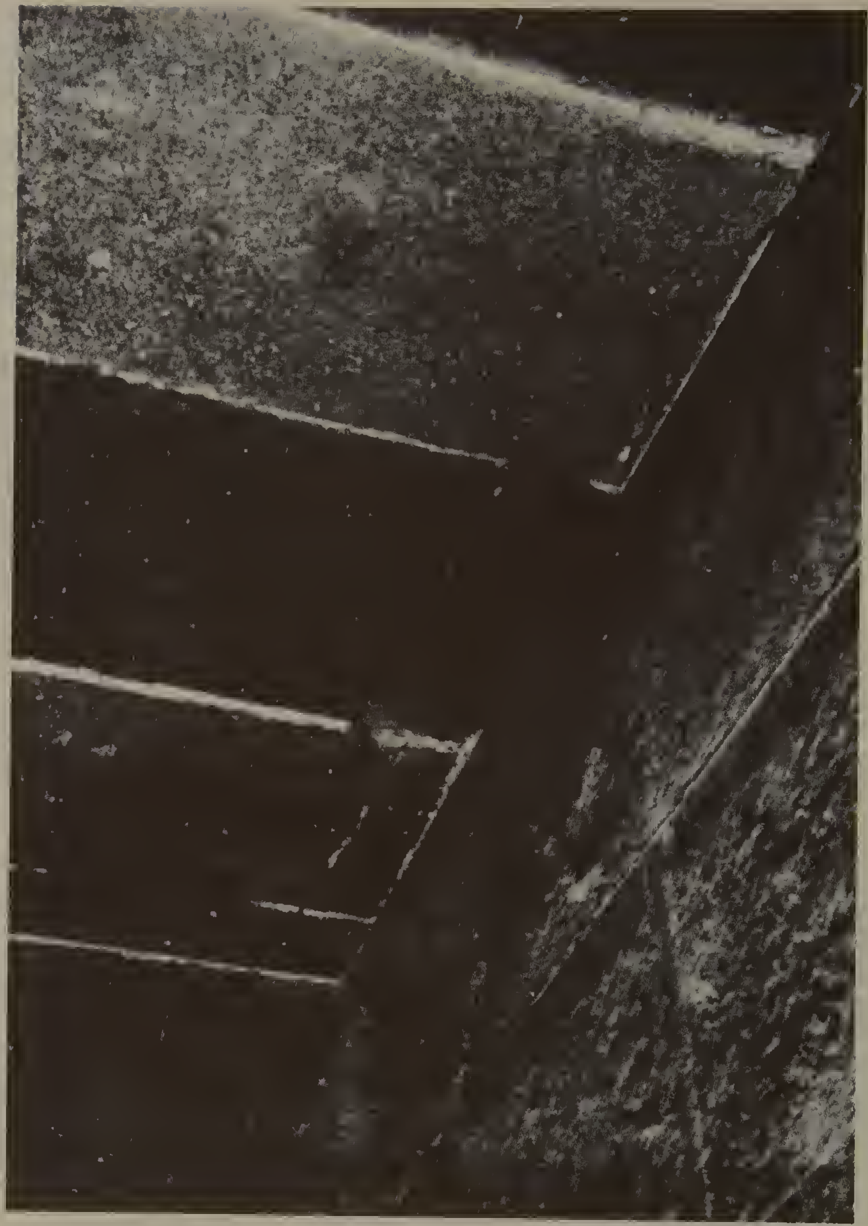
Once they had reached the Grand Gallery, says Davidson, the keepers dismantled the lower section of the Gallery floor for a dozen or so feet and uncovered the passage to the Queen's Chamber. This they inspected carefully, but found little or no sign of failure.

Proceeding to the King's Chamber, the keepers found indications of possible instability due to the movement. Inside the chamber they found the ceiling beams uniformly cracked along the south ends.

According to Davidson, it was then that the keepers smeared the fractures and open joints with cement and plaster. Petrie was later to report that he had found cement daubed on with fingers for about 5 feet on each side of the joints.

When Petrie carefully examined the King's Chamber he discovered that it had been badly shaken, probably by an earthquake, which caused the whole room to expand





Cracks in granite beams at the south end of the King's Chamber.

an inch or so. Every single beam had been wrenched more or less loose from the south end, and cracked through; the whole ceiling, weighing some 4000 tons, was held up solely by "sticking and thrusting." As Petrie summed up the situation, the downfall of the King's Chamber "is a mere question of time and earthquakes." What has saved it so far was not being bonded to the main structure.

Davidson says the five construction chambers were especially designed to take a considerable impact. Instead of resting the uppermost beams on a hard granite wall, the builders rested them on limestone, which could more easily crush and flow in case of subsidence, taking the strain off the lower rows of rafters and keeping the walls of the King's Chamber intact. Davidson says that a more rigid design, uniform from the lowest to the highest chamber, would have been disastrous.

To permit this buffer effect being fully developed, the rafters of the chambers were not tied into the east and west walls. Instead, two immense limestone walls, wholly outside of, and independent of all the granite floors and supporting blocks, were built on the east and west sides. As Petrie put it: "Between these great walls all the chambers stand, unbonded and capable of yielding freely to settlement."

To gain access to these important construction chambers above the King's Chamber, the keepers, says Davidson, next drove an opening into the east wall of the Gallery, starting at its upper, or south, end.

In support of the theory that this hole was bored by keepers who were precisely acquainted with the layout of the Pyramid (rather than by later explorers or thieves), Davidson points out that the hole is bored in exactly the right place, and takes off at the precise angle and direction to reach the lowest of the upper chambers.

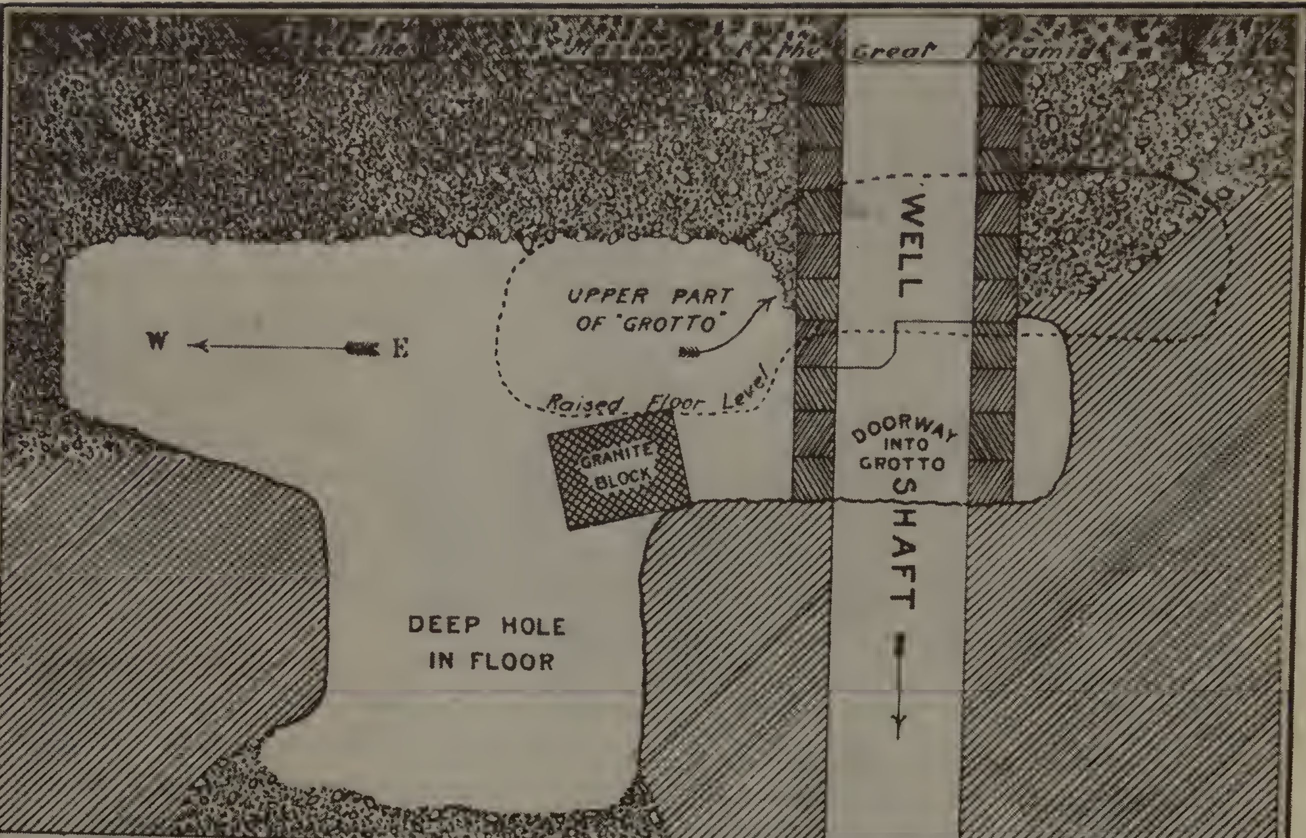
Once inside the first chamber (later to become known as Davison's), the Pyramid keepers, says Davidson, found that the indications of instability were not so serious as they had feared. The great granite beams were indeed cracked, but the damage did not seem to be enough to cause any further crumbling or subsidence, nor warrant their boring any higher into the overlaying chambers. Instead, the keepers again daubed the cracks with plaster so as to be able to return at a later date and observe if any further movement had taken place.

According to Davidson, the keepers then climbed back down the well, the bottom end of which they camouflaged, and left by the swivel-stone entrance on the north face.

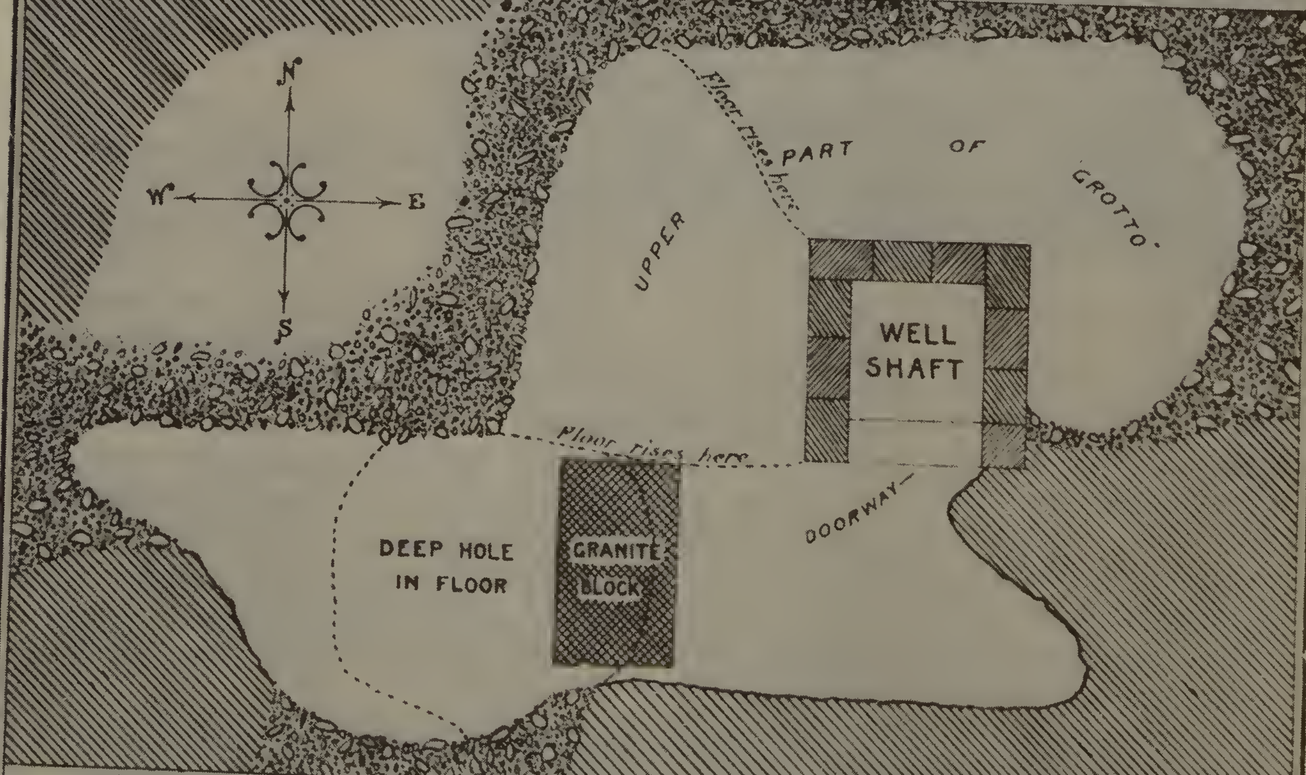
There is nothing inherently illogical about this version of events. It would have been no easy job to tunnel upward through the solid rock and the various courses of masonry—altogether hundreds of tons of material would have had to be chipped away and taken out of the Pyramid up the Descending Passage—but it would not have been impossible.

It would also have been a problem to get light and air to the men doing the chiseling, and it would have been tricky to raise a platform or system of suspension while chiseling upward; also it would have been a nuisance to have the fragments fall constantly in the face of the chiselers and those below them; but all of this would not have been impossible.

What militates against this theory is the observation of Maragioglio and Rinaldi that the walls of the well shaft upward from the Grotto are built and lined with regular blocks of limestone, apparently as a feature of the original structure.



VERTICAL SECTION *(From East to West, looking North)* OF THE "GROTTO"
SHOWING THE WELL-SHAFT BUILT THROUGH WITH TEN COURSES OF LIMESTONE BLOCKS;
ALSO THE MYSTERIOUS DRILL-HOLED GRANITE BLOCK WEDGED AT THE EDGE OF THE DEEP HOLE IN THE FLOOR.



GROUND PLAN OF THE "GROTTO" IN THE **GREAT PYRAMID OF GIZEH**
SHOWING THE POSITION OF THE WELL SHAFT, THE GRANITE BLOCK, AND THE DEEP HOLE IN THE FLOOR
SINGLE SHADED LINES INDICATE NATURAL ROCK.

Grotto showing walls of the well shaft built out of masonry from the level of the Grotto to the first course of masonry of the Pyramid.

Conceivably these walls could have been lined by the keepers, operating from the Grotto, perhaps to insure a stable surface in this final section of the shaft.

Clear indications that it was *not* designed from the beginning were found by Petrie in the fact that the shaft is irregular and tortuous through the rest of the masonry, and that blocks with sharp corners were left in an irregularly curved shaft.

A French professor of architecture, J. Bruchet, who went to the spot to verify and measure, and who published an illustrated book on the subject in Aix-en-Provence in 1966, agrees with Davidson that the granite plugs could not have been slid down the Ascending Passage; he believes they were put in place at the moment of construction, when the Pyramid was still a truncated body. To have slid them down, with so little clearance, says Bruchet, would have required walls as smooth as glass, whereas he found the walls of the corridor roughly finished.

But Bruchet disagrees with Davidson that the well shaft could have been dug from the bottom up, giving as his reason the fact that the bottom of the well shaft goes slightly below the level of the Descending Passage. Bruchet believes that this would not be so if the shaft had been started from below.

For the well shaft to have been dug from above, the operation could only have been completed *before* the Ascending Passage was plugged, or *after* the opening of "Al

Mamun's hole." In a closed upper Pyramid there would have been no place to store the carloads of rubble from the digging of the well shaft: the King's and Queen's chambers would not have been sufficient, and storage in the sloping Grand Gallery would have required crosspieces and sacks.

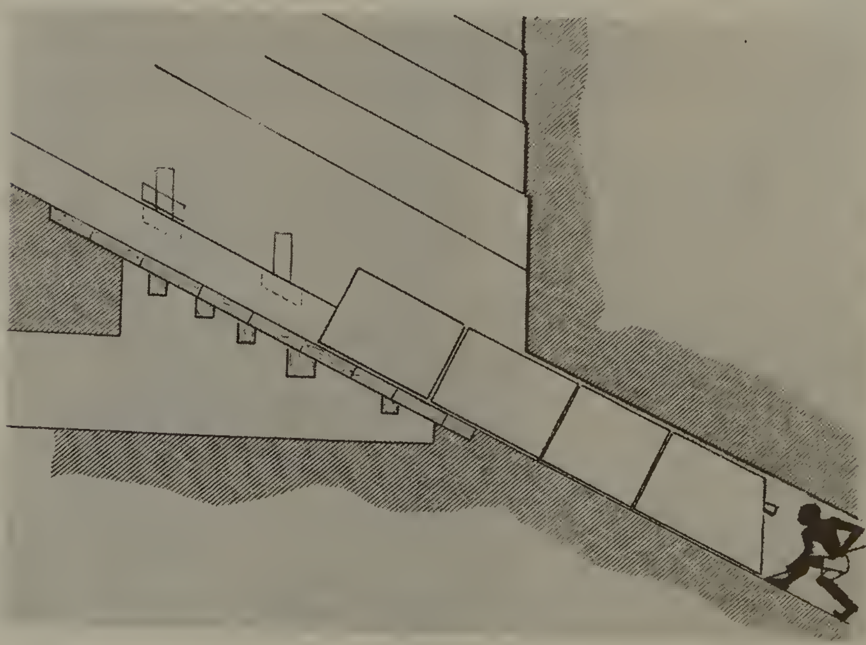
Bruchet points out that the well shaft could not have been dug *after* Al Mamun, because the lower end of the Descending Passage was filled by him with the refuse of broken limestone plugs, which were not cleared out till 1817 by Caviglia. Also, says Bruchet, there are no graffiti to indicate the presence of visitors in the lower passage after the date of the Hegira.

Another Frenchman, Georges Goyon, who collected reproductions of all the graffiti on the Pyramid, which he put into a book dedicated to King Farouk, also does not accept the idea that the service shaft was used as an escape way. He too believes the Pyramid was violated a short time after it was built, and that "Al Mamun's hole" was made at this early period. He even goes so far as to suggest that the first violators entered by the tunnel now attributed to Al Mamun, and that Al Mamun's violation was made *after* the ablation of the Pyramid casing, which is in strict contradiction with the historical record.

Maragioglio and Rinaldi find some of Goyon's theories tenable, but are awaiting the publication of a booklet by Goyon in which he promises to add further material on the subject.

In a recent article in *Revue Archéologique,* entirely devoted to the mechanism of the closing of the Great Pyramid, Goyon suggests that one or two men alone could have manipulated the whole train of blocks down the Ascending

Goyon's view of how a single man could have eased a train of granite plugs down the Ascending Passage with the help of unguents and wooden wedges.



Passage by simply sliding them on clay mixed with cows' milk for greater viscosity, controlling the downward motion by means of wooden wedges on either side of the first block.

Goyon says there are indications on the lowest granite block of two slots 7 centimeters wide intended for wedges.

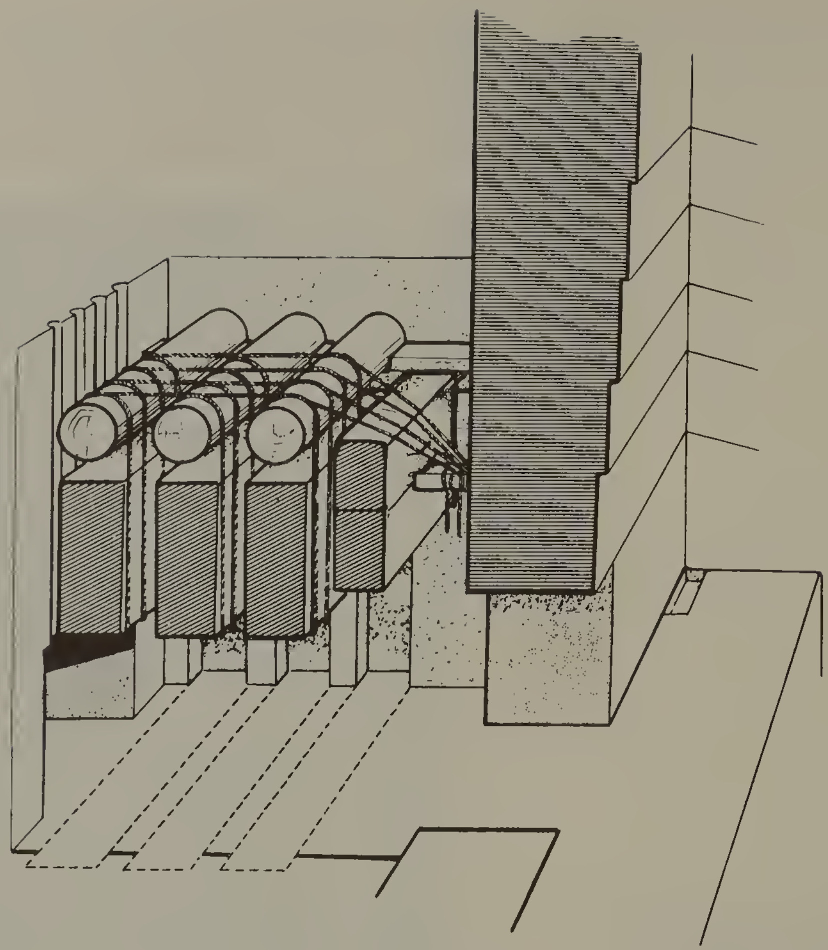
Goyon's arrows indicate slots in the granite plug for the insertion of wedges to control its downward movement.

Goyon disputes the point made much of by Davidson that the purely stylized portcullis outside the King's Chamber indicates it was never used to seal an actual tomb.

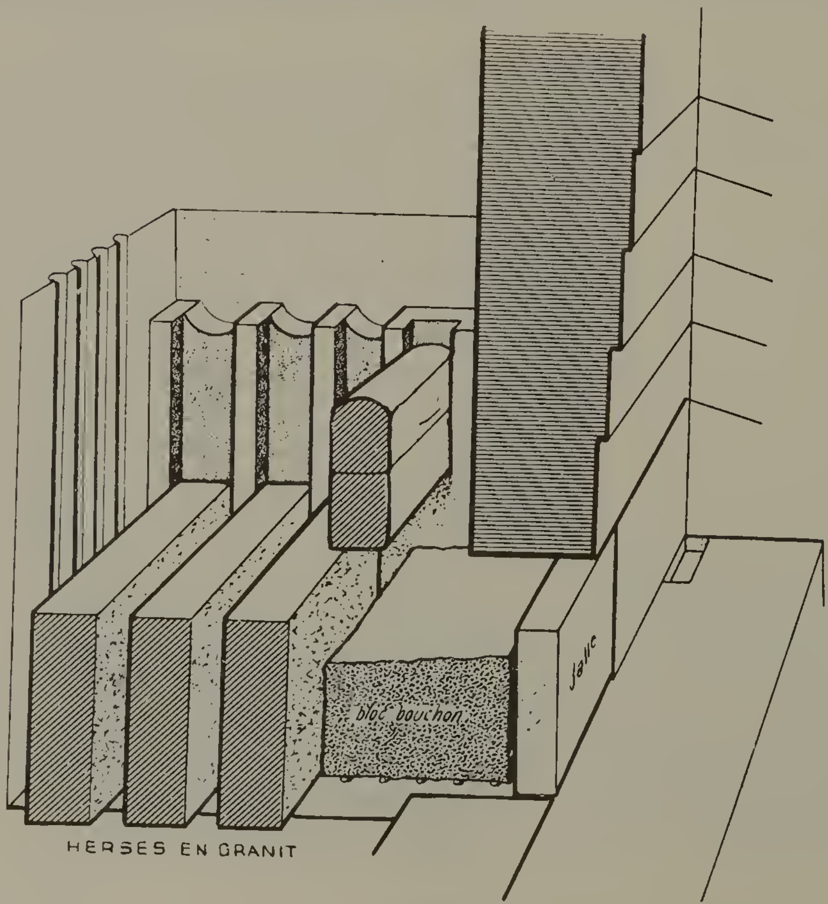
Goyon believes that the granite slabs—long since removed by grave robbers—could have been lowered in the appropriate side slots by ropes run on wooden rollers, and that the four vertical slots carved in the face of the portcullis were intended to allow free play for the ropes.

In the final analysis, the theory which stands up best, and is not in conflict with Davidson's findings, is that of the astronomers Proctor and Antoniadi, which is supported by Kingsland and John and Morton Edgar, that the truncated Pyramid served as a stellar observatory by means of which the ancient Egyptian priests were able to make accurate maps and tables of the visible stars from which to create their entire science of astronomy, geography and geodesy. Once they had obtained what they needed for their astronomical and astrological predictions (and for the secrets of surveying and map making), they may have decided to wall up their instrument so that no one else could know how their lore was obtained.

Borchardt's idea of how ropes around wooden rollers could have been used to lower the granite slabs of the portcullis.



Goyon's rendition of granite blocks plugging passage to the King's Chamber.



It would then have made sense to place the granite and limestone plugs in the Ascending Passage while the top of the Grand Gallery was still open to the level of the King's Chamber. To satisfy this theory, the well shaft could have been carved upward, as suggested by Davidson, or it could have been built in earlier to serve the builders for a variety of reasons, including to serve as a means of coming and going to the pit while the Descending Passage was blocked by a reflecting pool. In any case, the shaft could have been comfortably filled from the top before the builders finished off the building to its apex to serve as a sundial and almanac.

Donald Kingsbury, a professor of mathematics at McGill University, suggests that the well could have been used for observing the passage of stars at the zenith above the Pyramid. There are two vertical sections of the well which could have served this purpose admirably and at different moments in the construction. There is a short vertical passage dug into the plateau which is served by the Grotto and linked to the Descending Passage so that signals could have been freely passed between polar and zenith observers. Another vertical section leads from the bottom of the Grand Gallery and could have been used for zenith observation in conjunction with the Ascending Passage looking south and reflecting north. Kingsbury points out that with two such wells a short distance apart the circumference of the earth could have been computed by observing the passage of a zenith star.

Duncan Macnaughton in *A Scheme of Egyptian Chronology* subscribes to the slightly different theory that ancient scientists used the truncated Pyramid as an observatory, but that a later generation finished it off as a tomb for some Pharaoh.

The custom of burying distinguished citizens in national monuments that were not originally designed for that purpose is common to the world, as in Westminster Abbey, the Invalides, the Pantheon, and Maes-Howe.

Then there is the idea that the sarcophagus was never an actual tomb, but "an open tomb" symbolic of the resurrection, and of a reawakening of the dormant spirit of the great initiates.

XX. TEMPLE OF SECRET INITIATION

Several authors have expressed the opinion that there is a close connection between the Great Pyramid and what are known as the Egyptian mysteries, that is to say, the secret knowledge possessed by a hierarchy of initiates which was communicated to those who could prove their worthiness by passing a long period of probationary training and severe trials, the sort of system that was perpetuated or debased by such societies as the Templars, the Rosicrucians, and the Masons.

In due course the initiates are said to have been shown the great laws and principles of the cosmos and of man's relation thereto, which could not be explained to the more or less ignorant, "who could not rise above the level of a crude realism which takes things to be what they *seem.*"

The Egyptian temple order is described by modern Free Masons as a gradual process of initiation and admission, in which the Great Pyramid was probably used for the initiation of the highest degree, or the three highest degrees in the order.

Throughout the graduated admission, which is said by Masonic writers to have lasted twenty-two years, the prospective initiate was taught the various sciences, of which geometry and numbers were among the most important. "In this context," says Tons Brunés, author of *The Secrets of Ancient Geometry,* "it is not surprising that they should have worked this knowledge into the structure of the initiation temple."

Knowledge of the astronomical cycles and their application also formed part of the ancient initiatory teaching. In those days, says William Kingsland, astronomy was not the mere science of the mechanism of the heavens, but was intimately connected with astrology, "a profoundly esoteric science connected with the great cycles of man's evolution, understood only by the Adepts."

Kingsland adds that if the Great Pyramid was built by initiates for initiates, "What could be more likely than that some of the deeper forces of nature were used in its construction, and that these would—did we but know of them—solve the problems of construction which still remain an enigma to us."

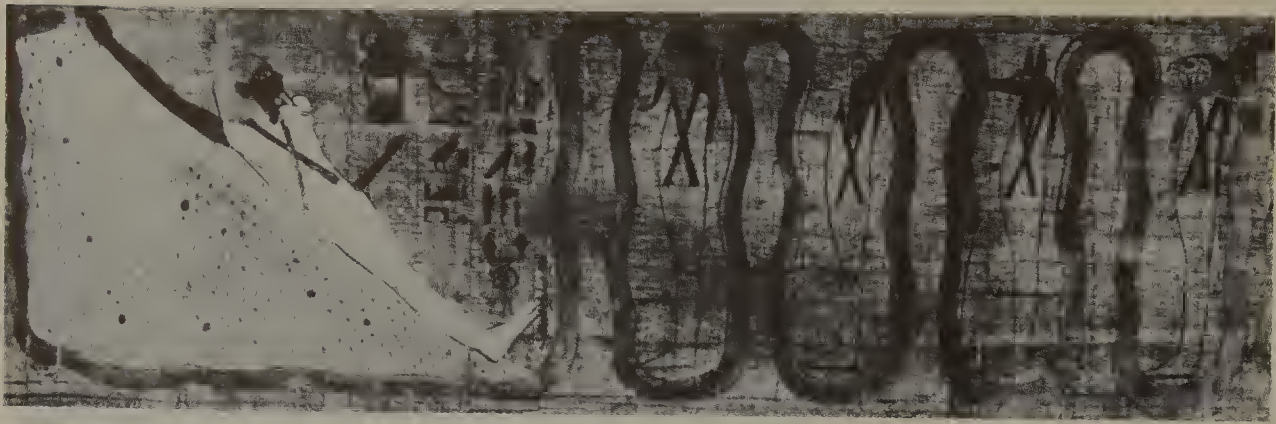
The theosophist H. P. Blavatsky in *The Secret Doctrine* says the Pyramid not only indicated the courses of the

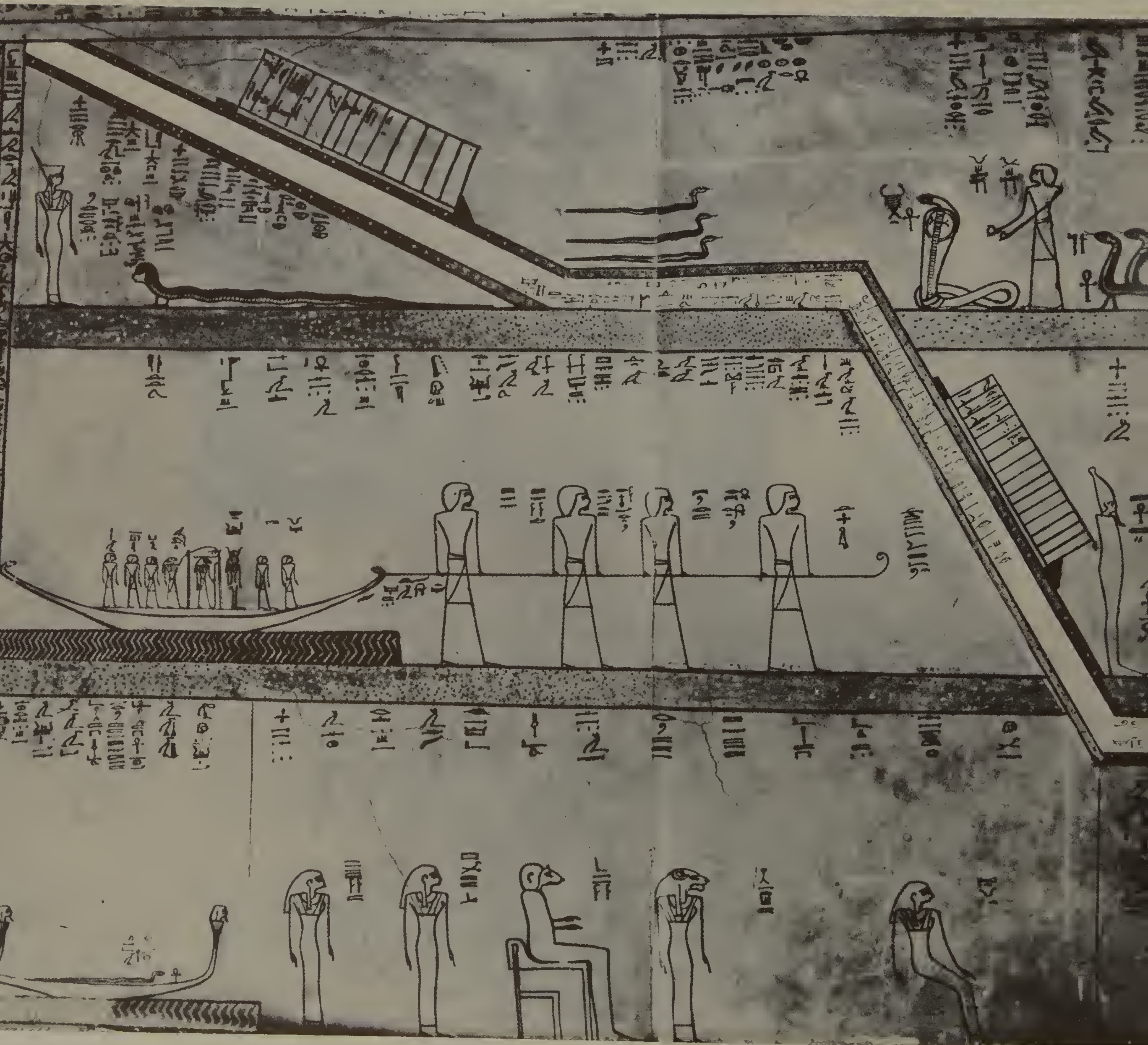
According to Manly P. Hall, the illumined of antiquity passed through the mystic passageways and chambers of the Great Pyramid, entering its portal as men and coming forth as gods.

"The candidate," says Hall, "was laid in the great stone coffin, and for three days his spirit—freed from its mortal coil—wandered at the gateways of eternity. His *Ka*, as a bird, flew through the spiritual spheres of space. He discovered that all the universe was life, all the universe was progress, all the universe was eternal growth. Realizing that his body was a house which he could slip out of and return to without death, he achieved actual immortality. At the end of three days he returned to himself again, and having thus personally and actually experienced the great mystery, he was indeed an Initiate—one who beheld and one to whom religion had fulfilled her duty bringing him to the light of God."

stars in heaven but was "the everlasting record and the indestructible symbol of the Mysteries and Initiations on Earth." In *Isis Unveiled* Madame Blavatsky elaborated, saying that whereas externally the Pyramid "symbolized the creative principle of Nature, and illustrated also the principles of geometry, mathematics, astronomy and astrology," within the building itself was the site of the mysteries of initiation—"a temple of initiation where men rose towards the Gods and the Gods descended towards men." To Blavatsky the coffer was "a baptismal font upon emerging from which the neophyte was born again and became an adept."

Brunés says that during the ceremony of initiation, the candidate was placed by the temple leader in a deathlike trance symbolizing death itself. On awakening from this condition, "having wandered in the world of the gods," he was regarded as having been reborn.





Blavatsky describes the ancient rite: "The initiated adept, who had successfully passed through all the trials, was attached, not nailed, but simply tied on a couch in the form of Tau . . . and plunged into a deep sleep (the 'Sleep of Siloam'). He was allowed to remain in this state for three days and three nights, during which time his Spiritual Ego was said to confabulate with the 'gods,' descend into Hades, Amenti, or Patala (according to the country) and do works of charity to the invisible beings, whether souls of men or Elemental Spirits; his body remaining all the time in a temple crypt or subterranean cave. In Egypt it was placed in the Sarcophagus in the King's Chamber of the Pyramid of Cheops, and carried during the night of the approaching third day to the entrance of a gallery where at a certain hour the beams of the rising Sun struck full on the face of the entranced candidate, who awoke to be initiated by Osiris, the Thoth and God of Wisdom."

For such a rite to have been possible, either the Pyramid must still have been truncated, or it contains secret passages at present undiscovered.

Most of the ancient philosophers and great religious teachers, including Moses and St. Paul, acknowledged or are acknowledged to have derived their wisdom from the Egyptian initiates. Individuals who admitted or hinted they were initiates include Sophocles, Solon, Plato, Cicero, Heraclitus, Pindar and Pythagoras.

Some of the ceremonies of what are sometimes referred to as the lesser mysteries have survived in a more or less degraded and merely formal manner in the ritual of Masonry and of the Christian churches. Kingsland believes the secret of the Pyramid is even known to present-day initiates, but is probably "one of those matters which they do not see fit to disclose to the world at large."

According to Norman Frederick de Clifford, author of *Egypt, the Cradle of Ancient Masonry,* ancient Masonry had its origin long centuries before the dawn of authentic history; he claims the ancient brotherhood "possessed a far greater knowledge of mechanical arts and sciences than is known to architects of the present day."

Several authors, including W. Marshal Adams, believe the Pyramid represented in monumental form the doctrine which *The Book of the Dead* sets forth in script, containing in an allegorical and symbolic manner the secret wisdom of the initiates, or the laws which govern and direct the universe, enabling the initiate to know "how he came into being in the beginning."

The Book of the Dead is the title generally given to a collection of Egyptian inscriptions and papyri found in tombs

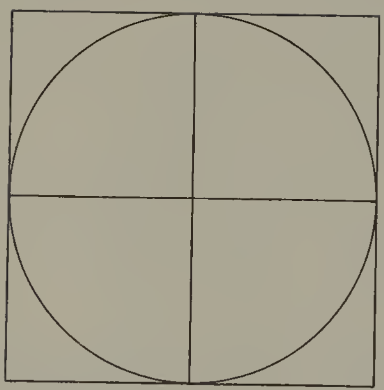
These illustrations from Albert Champdor's *The Book of the Dead* show a mummy with phallus erect sliding into the Seventh Region of the Lower World, described as being "filled with serpent's coils and the four sons of Horus who protect the viscera of the dead." This Twenty-first Dynasty drawing has lost the precise φ proportions of the earlier renditions of the same subject shown in earlier illustrations.

or in mummy wrappings. Sir E. A. Wallis Budge translated it as *The Book of the Mistress of the Hidden Temple*. One late text found with a mummy was on a papyrus roll 20 meters long divided into 165 chapters. It is now in the Turin Museum.

The ancient Egyptians attributed *The Book of the Dead* to Thoth, Lord of Wisdom, and recorder of the deeds of men, which were produced when the soul came to judgment.

Egyptologists in general label it a collection of funerary and ritual texts of different periods in different forms, used by ancient Egyptian priests in their burial ceremonies. But Henri Furville in his *La Science Secrète* claims that the texts of *The Book of the Dead* are incomprehensible to those who never made a careful study of them from the point of view of psychic science. The obscure texts, says Furville, "shine in the light of initiation, and the practices which seem extraordinary and even absurd to the profane, are, on the contrary, the result of the most profound science."

The problem of translating hermetic language from hieroglyphs is highlighted by Giorgio de Santillana when he points out that in the Erman-Grapow Egyptian dictionaries there are thirty-seven terms for "heaven." As a result, says Santillana, the elaborate instructions in *The Book of the Dead* referring to the soul's celestial voyage translate into "mystical" talk, and must be treated as holy mumbo-jumbo. Modern translators, says Santillana, believe so firmly in their own invention, according to which the underworld has to be looked for in the interior of our globe—instead of in the sky—that even 370 specific astronomical terms would not cause them to stumble. He gives as an example the goddess Hathor being described as "lady of every joy," when the literal translation is "the lady of every heart circuit." The determinative sign for "heart," explains Santillana, often figures as the plumb line coming from the astronomical or surveying device, the *merkhet*. "Evidently," says Santillana, "the heart is something very specific, as it were, the center of gravity."



J. Ralston Skinner in *The Source of Measure* was convinced that the Pyramid was not a tomb, but a temple of initiation. He went further and linked the Pyramid to the Jewish cabala, a system of allegorical symbolism among the initiated which sets forth the secret teachings of the Bible, concealing the great cosmic principles of man's origin.

According to Skinner the key to the cabala was said to be the geometrical relation of the area of the circle inscribed in the square, or the sphere in the cube. This gave rise to the relation of the diameter to the circumference of a circle, with the numerical value of the relation expressed in integrals, such as 22/7.

The relation of diameter to circumference, says Skinner, was considered a supreme one, connected with the god names Elohim and Jehovah, the first being the circumference, the second the diameter, which were numerical expressions of these relations.

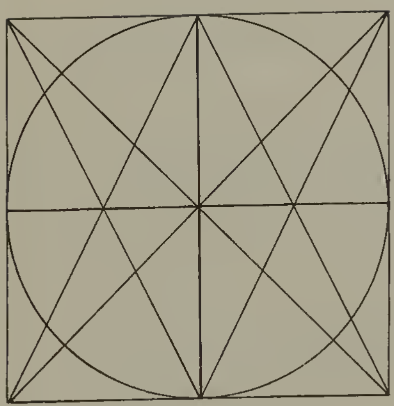
Tons Brunés, who dedicated his *The Secrets of Ancient Geometry* to the Fraternity of Free Masons, shows that the Great Pyramid, like most of the great temples of antiquity, was designed on the basis of an advanced but hermetic geometry known only to initiates, only fragments of which percolated to the classic and Alexandrine Greeks. According to Brunés, the secret of this ancient geometry was so well guarded that the whole of it was not revealed until the publication of his book in 1969.

Brunés shows how the ancient Egyptians used the basic design of a circle inscribed in a square to divide both circle and square geometrically into equal parts from 2 to 10, and all their possible multiples, without recourse to measuring or arithmetical calculations, with the aid of nothing but a straightedge and a compass—common emblems, along with the Pyramid, of the Masonic orders of yesterday and today.

In Brunés' reconstruction of the secret geometry, the cross emerges as the first geometric addition to the circle and square, and is the key not only to the solution of geometric problems but to the development of numerals and the alphabet.

By including the diagonals, every number both Latin and Arabic and all the letters of several alphabets may be obtained.

According to Brunés, both mathematics and the alphabet sprang from geometry, not the reverse. He says that nowadays we use numbers as the primary factor in our calculations, and geometry only as a subsidiary, whereas he believes the Egyptians reversed the order. He uses a detailed analysis of the Rhind Mathematical Papyrus to demonstrate that the ancient Egyptian system of counting was directly governed by geometric factors and that their ideas and theories were bound in geometric rules.



Brunés found that the circle was indeed considered sacred by the Egyptians, as were the square and the cross and the triangle, all of which are intimately incorporated into the Great Pyramid with its square base and triangular faces designed to represent the "sacred" circle.

Brunés demonstrates how the circle inscribed in a square and quartered by a cross enabled the ancient Egyptian geometer to inscribe in a circle the basic figures of pentagon, hexagon, octagon and decagon.

Of these the pentagon with its five-pointed star is perhaps the most important: it automatically produces the Golden Section and the φ proportion in the simplest geometric manner.

Each line of the five-pointed star—the symbolic sign of recognition of the initiated Pythagorean, whose hermetic meaning it meant death to reveal—cuts the other in the proportion of major to minor: the Golden Section.

Furthermore, the side of a pentagon inscribed in a circle whose circumference is equal to the perimeter of the Pyramid will be equal to the apothem, or slant height, of the Pyramid, which will be the value of φ.

A pentagon divides a circle in 72° segments. With the main cross, the pentagon radii form angles of 18°, 36°, 54° and 72°.

Though Greece has been looked upon as the birthplace of mathematics—largely because of surviving written material on the subject of mathematics and geometry—Brunes points out that Pythagoras, the founder of Greek mathematics, spent 22 years in Egypt as a priest of the temple, and only returned to Greece after Cyrus the Great, king of Persia, burnt the temples at Memphis and Thebes in 527 B.C. and dragged him off as a prisoner to Babylon.

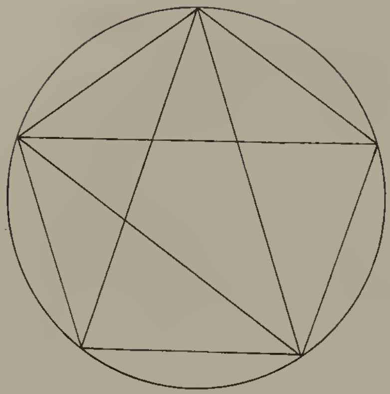
Back in Greece, Pythagoras taught mathematics on the basis of what he had learnt in Egypt; but after his death his followers were persecuted and had to take refuge abroad. Some eighty years later, Plato left Athens after the execution of Socrates and joined the Pythagorean societies. He traveled to Egypt, where he too was initiated into the lower degrees of learning in the temple, which were slowly recovering from being disbanded by the Babylonian-Persian conquerors.

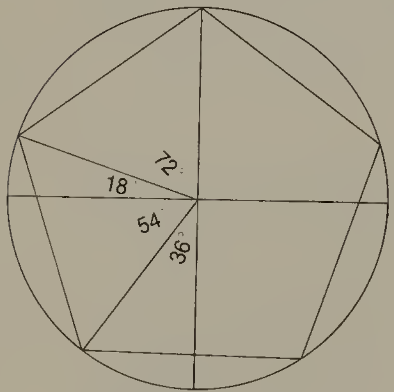
Plato collected documents and writings connected with Pythagoras. In the end he produced the concept that the cosmos was represented by the five regular solids that can be inscribed in a sphere.

Brunés maintains that Plato incorporated into the body of his writings, and especially in the *Timaeus,* the secret teachings of the Egyptians, which he had sworn not to divulge directly, but which he handled in a hermetic language for which Brunés provides a solution.

Brunés says that Moses, who was also an Egyptian priest, had knowledge of the ancient geometry, which he passed hermetically in his instructions for building the Tabernacle, data which eventually reached Jerusalem and were incorporated into holy teaching.

The French archeologist and mathematician Charles Funk-Hellet, in his *La Bible et la Grande Pyramide d'Egypte,* agrees that the cubit of the Bible can only be the Egyptian





$\sin 18° = \frac{1}{2}\varphi$
$\sec 36° = 2/\varphi$
$\sin 54° = \varphi/2$
$\sec 72° = 2\varphi$

The circle in a square with a cross and diagonals, plus a pentagon or decagon, enabled ancient mathematicians to measure lengths of $\sqrt{2}$, $\sqrt{3}$, $\sqrt{5}$, as well as multiples and fractions thereof without arithmetical computation.

royal cubit, which he makes a hair, or 1/2 millimeter, shorter than Stecchini's. According to Funk-Hellet the cubit was incorporated into the Temple at Jerusalem as $\pi/6$, or 523.6 millimeters, instead of Stecchini's 524.1.

Funk-Hellet points out that Solomon had Hiram Abiff build a temple whose columns were 18 cubits high and 12 cubits around. In other words, one cubit equaled the twelfth part of the circumference of the arc of 30°, or $\pi/6$.

By subtracting the circumference from the height, they obtained 6 cubits in a straight line, which was equal to half the circumference, or the exact value of π; so that a thousand years before Christ the Hebrews knew that a cubit was a mathematical entity dependent on the circumference, and were able to resolve π to four points of decimal.

Using *one unit* of measure as the radius of a circle, the ancients found the trigonometric value of 30° to be $\pi/6$, which was the value of the royal cubit, or .5236 of the unit used.

$$\frac{3.1416}{6} = .5236$$

SERIES P

I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII	XVIII
1	*5*	*6*	*11*	*17*	*28*	*45*	*73*	118	191	309	*500*	809	*1309*	2118	3427	5545	8972
2	10	12	22	34	*56*	*90*	*146*	236	*382*	*618*	*1000*	*1618*	*2618*	*4236*	6854	11090	17944
3	15	18	33	51	84	135	*219*	354	573	927	1500	2427	3927	6354	10281	16635	26916
4	20	24	*44*	*68*	*112*	*180*	292	472	764	*1236*	*2000*	3236	*5236*	8472	*13708*	22180	35888
5	25	30	55	*85*	*140*	*225*	365	590	955	1545	2500	4045	*6545*	10590	17135	27725	44860
6	*30*	*36*	66	102	168	270	438	708	1146	1854	3000	4854	7854	12708	20562	33270	53832
7	35	42	77	119	196	315	511	826	1337	2163	3500	5663	9163	14826	23989	38815	62804
8	40	48	88	136	224	*360*	584	944	1528	*2472*	4000	*6472*	*10472*	16944	*27416*	44360	71776
9	45	54	99	*153*	252	405	657	1062	1719	2781	4500	7281	11781	19062	30843	49905	80748
10	50	*60*	110	170	280	450	730	1180	1910	3090	5000	8090	13090	21180	34270	55450	89720
11	55	66	121	*187*	308	495	803	1298	2101	3399	5500	8899	14399	23298	37697	60995	98692
12	*60*	*72*	132	204	336	540	876	1416	2292	3708	6000	9708	15708	25416	41124	66540	107664
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
24	120	*144*	264	408	672	1080	1752	2832	4584	7416	12000	19416	*31416*	50832	82248	133080	215328

Funk-Hellet found another additive series made by adding 5 to 1, and so on; 1, 5, 6, 11, 17, 28. . . . He developed the series in 18 columns and 36 lines horizontally, with some extraordinary results, including values for π, φ, and the royal cubit; this led him to conjecture that the royal cubit might have had a theoretical value before it had a practical one.

The first line gives the numbers 11, 17 and 28, which are divisions of both the royal cubit and the Chaldean cubit; furthermore, 11 × 17 × 28 equals 5236, which is Funk-Hellet's figure for the royal cubit in millimeters, or $\pi/6$.

The fourteenth column of the series gives the φ^2 value of 2.618, the royal cubit value of 5236, and the π value of 3.1416.

The second row produces the φ, or Fibonacci-type, series of $1/\varphi$, 1, φ, φ^2 with 618, 1000, 1618 and 2618.

The seventh column gives the divisions of a 360-degree circle in halves, quarters, eighths, etc.

Funk-Hellet maintains that as early as the fourth millennium B.C. the Chaldeans had a mathematical series which gave the exact values of the cubit, the meter and π. What's more, he insists that the present *meter,* as developed by the French in the nineteenth century, was already a hermetic measure known in antiquity, and was linked trigonometrically with the cubit.

To Funk-Hellet the Great Pyramid is a geodetic gnomon, or pillar, incorporating values for both the meter and the cubit. He says the finger, palm and cubit are built into the apothem. In the King's Chamber, he says, the double square of the floor is 5.236 meters by 10.472 meters—which varies from Petrie's and Davidson's measurements by a few millimeters.

Funk-Hellet says the basic meter unit from which the cubit was derived had to be kept a deep secret, presumably so that all the calculations, including the means for obtaining the exact length of the year, would remain the sole property of the officiating priests.

Schwaller de Lubicz in *Le Temple de l'Homme* corroborated the evidence that the Egyptians knew the meter, pointing out that on the whole length of a surrounding wall of the Third Dynasty (3000 to 2000 B.C.), "one finds three lines painted at the time, of which the distance between two lines is exactly one meter," adding that this is not an isolated case, "but one of thousands." In ancient constructions of Troy, Heinrich Schliemann found a unit of measure which was exactly half a meter, or 50 centimeters.

Funk-Hellet says the meter and the cubit depended from each other and were both defined by geodetic measurements. He suggests the way the meter was derived by the ancients was by watching from a measured height the moment a light disappeared on the horizon.

At the beginning of the nineteenth century, Sir John Herschel tried to calculate the radius of the earth with two observers placed 10 feet above the sea who ceased to see each other at 12,873 meters. This gave Herschel an earth radius of 6797 kilometers instead of the correct 6378, or an error of 419 kilometers.

Funk-Hellet believes the ancient Egyptians did better. He points out that the full apothem of the Pyramid including the pyramidion is 10,000 fingers long, or 187 meters. He then computes that if 1870 meters is taken as an arc of 30°, the resulting radius will be 3570 meters. Modern experiments indicate that a light disappears on the horizon at 3570 meters when the eye of the observer is exactly 1 meter above the ground.

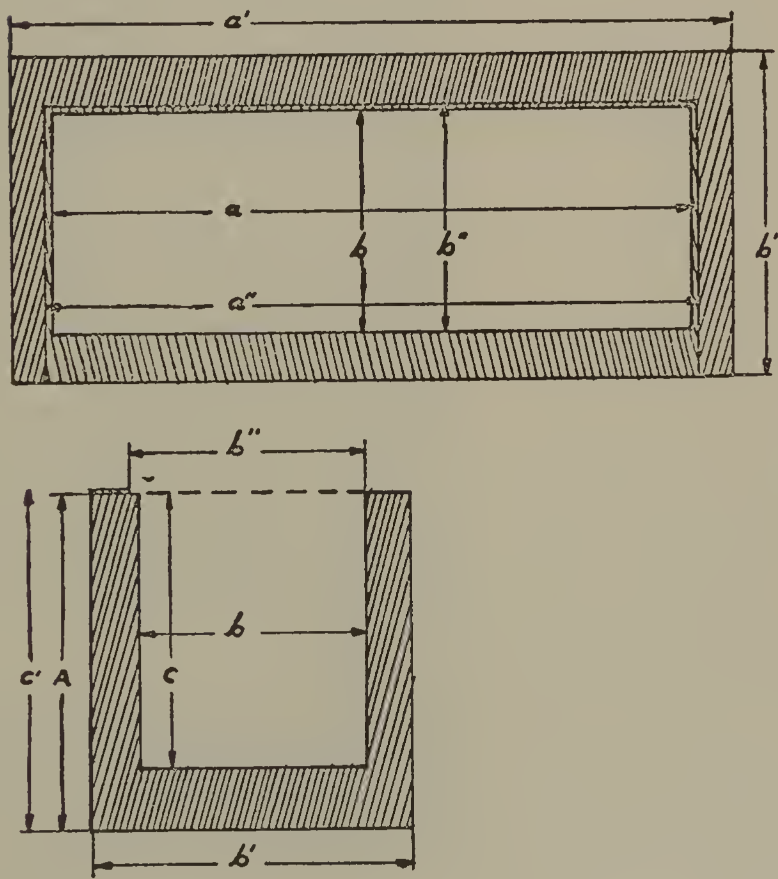
José Alvarez Lopez of Argentina, in his work *Fisica y*

Creacionismo, says that a cubit of 523 millimeters—about half a millimeter shorter than Funk-Hellet's and 1 millimeter shorter than Stecchini's—is exactly half of what he calls an *absolute meter,* which he says occurs as a natural unit in the solar system.

According to Alvarez Lopez the planets of our system orbit in harmonic distances from the sun which are multiples of a single unit of length—his *absolute meter*—in an arrangement which is naturally decimal.

Alvarez Lopez says that beginning with Mars, the planets are disposed in the order of the colors in the solar spectrum—with Mars as red, Jupiter yellow, Saturn yellowish-green, Uranus green, Neptune blue, and Pluto violet. According to Alvarez Lopez the Pyramid may once have been painted with the colors of the spectrum starting with red for Mars, just below the gilded pyramidion representative of the sun, and diminishing through yellow and blue to violet at the base, symbolizing the construction of the solar system both geometrically and with color.

The only evidence that the Pyramid may have once been painted, apart from the legends of the Arab storytellers, are some fragments of casing stone found in the early nineteenth century which were covered with what appeared to be red paint. Subjected to careful chemical and spectrographic



Alvarez Lopez's rendition of the dimensions of the coffer used by the Egyptians for basic astronomical ratios.

analysis at the Sorbonne, it was determined that the casing stones had once been covered with a layer of paint with a red ochre base, and that the paint could not have been caused by any chemical recomposition of the stone itself.

The Great Pyramid, says Alvarez Lopez, represents a decimal schema of the solar system. He figures the height of the Pyramid to be a millionth part of the distance to the sun, measured from the limit of the earth's atmosphere, and its base to be the ten-thousandth part of the surface of the earth.

The dimensions of the granite coffer in the King's Chamber, as worked out by the Argentine professor, are arranged to form a perfect "astronomical atlas": he says the inner measure gives an *absolute cubic meter,* but that the coffer was not designed as a cube so that its various inner and outer measures could also represent the various astronomical constants of the solar system.

He says there was just one way to build a coffer so that it would include not only the distance from the earth to the sun (a basic astronomical unit), but the weight of the earth, the weight of the earth and the moon, the weight of the sun in relation to the earth, the weight of the sun in relation to the earth and the moon, the weight of the earth in relation to the moon, the value of the absolute cubic meter, and the polar radius (one-half the diameter from pole to pole) of the earth in terms of an absolute meter.

Alvarez Lopez considers the original discovery of these figures to have been perhaps the hardest job yet mastered by man, and says this explains the care and trouble taken by the builders of the Pyramid to secrete the information in the heart of the building. Were the coffer not so badly chipped and worn, says Alvarez Lopez, it might give us more exact astronomical figures than we now possess.

All these astronomical constants, says the professor, depend on a precise knowledge of the solar parallax; he is amazed that the builders of the Pyramid could have known the parallax and the earth's polar radius so exactly without the help of telescopes and cameras. It will be interesting, he says, to compare our new figure for the sun's parallax with that of the granite coffer, as determined by the near passage of the small planet Eros, which occurs every 37 years and is due in 1975.

Stecchini is more *terre-a-terre.* He can show that the half meter found by Schliemann is really a Babylonian cubit of .49907 meter and that the meter of Funk-Hellet and de Lubicz is in fact three feet of .3329 meter, both derived from the geographic foot and cubit.

When I reminded Stecchini that Petrie had found the coffer in the King's Chamber to be designed in even numbers of fifths of a cubic cubit, Stecchini resolved the millennial riddle of the coffer by showing that it contains exactly 40 *artaba,* or 40 cubes whose sides are one geographic foot, and that its outside volume is twice this amount, or 80 cubes of one geographic foot.

Would it not be worthwhile, nonetheless, for academic institutions, so admirably equipped with computers and talent, carefully to analyze such conceits as those of Alvarez Lopez and Funk-Hellet and either refute them or support them with reliable data? Some of their ideas may turn out to be no wilder than those for which Jomard, Taylor, Smyth and maybe even Davidson were unjustly lampooned.

Napoleon's French Institute in Cairo.

XXI. MORE SECRET PASSAGES AND CHAMBERS

Many Egyptologists and explorers were convinced—and many still are—that the Pyramid conceals one or more secret and yet undiscovered chambers. It is also believed that the Pyramid is connected by subterranean passageways to other pyramids, to the Sphinx, and to long-demolished reception halls, small temples and other enclosures.

The engineer of the Australian railways, Robert Ballard, believed the Giza pyramids may also have been built above a vast series of catacombs, with chambers and galleries, like the pyramids of Lake Moeris, which are said to have vast subterranean residences for its priests and keepers.

Ballard suggests that much of the limestone for the structure of the pyramids of Giza may have been quarried from such catacombs. He suggests that a good diamond drill with two or three hundred feet of rods be used to make tests on the Giza plateau. Ballard believes that when this subterranean city is discovered, it will be found that it had access passages for the priests and the surveyors linking it to every pyramid.

While the pyramids appeared to the outside world to have been sealed up as mausoleums for the dead, says Ballard, the sealing may simply have rendered more mysterious and private the recesses and abodes of the priests who entered from below, and who were possibly enabled to ascend by private passages to their very summits.

When Perring and Howard-Vyse were exploring the bent pyramid at Dashur in 1839, they noticed an extraordinary phenomenon. The workmen clearing the passages were suffering from intense heat and lack of oxygen when suddenly a strong cold wind began to whistle through the passages. It blew so fiercely for two days that the men had trouble keeping their lamps lit. Mysteriously it stopped and no one has yet figured out the mystery.

Ahmed Fakhry, working in the same pyramid in the 1950s, heard weird noises which led him to conclude that there must be undiscovered passages within or under the bent pyramid.

Edgerton Sykes, an archeologist and author, who is perhaps the best living authority on ancient Atlantis, also

Herodotus speaks of a palace complex of 3500 chambers half above and half below ground at Moeris. The Egyptians called it "the temple at the entrance to the lake." Herodotus called it a "labyrinth," and considered that it outranked the pyramids as a wonder.

believes there is a whole maze of corridors and passages dug into the Giza hill. Sykes quotes an ancient Arab source to the effect that the designers of the Pyramid made "several doors, built over underground vaults of stone, each with a secret stone door revolving upon a hinge."

Peter Kolosimo believes there are more tombs and caves beneath Saqqara, Abydos, and Heluan, of very ancient dynasties, and reports the legends of hidden doors "that could be opened by a mysterious force" such as a supersonic wave length, or specially resonant voice.

According to the Baron de Cologne, as quoted by Robert Charroux in *Le Livre des Secrets Trahis* (Paris, Laffont, 1965), there is an underground kingdom under the Egyptian desert similar to the "Agartha" of Tibet.

Commander Barber, the American attaché who gave such attention to the construction of the Pyramid, wrote that "when one considers the inexplicable and yet exact arrangement of the various chambers and galleries, and that there is room for 3700 more such chambers, provided we could find them, we can almost be tempted to believe that we have not yet discovered all the chambers or even the true chamber of Cheops."

Piazzi Smyth was equally convinced that there was an undiscovered chamber in the Great Pyramid "which will prove to be the very muniment room of the whole monument."

Bent pyramid at Dashur. Arrow points to a secondary entrance to pyramid high on the north side.

When a multitude of chips of black diorite rock were discovered on the Pyramid hill, Smyth surmised that the undiscovered chamber might be lined with black diorite.

Thomas Holland, a Thirty-third Degree Free Mason, believed that if the granite leaf were removed from the portcullis it would disclose the way to "magnificent passages and chambers hitherto undiscovered."

Louis P. McCarty, in a privately printed booklet, *The Great Pyramid of Jeezeh,* published in San Francisco in 1907, says he believes the Pyramid contains at least three more chambers located between the King's Chamber and the apex, and at least one with double the capacity of the King's Chamber. McCarty believes the next largest chamber will be found at the 75th course, and the largest at the 100th course, and that the largest should be of an equal capacity to the three below it. He believes there is a fifth and final chamber on the 120th course of masonry, and that this one should be just half the capacity of the King's Chamber. McCarty also subscribes to the theory that there is a passage somewhere beneath the northeast corner of the Pyramid which leads to the Sphinx.

Funk-Hellet suspects there might have been a room on top of the present platform, now destroyed.

William Kingsland, in his two-volume work on the Pyramid, suggested generating radio waves of 5 meters length in the King's Chamber, and by noting the strength of reception at measured intervals all round the outside of the Pyramid, determine if some hidden chamber might exist.

In the late 1960s Dr. Luis Alvarez, the 1968 Nobel Prize winner for physics, developed a machine for recording the passage of cosmic rays through the pyramid of Kephren, by means of which he hoped to discover any secret chambers or passages within its body.

The operation, which required a team of scientists, turned into an expensive venture in which twelve United States and United Arab Republic agencies became involved, including the U.S. Atomic Energy Commission, the U.A.R. Department of Antiquities, the Smithsonian Institution and the Faculty of Science of the Ein Shams University in Cairo.

Alvarez's project was based on the fact that cosmic rays, which bombard the planet day and night, lose part of their energy as they pass through an object, in proportion to the density and thickness of the object.

By placing a "spark chamber" in the subterranean vault of the pyramid the scientists planned to monitor the number of cosmic rays which made their way through the pyramid walls. Those rays which passed through a void in the body of the pyramid would reach the chamber more frequently than those traversing solid rock, and the variance would indicate the presence of a secret chamber or passage in the pyramid.

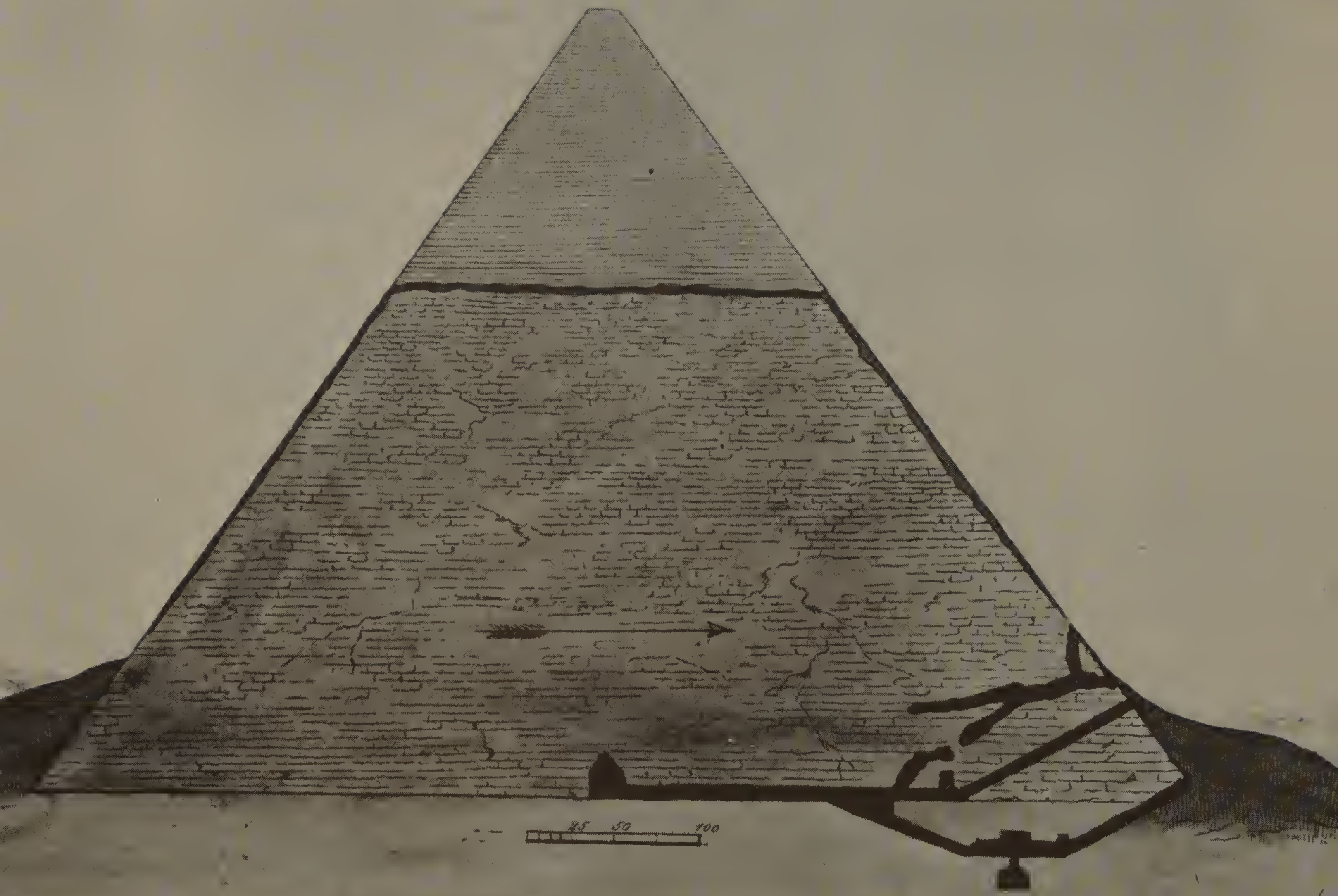
The path of each ray is recorded electronically and stored on a magnetic tape. The tapes are then fed into a computer to calculate and memorize the point at which each recorded ray penetrated the surface of the pyramid.

To pinpoint the location of any cavities which showed up, the scientists planned to shift the "spark chamber" and obtain a sort of stereo picture.

Were any hidden chamber located, it would then be possible to dig directly to it without risking great damage to the rest of the pyramid. The operation would consist of drilling a small hole upward in the indicated direction of any cavity that appeared on their "X-ray plate." Modern optical tools would allow archeologists to look into the chamber through a long hole, perhaps 100 feet long and only 3/4 inch in diameter.

Dr. Alvarez chose the pyramid of Kephren because he considered it unlikely that Kephren, as the son of Cheops, would have had such an imposing pyramid erected without incorporating some secret system of passages and chambers such as have been discovered in the Great Pyramid.

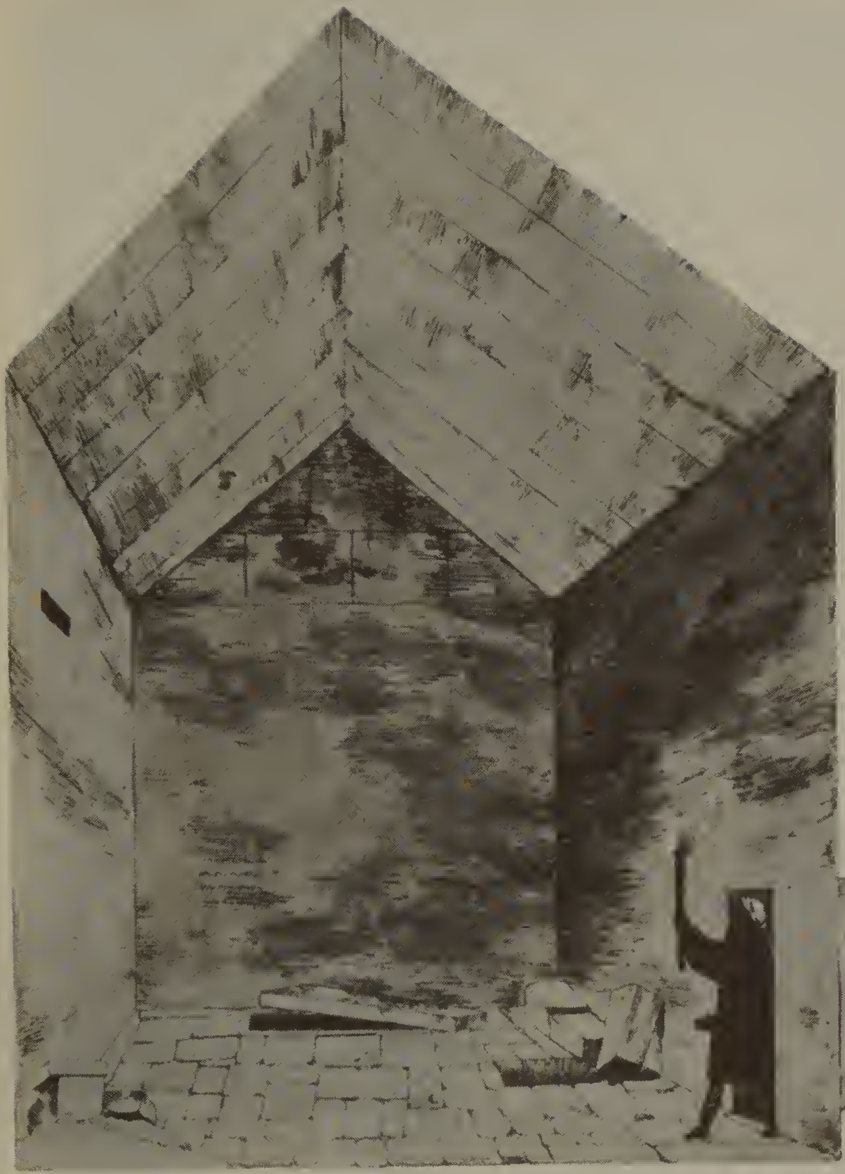
Alvarez assumed that Cheops' architects must have had a choice of clever ideas for secreting chambers, some of which had to be left out of his pyramid, but could have been applied to Kephren's. "My hunch," says Alvarez, "was that younger architects working on Cheops' pyramid would have had their ideas rejected. Later, in Chephren's time, they could have persuaded Chephren to use them, or some other improved plans."

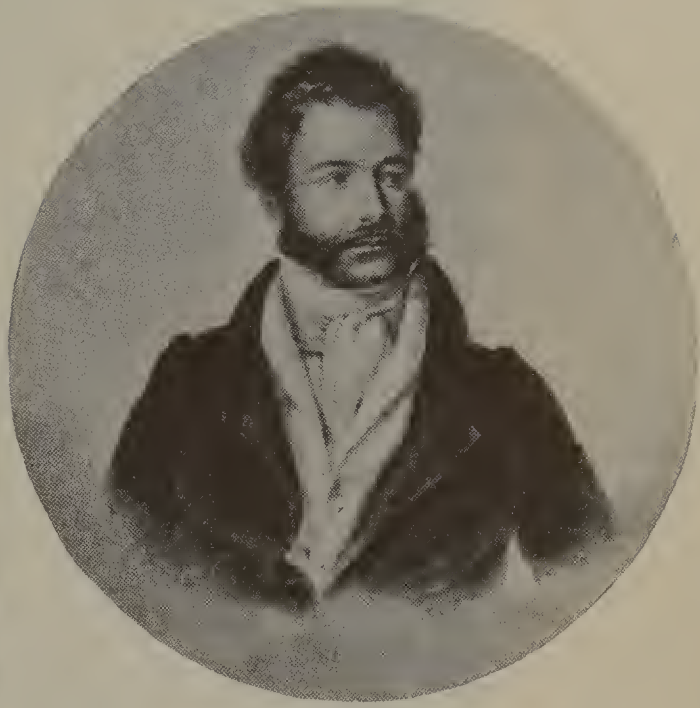


On this tenuous assumption Alvarez hoped to find a secret chamber in Kephren, and perhaps even the sarcophagus of the dead Pharaoh: an Egyptologist's dream.

Alvarez also chose Kephren's pyramid because its central chamber was more convenient for setting up his complex electronic equipment. The subterranean vault discovered in 1818 by the Italian explorer Giovanni Belzoni had recently been cleared of rubble, and other chambers and passages in the pyramid had been lit with electricity by cable from the nearby Mena House.

By September of 1968 two million cosmic-ray trajectories had been measured: these were considered ample for finding any hidden vault within the field of view of the upward-looking equipment. When the tapes were run through the local computer in Cairo for the first analysis, the results looked wonderful. They clearly





In 1818 the Italian adventurer Giovanni Belzoni tried to find an entrance to the second pyramid of Kephren.
He found what appeared to be the original entrance close to the ground plugged by three granite blocks. The passage was cleared all the way down to a funerary chamber containing only a granite sarcophagus. On the west wall of the chamber an inscription in Arabic indicated the chamber had been penetrated some time after the Hegira.

Portrait of Giovanni Belzoni used as a frontispiece for a book edited by his wife commenting on his exploits in Egypt.

showed up the corners and the faces of the pyramid as outlined by the passing cosmic rays, recorded in the central chamber. The equipment appeared to be functioning excellently. But there were some mysterious developments.

As Dr. Lauren Yazolino, Alvarez's assistant, returned to the United States to analyze the tapes on the most up-to-date computer at Berkeley, a correspondent from the London *Times* visited Cairo to check on the results locally. At Ein Shams University, John Tunstall found an up-to-date 1130 IBM computer surrounded by hundreds of tins of recordings.

"It defies all known laws of physics," Tunstall quoted Dr. Amr Goneid, who had been left in charge of the pyramid project since the return to America of Dr. Yazolino.

According to Tunstall's report, each time Dr. Goneid ran the tapes through the computer a different pattern would appear, and the salient points which should have

been repeated on each tape were absent. "This is scientifically impossible," Tunstall quoted Goneid, explaining that earlier recordings which had raised the hopes of a great discovery were now found to be a jumbled mass of meaningless symbols with no guiding pattern whatever.

Tunstall asked Goneid: "Has all this scientific know-how been rendered useless by some force beyond man's comprehension?" To which Goneid is reported to have answered: "Either the geometry of the pyramid is in substantial error, which would affect our readings, or there is a mystery which is beyond explanation—call it what you will, occultism, the curse of the pharaohs, sorcery, or magic; there is some force that defies the laws of science at work in the pyramid."

At Berkeley, Alvarez refuted Tunstall's account, insisting that the equipment was functioning admirably. In the 35° cone scanned by the spark chamber there was no sign of any hidden passageway or chamber. This was the area believed by the scientists to be the most likely to contain them, though there was still hope of finding something in the remaining sections.

As soon as further funds were available the team of scientists planned to resume their scanning of Kephren. Dr. Yazolino added that if sufficient funds were available they might even move their equipment to the Queen's Chamber in Cheops to see if they could find any unknown passages or chambers in the Great Pyramid.

Yazolino explained that the only trouble they had encountered had been poor readings when the spark chamber ran out of neon and produced some mysterious dark spots which looked like a possible chamber till they were carefully analyzed and found to be caused by the gap between two spark chambers.

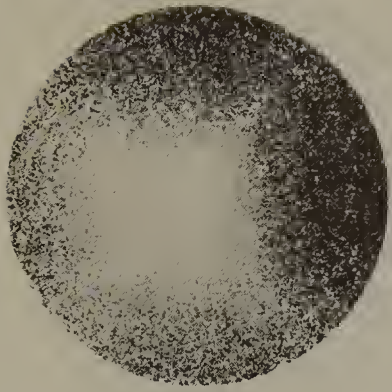
Alvarez stressed his confidence in Dr. Goneid as a very able physicist, saying that he thought so much of him he had invited him to spend a year at his lab at Berkeley. "If I thought for a moment that he had said any of the nonsense attributed to him, you can be sure I wouldn't want him as a member of my research group."

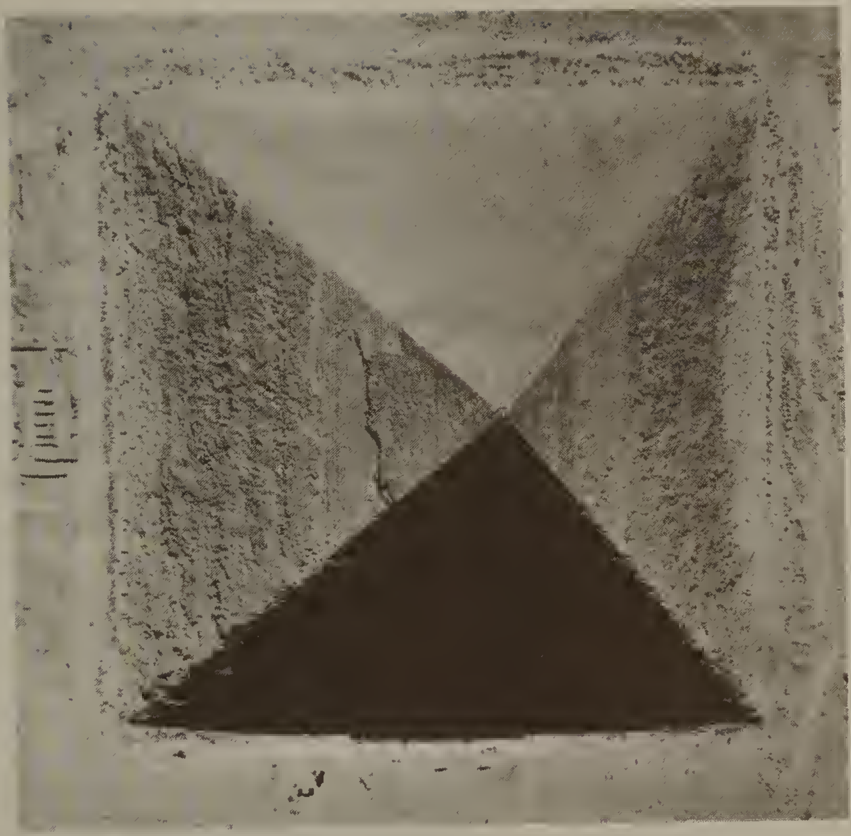
Yet there remains something mysterious about the pyramid which needs to be explained.

When a Frenchman, M. Bovis, visited the Great Pyramid he noticed that some garbage cans in the King's Chamber contained dead cats and other small animals that had apparently wandered into the Pyramid and died.

There was something odd about these corpses: there was no smell or decay to them. Curious as to the cause

Diorite statue of Kephren dating from the Sixth Dynasty found by Marietta Bey in the so-called Temple of the Sphinx, now in the Cairo Museum.





of this phenomenon, Bovis examined the animals and found them dehydrated and mummified, despite the humidity in the chamber.

Bovis wondered if the mere shape of the Pyramid could have been responsible for this natural process of embalming: so he made a wooden model of Cheops with a base three feet long, and oriented it due north. Inside the model, a third of the way up, he placed a freshly dead cat. After a few days it mummified. Bovis then placed other organic materials in the model, especially matter that normally decays very quickly, such as calf's brains, and when these failed to putrefy, he concluded there must be something about the shape of the Pyramid which prevents decay and causes dehydration.

A Czechoslovakian radio engineer named Karel Drbal read Bovis's reports and made some further experiments with pyramid models, concluding that there is "a definite relation between the shape of the space inside the pyramid, and the physical, chemical and biological processes going on inside that space."

The same phenomenon has been noted in Italy and Yugoslavia where milk packaged in pyramidal cartons keeps fresh indefinitely without refrigeration. A French firm has also patented a pyramidal container for yogurt.

Drbal wondered if the shape might be responsible for an accumulation of electromagnetic waves or cosmic rays, or of some unknown energy. Placing a used razor blade within a six-inch-high cardboard model of Cheops' pyramid, oriented to true north, Drbal found that the edges of the blade automatically recovered their sharpness after use, that he could shave with one Gilette blue blade as many as 200 times. He concluded that the environment inside the pyramid somehow made the crystals in the blade return to their original form. Drbal was issued patent no. 91304 by the Czechoslovak patent office and began manufacturing "Cheops Pyramid Razorblade Sharpeners" out of cardboard. Today they are being made of styrofoam.

An engineer and former professor of radio, L. Turenne, maintains that all sorts of different forms—being combinations of different frequencies—act as different types of resonators for energy in the cosmos. This has led to speculation that the Pyramid might be some sort of gigantic lens which is able to focus an unknown energy simply by means of its shape.

Even the coffer in the King's Chamber has been considered such a device by Worth Smith, who points out that the cubic capacity of the coffer is *exactly* the same as that of the biblical Arc of the Covenant.

According to Maurice Denis-Papin, descendant of the famous inventor, the Arc of the Covenant was a sort of electric capacitor capable of producing an electrical charge of 500 to 700 volts. The Arc is said to have been made of acacia wood, lined inside and out with gold: that is to say, two conductors separated by an insulator. On either side were garlands which may have served as condensors. Denis-Papin says the Arc was placed in a dry spot where the magnetic field reached a normal 500 to 600 volts per vertical meter.

Insulated from the ground, the Arc is said to have given off fiery rays, acting like a Leyden jar. According to Denis-Papin the capacitor was discharged to earth by means of the garlands. To move the Arc, two golden rods were slid through rings attached to the exterior.

The similarity of such an "energy accumulator" to the orgone box developed by Wilhelm Reich, which was such a puzzle to Albert Einstein, is also striking.

Sir W. Siemens, the British inventor, related that one day while he was standing on the summit of Cheops' pyramid an Arab guide called his attention to the fact that whenever he raised his hand with his fingers outspread an acute ringing noise was heard.

Raising just his index, Siemens felt a distinct prickling in it. When he tried to drink from a wine bottle he had brought along he noted a slight electric shock. So

Siemens moistened a newspaper and wrapped it around the bottle to convert it into a Leyden jar. It became increasingly charged with electricity simply by being held above his head.

When sparks began to issue from the wine bottle, Siemens's Arab guides became distrustful and accused him of practicing witchcraft. One of the guides tried to seize Siemens's companion, but Siemens lowered the bottle towards him and gave the Arab such a jolt that he was knocked senseless to the ground. Recovering, the guide scrambled to his feet and took off down the Pyramid, crying loudly.

Such weird but soberly recounted tales about the Pyramid are tame compared to the wilder conceits that have been propounded by pseudoscientific, science-fiction and sensational authors. According to one science-fiction theory, the Pyramid was used as a huge protecting baffle for ancient scientists who had found a way to tap the energy of the Van Allen belts by letting it flow on an ionized path through the atmosphere to the peak of the Pyramid, possibly on a laser beam. The authors of this science fiction recount how an error was committed in the length of time the energy was allowed to flow, causing an avalanche of power which knocked the planet off its axis.

Another popular idea is that the truncated Pyramid served not merely as an observatory but as a landing pad for extraterrestrial space ships. The polished sides of the Pyramid would have made such a platform inaccessible to the hoi polloi, so that godlike visiting astronauts could have confabulated in security with the high priests who had access to the platform from interior passages. Herodotus lends romance to the idea that ziggurats and pyramids were steppingstones for the gods from heaven and that the King's Chamber—which Petrie found to be built quite separately from the surrounding Pyramid—could have served as a reception room on the truncated platform.

Herodotus describes a reconstructed ziggurat which he visited in Babylon. "On the topmost tower there is a spacious temple, and inside the temple stands a great bed covered with fine bed-clothes, with a golden table by its side. There is no statue of any kind set up in the place, nor is the chamber occupied at night by any but a single native woman who—say the Chaldean priests—is chosen by the deity out of all the women of the land. The priests also declare—but I for one do not credit it—that the god comes down in person into this chamber, and sleeps upon the couch."

In the light of recent scientific discoveries, one more theory must be added to this world of fable: that the Great Pyramid was built not only as an astronomical observatory but as an astrological one in order to make accurate large-scale horoscopes for the reigning monarch.

XXII. ASTROLOGICAL OBSERVATORY

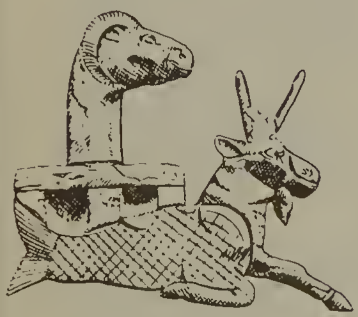
Though many of the doctrines of astrology appear to be preposterous, modern science is beginning to indicate that in its original form astrology may have been based on some reasonable theories.

Proctor points out that the ancient Egyptians viewed the king as the representative of all the people in their relations with the forces of the cosmos, and the world of spiritual powers.

On the theory that what was good for the king was good for the country, Proctor suggested that the Egyptians made no move in either domestic or foreign policy without the recommendation of their astrologer priests, whose opinions were based on the movement of heavenly bodies as scanned from a pyramidal observatory.

Once the king was dead, Proctor believes, his body may have been buried within the pyramid and the platform finished off to a point.

The idea that the shifting of heavenly bodies bears some relation to man's fate is so ingrained that people are still called martial, jovial, saturnine or lunatic; the days of the week are still named for sun, moon and planets; and our religious festivals are still based on the astrological system of ancient Egypt, with Christmas tied to the winter solstice and Easter to the spring equinox.



In his *The Scientific Basis of Astrology,* published in 1969, Michel Gauquelin describes some of the effects of the motions of the sun and moon upon terrestrial phenomena. Apart from such obvious effects as the seasons, the growth of vegetation and the tides, he deals with the less apparent but equally powerful effects of the eleven-year cycle of sunspots on our flora, fauna and inhabitants.

Sunspots, which appear like dark flowers on the surface of the sun, spring up, develop and disappear. As they do so, the sun spews up fantastic incandescent clouds of gas, and whips up huge magnetic whirlwinds.

Rotating on its axis in a twenty-seven-day cycle, the sun periodically aims these spots and eruptions directly at the earth. The result is an increased projection of waves and particles towards the earth. In the words of Gauquelin, "we terrestrians can regard ourselves as living in the interior of the sun."

The position of the earth in its orbit also affects the sunspots: when Venus and Earth are on the same side of the sun, their effect on the sunspots is combined. The sun's vagaries induce earthquakes and even alter the duration of the day; the earth's magnetic fields are disturbed; there are radio interferences and other such mysterious phenomena. At the same time the earth is subject to bombardment by galactic particles such as Alvarez's cosmic rays, which also have their effect.

Sunspot activity has been related to such different phenomena as the number of icebergs in the North Atlantic, the level of water in lakes, the concentric rings in the growth of trees and the number of rabbit skins taken by the Hudson's Bay Company. Even the quality of wines in Burgundy is affected, excellent vintages corresponding to periods of maximum solar activity.

Sunspots have been proved to affect the smallest cells, and the world of microbes is disturbed to the point that waves of epidemics can be generated. Gauquelin quotes a Doctor Fauré to the effect that the frequency of diphtheria cases in Central Europe and of smallpox victims in Chicago follow the eleven-year cycle of sunspots, as did the recurrent great plagues of typhus and cholera in Europe.

Indirectly, most of the phenomena of weather, such as barometric pressure and the rate of winds, depend on the eruptions of sunspots. Gauquelin wonders if there may not be more subtle effects on the air we breathe, on our physical and mental states, and even on the way we think.

Recent experiments indicate that subjects breathing air charged with positive ions are likely to feel discomfort, headaches and giddiness; whereas when the atmosphere is full of negative ions the same subjects feel cheerful, relaxed and in top form.

The concentration of positive and negative ions in the air we breathe depends in the final analysis on solar activity. The ionosphere is filled with positive and negative ions. Particles which induce a very high ionization in the upper atmosphere are directed toward the earth by the sun. Unfortunately, negative ions have a tendency to attach themselves to clouds, whereas positive ions tend to accumulate on the ground.

Such data tie in with the theories of Wilhelm Reich about the healthful effects of what he calls "orgone energy" and the toxic effects of its counterpart "deadly orgone," which was reputed to turn rocks brown, make strong men giddy and bring on women's menses out of season.

Current research and experiments behind the Iron Curtain as reported by Ostrander and Schroeder in their *Psychic Discoveries Behind the Iron Curtain** have added even more fantastic details to the use of astrology as a science.

These authors describe a Czechoslovak Ministry of Health center, complete with modern computers, run by gynecologists and psychiatrists. It is called Astra Research Center for Planned Parenthood and uses astrological data, or the position of sun, moon and planets in relation to the birth of an individual, in order to assure a safe and reliable means of birth control without pills, contraception or operations. The same system is being used to help seemingly sterile women become fertile, help women who have had nothing but miscarriages deliver full-term babies, and even allow them to choose whether they will have a boy or a girl child.

In a book called *Predetermining the Sex of a Child,* Eugen Jonas, a Czech medical doctor who developed the Astra clinic, maintains that women's cycles are affected not only by the phases of the moon, but that each individual at birth is affected by the basic pattern of sun, moon and planets. From this basic pattern Dr. Jonas claims to be able to figure out the exact days in a woman's entire lifetime when she can conceive, as well as the ones which are the best or worst for a forthcoming child. The woman may then take advantage of such days, or avoid them.

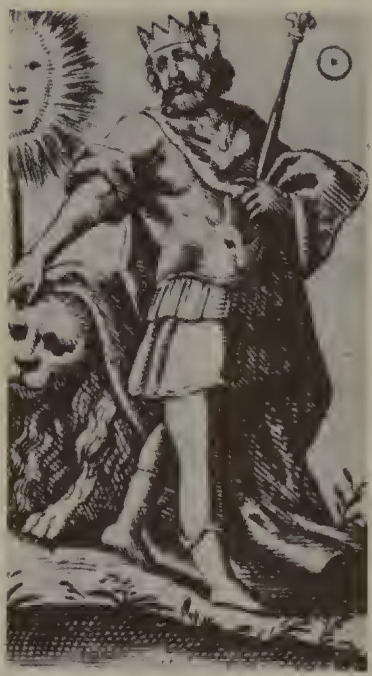
Jonas found that dead, deformed and retarded children were produced when women conceived during certain oppositions of the sun, moon and major planets.

The system is now being tested in Hungary as well as Czechoslovakia, where Dr. Kurt Rechnitz, former director of the Budapest Obstetric Clinic prescribed astrological birth control for one hundred twenty women. None was reported pregnant.

It has been too short a period to establish the validity of such data, but the endeavor could prove more rewarding than voyaging to the moon. It would certainly be simpler for a lady in New York to step into the booth of an astrological computer in Grand Central Station in order to arrange her calendar of engagements for the year. And it might do wonders for an overpopulated planet.

Jonas' good-humored complaint is that most gynecologists know as little about astronomy as astronomers know about obstetrics, and that both believe

* Prentice-Hall, Englewood Cliffs, New Jersey, 1970.



astrology to be superstitious nonsense. If the disciplines were combined, the results, says Jonas, might be great for mankind. Had the designers of the Great Pyramid been able to monitor the sunspots with a screen across the Grand Gallery, as suggested by Proctor, and had they been aware of such phenomena as has been described by Dr. Jonas, they may well have been able to use the Great Pyramid as a means of providing accurate astrological data on which to formulate the charts for individual behavior, if not for the thronging masses, at least for the pharaohs, priests or nobles.

In his book on the Great Pyramid William Kingsland declares flatly that the ancient Egyptians used "their profound knowledge of what we call the outer facts of astronomy" to connect them astrologically with the principles of man's relation to the cosmos, and that this formed part of the concealed knowledge contained in the mysteries.

Kingsland notes that from the very remotest antiquity the Egyptians believed firmly in an afterlife and were not afraid to think cosmically in terms of millions of years. He quotes an introductory hymn to *Ra* in *The Book of the Dead* as saying: "millions of years have gone over the world; I cannot tell the number of those through which thou hast passed. . . ."

To Kingsland *The Book of the Dead,* though it appears to be a ritual for funerary rites of a deceased king or high official, was actually a description of the trials, temptations and difficulties which the adept had to meet and overcome as he progressed from knowledge to knowledge and from power to power, as he penetrated the superphysical regions from plane to plane. The ultimate goal of initiation, says Kingsland, was "the full realization of the essential *divine nature of man,* the recovery by the individual of the full knowledge and powers of his divine spiritual nature, of that which was his source and origin, but to the *consciousness* of which he is *now* dead through the 'Fall of Man' into matter and physical life."

The old Greeks, says Kingsland, learning from the Egyptians, embodied these trials and difficulties of the great initiates into the legends of their heroes and demigods.

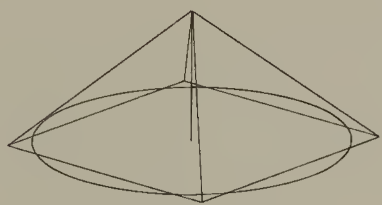
Manly P. Hall, a lifelong researcher into the mysteries of ancient initiation, says the Great Pyramid was dedicated to the god Hermes, the personification of Universal Wisdom; it was not only a temple of initiation but a repository for the secret truths which he calls the foundation of all the arts and sciences. The time will come, says Hall, when the secret wisdom shall again be the dominating religious and philosophical urge of the world: "Out of the cold ashes of lifeless creeds, shall rise phoenix-like the ancient Mysteries . . . . The unfolding of man's spiritual nature is as much an exact science as astronomy, medicine and jurisprudence."

Whatever mystical, occult or science-fiction tales may be associated with the Great Pyramid, it is still an extraordinary piece of masonry, and its designers must have been extraordinary beings. Who they were and when they built their Pyramid remains a mystery. So the quest continues.

But certain facts must be confronted, and the textbooks amended to conform with them. Eratosthenes was obviously not the first to measure the circumference of the earth. Hipparchus was not the inventor of trigonometry. Pythagoras did not originate his famous theorem. Mercator did not invent his projection—though he did visit the Great Pyramid and leave his graffito to prove it.

Whoever built the Great Pyramid knew the dimensions of this planet as they were not to be known again till the seventeenth century of our era. They could measure the day, the year and the Great Year of the Precession. They knew how to compute latitude and longitude very accurately by means of obelisks and the transit of stars. They knew the varying lengths of a degree of latitude and longitude at different locations on the planet and could make excellent maps, projecting them with a minimum of distortion. They worked out a sophisticated system of measures based on the earth's rotation on its axis which produced the admirably earth-commensurate foot and cubit which they incorporated in the Pyramid.

In mathematics they were advanced enough to have discovered the Fibonacci series, and the function of π and φ. What more they knew remains to be seen. But as more is discovered it may open the door to a whole new civilization of the past, and a much longer history of man than has heretofore been credited.

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APPENDIX

NOTES ON THE RELATION OF ANCIENT MEASURES TO THE GREAT PYRAMID

by LIVIO CATULLO STECCHINI

The following pages constitute an abstract from a lifelong research into the history of measures. I became interested in this subject toward the end of my secondary education, when I was trying to put to some use my eight years of Latin and Greek grammar. It was then that I became an acolyte of Angelo Segré, whom I knew as a fellow law professor with my father at the University of Catania. Segré was a scholar of Roman law, but, coming from a family of distinguished scientists and mathematicians, had specialized in the study of ancient measures.

Upon completing my secondary education, I ended my study with Segré to register as a student at the University of Freiburg, Germany. Since at that age one believes that a thinking person must have a philosophical foundation, I chose Freiburg because it was the university where Husserl taught, whose philosophy appealed to me because of its mathematical rigor. But at Freiburg at the moment the focus of attention was the philosopher Heidegger, who had just announced to the world the discovery of something called existentialism. I did not share the excitement of my fellow students for the new dispensation (although I liked the lectures on existentialist mathematics by Oskar Becker), but there were a couple of things that I learned from Heidegger. One was that the idea of the progress of human civilization, on which practically all historians operate, is a theological doctrine developed by the Church Fathers. The other, more specific, was that scholars of Greek culture have murdered the texts of early Greek philosophers, on the assumption that since they were early philosophers they must have had infantile conceptions. In the area of my vocational studies, I identified myself with a group of professors, led by Fritz Pringsheim, who had dedicated themselves to one topic, the contract of sale in ancient times. Since seminar work consisted in interpreting contracts from several areas of the eastern Mediterranean, I focused my attention on the clauses relating to measures, which these contracts contain in abundance. My teachers were tolerant of my passion; for instance, Otto Lenel in his *privatissimum,* dedicated to the development of postclassical Roman law, allowed me to read a paper on the length of the miles in the Syro-Roman Law Book.

After the Freiburg group was disbanded by Hitler, I returned to Italy, where I received a doctorate in the field of Roman law. On that basis I became assistant to the chair of history of Roman law at the University of Rome and a member of the Institute of Roman and Oriental Law of that University. During my Roman years, I learned the most from Edoardo Volterra, later holder of the chair of Oriental law at the University of Rome; he was sympathetic to my interests, since he was the son of the famous mathematician Vito Volterra.

When World War II brought me to the United States, since my interests were historical rather than legal, I registered as a candidate for a doctorate in ancient history at Harvard University. There I discovered that those who come to ancient history from literature have a completely different view of the ancient world from the practical, realistic, and utilitarian view which prevails in legal studies: in substance they see the ancient world as the realm of poetic fantasy. My Harvard teachers used to admonish me to understand "the spirit of the ancients," but the only image that their perorations could stir in my mind was the image of the ancients in a constant state of alcoholic stupor. As to my special field of research, my teachers thought that my notion that the Greeks were concerned with precision in measurement was intellectually preposterous and historically impossible.

The terms of the controversy were clarified for me by Werner Jaeger, who tried to support me by suggesting that I write under him a thesis on the concept of *akribeia,* "precision," in Greek thought. In outlining the proposed thesis, Jaeger explained that with Isocrates there was developed in Greece a new conception of humanism opposed to *akribeia.* Jaeger was impliying that my critics were followers of Isocratean humanism. Because of youthful stubbornness, I declined the flattering offer of Jaeger, being convinced that what counts is to put precision into practice, rather than to talk about it. I tried to prove my point by submitting a thesis on "The Origin of Money in Greece." It was accepted as containing much that was valuable, but I received the advice that before publishing it I should cut down on "all those numbers."

After this, I thought that I could still achieve a result by expanding my documentation. From the study of Greek monetary weights and the operation of Greek mints, I passed to the topic of the dimensions of Greek temples. The study of Greek temples much later led me to the study of ancient geography and geodesy. But I was gradually forced to accept the fact that scholars of ancient history do not read numbers, neither in ancient texts nor in research papers. I noticed a number of times, when I submitted a paper for judgment to a specialist of a particular area, that he would quickly turn a page if he saw numbers on it. In many different guises I was told that "numbers do not constitute evidence in ancient studies." Finally, I learned that I had no choice but to pursue my interests in splendid isolation.

About ten years ago I exchanged manuscripts with Hertha von Dechend, who was then beginning to write her book *Hamlet's Mill*. As an expert of ancient cosmology, she raised a strong objection to the fact that I would discuss length, volume, and weight for hundreds of typewritten pages, without ever mentioning time, whereas the ancients were dominated by the preoccupation with cosmic time, with the movement of the vault of heaven. I answered that she was right, but that I had not yet found in the texts anything that would establish a connection between time and other measures. Giorgio de Santillana, who was writing *Hamlet's Mill* together with Dechend, teased me in a friendly way by saying that I had become so stuck in the mire of economic documents that I could not lift myself out of it; I replied in the same half-serious tone that I was willing to lift my eyes to heaven only on condition of being sure that my feet remained firmly planted on the ground.

Although I recognize that astronomical measurements are extremely important, I have always been wary of dealing with them, because studies of ancient astronomy have become cluttered with metaphysical and theological doctrines. My opposition to the view that the ancients lived in a world of fantasies or even of outright hallucinations (as it is specifically claimed by scholars of ancient astronomy) is such that, after years of dealing with all sorts of measurements, I still feel most at ease with agrarian measures in cuneiform tablets, rates of money exchange in Greek inscriptions, or the volume of jars in papyri from Egypt. Yet the techniques of land surveying used in Meso-

potamia are a key to the understanding of how the ancients mapped the sky.

Because of my horror of metaphysical or pseudo-metaphysical intrusions, I had several times picked up and then dropped the problem of the dimensions of the Great Pyramid of Giza. It was only after Peter Tompkins took upon himself the task of organizing the literature in the field, separating sense from nonsense, that I gained the courage to deal with the problem to the point of some conclusion. In the course of discussing with me the geometry of the Great Pyramid, Tompkins explained how the Great Pyramid with its galleries could have been used to measure the movements of the vault of heaven. In describing the possible procedures, he pointed out how a second of time in the motion of the vault of heaven corresponds to a definite length on earth. For me this was a Galilean revolution in that it permitted me to see ancient astronomy in terms of observational techniques based on measurements, rather than systems based on the theological persuasions or the psychological projections of the modern investigators. Once I was able to link time together with length, volume, and weight, a number of scattered researches suddenly became related to each other. Up to that moment I had had the uncanny feeling that somewhere there was a piece missing, and I knew that a missing piece, even a little one, is vital when one deals with measurements.

Since Tompkins has asked me to write a summary of my findings that relate to the problem of the Great Pyramid, I have tried to comply with his request.

I. EGYPTIAN GEODETIC SYSTEM

1. The present Arabic name of Egypt is *al Misri*, which is the equivalent of the biblical *Miṣraîm*. This name is derived from the Semitic root which in Akkadian gives the verb *aṣaru*, "to cut, to delimit, to delineate," and hence "to draw a picture, a plan," and the noun *eṣertu*, "drawing plan, representation," applied in particular to the specifications for the construction of a building. In Semitic language an "m" before the root of a verb forms what we would call a past participle: Egypt is the country built according to a geometric plan.

The Egyptians expressed this idea by calling their land *To-Mera*, "the land of the *mr*." The word *mr* is used to refer to the pyramids, but more specifically it refers to the meridian triangle of a pyramid, whose hypotenuse is the apothem. The *mr* essentially is a right triangle with an angle of 36° and another angle which of necessity is 54°.

Since the Egyptians did not have trigonometric tables, they used this triangle to obtain the value of trigonometric functions. They conceived of this triangle as the basic building block of the cosmos. They used this triangle or modifications of it by a few degrees in geometric constructions, in the planning of buildings, in surveying, and in geography.

In the last century the Egyptologist Karl H. Brugsch noticed that the hieroglyphic sign for *mr* when used in the name *To-Mera* is accompanied by a determinative in the form of a fret or Greek key. In hieroglyphic writing a determinative is an extra sign which helps in understanding the meaning of a word by indicating the class of concepts to which the word belongs. Brugsch observed that this fret is "a peculiarly shaped geometric figure which in principle could represent the entire land *Mera* and must have a meaning pertaining to a specific peculiarity of Egypt." But, although he was much more sympathetic to science than Egyptologists usually are, he did not pursue this line of reasoning. He resisted accepting the notion that the Egyptians conceived of their country as having an exact geometric shape.

The Egyptians were proud that their country had some unique geographic features which could be expressed in rigorous geometric terms and had a shape which related to the order of the cosmos as they saw it. They believed that when the gods created the cosmos they began by building Egypt and, having created it perfect, modeled the rest around it.

2. Everybody knows that Egypt is a most peculiar, almost unique, country. Since it seldom rains there, the entire life of humans, animals, and plants depends on the water of the Nile. It is also known that the Egyptians linked the regular flood of the Nile with the movement of the sun and other heavenly bodies, such as the star Sirius. But the Egyptians put great stress also on the geographic peculiarities of the course of the Nile.

The Nile originates at the equator from lakes so immense that their water could be identified with the primeval water of the ocean. From the equator it moves north following substantially the meridian of its source at Lake Albert. It follows this line up to latitude 30°, one-third of the distance from the equator to the pole.

The key geographic position in Egyptian geography was the southern tip of the island today called al-Warraq, at the northern limit of the city of Cairo, where the Nile begins to divide into branches to form the estuary which the Greeks called Delta, after the triangular shape of the fourth letter of their alphabet. The apex of the Delta, the tip of the island al-Warraq, is cut by meridian 31° 14′ east. This meridian indicates the main line of the course of the Nile from the equator to the apex of the Delta and divides the Delta into two equal parts. It was considered the main axis of Egypt.

But in terms of latitude the apex appeared at first not as perfect as it should have been, since it was at latitude 30° 06′ north and not at the perfect latitude 30° 00′ north, which is the latitude of the Great Pyramid of Giza. But the Egyptians reassured themselves by observing that the southern limit of Egypt is indicated by the First Cataract. The upper edge of this cataract is at the perfect latitude 24° 00′ north, whereas its lower edge is at 24° 06′ north. Hence, they could say that Southern Egypt has an extension of 6° 00′, which may be counted either from 24° 00′ to 30° 00′ north or from 24° 06′ to 30° 06′ north. They adopted as a principle that geographic distances are measured by units of 6 minutes (1/10 degree). They assumed that the interval between the equator and the pole was divided into belts (in pictures they portrayed actual belts with clasps) of 6′; on the basis of this the Greeks introduced into our geography the term *zone,* which in Greek means "belt."

For the benefit of those who understand mathematics, I may add that the Egyptians analyzed curves by dividing the area under a curve into a series of rectangles, which is the basic principle of integral calculus. It seems that in analyzing the curvature of the earth, they used rectangles 6′ wide.

Geographically Egypt is divided into two different parts. Southern (or Upper) Egypt is essentially a canyon cut into the desert plateau by the Nile; it is long and narrow. Northern (or Lower) Egypt is a typical estuary, swampy and wide. In spite of the efforts of the rulers to stress the unity of the country, the two parts continued to be conceived as different even in political and administrative terms. This is the reason why the Hebrew word for Egypt, *Miṣraîm,* has the grammatical form of the dual. The Pharaoh wore two crowns on his head: a red straw hat for Northern Egypt and a white wool cap for Southern Egypt.

Although not much is known about the history of predynastic Egypt, it seems rather well established that in this period the two Egypts were unified for a time, with a capital at Behdet at the extreme north of the curved coastline of the estuary, as far north as one could go in Egypt. Although archeologists have not yet identified the location of Behdet, the data of geography indicate that Behdet, either as a geodetic point or as an actual city, was at 31° 30′ north 31° 14′ east. It was on the main axis of Egypt and of the

Nile, on the meridian of the apex of the Delta, at a distance of 7° 30′ (1/12 of arc of meridian) from the southern boundary of 24° 00′ north and at a distance of 1° 24′ = 1.4° from the apex. The distance from latitude 30° 00′ north is 1° 30′, so that it could be assumed that Southern Egypt relates to Northern Egypt as 4:1. Southern Egypt is 1/15 of arc of meridian and Northern Egypt is 1/60. We shall see that the total length of Egypt from 24° 00′ north to Behdet was calculated as 1,800,000 geographic cubits. Since 400 cubits is a stadium and 600 stadia is a degree, it is a length of 4500 stadia (3600 stadia for Southern Egypt and 900 stadia for Northern Egypt).

This is the way in which the dimensions of Egypt were rationalized in the predynastic period.

3. The dynastic period begins with the final unification of the two Egypts. At this moment Egypt emerged from prehistory, because writing was invented in the form of hieroglyphs. At the same time the geodetic system of Egypt was revised, stressing the importance of the number 7 and linking the geography of Egypt with the geography of the heavens.

The main feature of the map of the sky is that the sun follows a course which is at an angle with the equator. The circle marked by the sun is called the ecliptic and the angle of this circle with the circle of the equator is the angle of the ecliptic (roughly 24°). The ecliptic cuts the plane of the equator at two points and reaches its highest and lowest points in relation to the equator at celestial latitudes which are marked on the surface of the earth by the tropics.

The moon and the planets in their movements around the earth follow substantially the line of the ecliptic, being at times north and at times south of the course of the sun. (The body which deviates most sharply from the ecliptic is Mercury. Mercury can be as much as 7° 00′ north or south of the ecliptic.) For this reason it was conceived that there was marked in the heavens a great "highway" (*hodos* in Greek) in which there moved the sun, the moon, and the planets. This path is 14° wide and is the origin of the concept of the zodiacal band. Since Mercury determines its dimensions and determines them by a perfect figure, in ancient religions this planet was associated with the god of measurement. It was conceived that the sun, the moon, and the planets were engaged in competing with each other running in the racing course of the zodiacal band. Another conception was that there were two walls, running parallel 14° apart, within which there was going on a ball game. The notion of a wall accounted for the fact that the heavenly bodies could not go beyond a given distance from the ecliptic; they appeared to run away from the ecliptic, hit a wall, and bounce back past the ecliptic to hit the wall on the other side. This is the ritual origin of racing competitions (such as the Olympic races, on foot or in chariots) and of ball games. The most vivid expression of the second conception is the famous ball court in the Mayan city of Chichen Itzá; the structure of this ball court can be understood when one realizes that its two parallel side walls are unfolded cylindrical projections of the sky.

The zodiacal band was conceived to be the inhabited part of the sky; the rest of the sky was still and lifeless (*erēmos*, "desert, desolate," in Greek), because nothing moved in it, except for the rotation of the vault of heaven in a solid block. Hence, in order to make a map of the sky for the study of the moving heavenly bodies, it was enough to draw a map that reaches latitude 31° (24° + 7°). Such a map could be drawn in the form of a cylindrical projection without substantial deformation; this cylindrical projection was unfolded to form a rectangle.

On the basis of this conception, stress was put on the fact that Egypt begins at the line of the tropic of Cancer (the upper edge of the First Cataract is at 24° 00′ north) and extends north for 7°, so that Egypt could be considered as the equivalent on earth of the northern half of the zodiacal band. For the sake of mapping the earth from the equator to the northern limit of Egypt, one could use a cylindrical projection. The maximum deformation in such a type of projection could be determined; it was established that a degree of longitude at parallel 31° 06′ north is exactly 6/7 of a degree of longitude at the equator. According to the Clarke Spheroid a degree of equator is 111,321 meters, of which 6/7 is 95,418 meters; according to the same Spheroid a degree of longitude at 31° 06′ is 95,407 meters. To the north of latitude 31° 06′ north there was the expanse of the Mediterranean, the "Great Green" for the Egyptians, which could be compared with the expanse of the empty sky, north of the same celestial latitude.

The angle of the ecliptic has decreased slowly (today it is 23° 27′; it was about at 23° 45′ in the age of Ptolemy), and accordingly the tropic of Cancer has moved south. This movement is due to the gravitational pull of the planets, particularly Jupiter and Venus. Nobody as yet has succeeded in constructing a valid formula for calculating the angle of the ecliptic in ancient times. But, it is a fact that when the second geodetic system of Egypt was established it was assumed that the tropic of Cancer was at 23° 51′ north. Greek scholars living under the rule of the last Egyptian dynasty, the Ptolemies, continued to quote this figure, although it was not correct at their time.

If the tropic is at 23° 51′ north, it would follow that the southern border of Egypt is out of place. But the discrepancy was rationalized by considering the fact that when one follows the movement of the sun along the ecliptic by observing the shadow cast by a pointer, there must be introduced a correction of about 15′. The position of the shadow is not determined by the center of the sun, but by the upper limb of the disk. The apparent diameter of the sun is about half a degree; calculating exactly, it varies between 32′ 30″ and 31′ 28″, according to the seasons, but, considering the corrections that have to be made for the phenomenon of irradiation, the figure of 15′ for the half diameter of the disk of the sun is satisfactory.

If the tropic of Cancer is at 23° 51′ north, the point at which the sun is at the zenith at noon of the day of the summer solstice is at 24° 06′ north, that is, at the latitude of the lower edge of the First Cataract. Hence, the Egyptians conceived that the line of the tropic of Cancer was marked by three parallels: 23° 51′, 24° 00′, and 24° 06′ north.

For this reason the hieroglyphic symbol for Southern Egypt consists essentially of three parallel lines with a vertical line rising at the middle. Since hieroglyphic writing aims at being colorful and pictorially decorative, this symbol was stylized in the shape of a trunk of a tree from which there sprout three parallel tiers of branches. Egyptologists who do not want to recognize the existence of scientific thought in Egypt have stressed the incidental vegetal appearance of this symbol. They have understood that the name for Southern Egypt, which is *To-Shemau,* "the land of the heat, of the sun, of the summer solstice," means "the land of the plant *sh-m-a.*" But if there was such a plant associated with Southern Egypt (which as yet has not been identified), it is possibly the same plant which is called *šamšu,* "sunflower" in Akkadian; the word *šamšu* means "sun" in Akkadian (Hebrew: *šemeš*). In a text of the Old Kingdom in which the hieroglyphs are drawn with particular care, in the symbol for *shemau* there is only one tier of branches, but the trunk starts from a little arc, a semicircle, which obviously symbolizes a parallel. But what probably is most revealing is that in most hieroglyphic texts the tiers of branches sprout from the bottom of the trunk and not from its top.

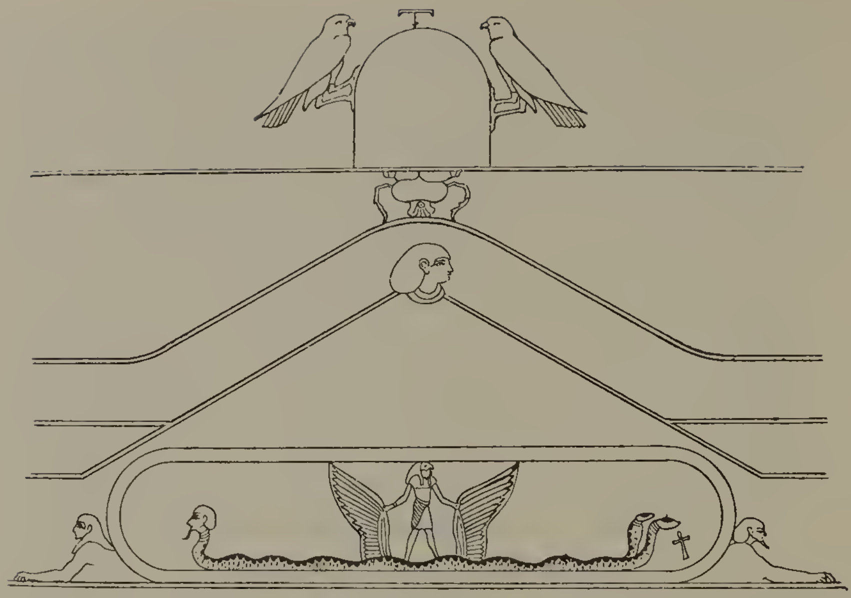
4. Once the latitudes of the southern limit of Egypt were rationalized by identifying the line of the tropic with three parallels (the first of which cuts the lower edge of the First Cataract at 24° 06′, the second cuts the upper

edge of it at the perfect latitude 24° 00′, and the other cuts the Nile at 23° 51′ north, at a place which the Greeks called Parembole, "supplement, addition"), it became possible to rationalize the boundary between Southern Egypt and Northern Egypt. This boundary was understood as marked by three parallels, the first at 30° 06′, the latitude of the apex of the Delta, the second at the perfect latitude 30° 00′, and the third at latitude 29° 51′.

In the administration of Egypt, the area between 29° 51′ and 30° 06′ north was organized as a special district which did not belong either to the list of nomes (provinces) of Southern Egypt nor to that of nomes of Northern Egypt. The hieroglyph for this district is a rectangle which is either empty or filled with water or fish. A distinguished Egyptologist, being at a loss for a better explanation, has read this hieroglyph as "fishpond." He did not realize that a rectangle, either empty or filled with water or fish, is the symbol of the Square of Pegasus. In *Hamlet's Mill*, de Santillana and Dechend have presented illustrations of this symbolism occurring all over the globe (between pages 434 and 435). There are in the sky four stars which are at a distance of about 15° from each other and mark a square with sides that run according to the celestial meridians or parallels; these four stars form the Square of Pegasus. In iconography this square was at times portrayed as filled with water or fish, because it was in the constellation of Pisces. The Square of Pegasus was considered the starting point in the mapping of the sky. The ancients, from the Sumerians to the Romans, in surveying land began by marking a square of a standard dimension and then proceeded to measure out of it in a checkerboard pattern. In cuneiform texts the name *ikū* is given to the basic surveying square, to a unit of land surface, and to the Square of Pegasus. The hieroglyph used to refer to the district extending for 15′ from Memphis-Sokar to the apex of the Delta indicates that this district was considered the basic reference unit from which there started the mapping of Northern and Southern Egypt.

The capital of united Egypt was established at Memphis, at latitude 29° 51′ north. But, since the capital city of necessity had to be on the bank of the Nile, which here runs slightly east of the apex, the geodetic point was set to the west of the city in the funerary area (the city of the dead is always to the west of the city of the living), on the basic meridian 31° 14′ east. This was the point called Sokar, the name of which is preserved by the present village of Saqqara (29° 51′ north, 31° 14′ east). In the religion of the Old Kingdom, Sokar is an important god of orientation

Egyptian papyrus depicting Sokar, the god of orientation. The gadget on top of the *omphalos* is a standard Egyptian measuring ruler (and also the symbol for the sky). The two pigeons facing each other are the standard glyph for the laying out of parallels and meridians.



and of cemeteries. The god and the geodetic point were represented by the stone object which the Greeks called *omphalos,* "navel"; it is a hemisphere (the northern hemisphere) resting on a cylinder (the foundations of the cosmos). Usually on top of Sokar, as on top of any *omphalos,* there are portrayed two birds facing each other; in ancient iconography these two birds, usually doves, are a standard symbol for the stretching of meridians and parallels.

The practice of placing the geodetic center in the city of the dead was followed by King Darius the Great, when he established a new capital for the Persian Empire, Persepolis. Historians have wondered why Darius should have chosen for Persepolis a most inconvenient location; actually the capital of Persepolis was seldom used except for ritualistic purposes. Persepolis is at latitude 30° 00′ north and three units of 7° 12′ east of the main axis of Egypt (31° 14′ east). The reason for choosing units of 7° 12′ is that the Persian Empire was mapped by drawing a series of geodetic squares, east and west of Persepolis, which extend 6° in latitude from 30° 00′ to 36° 00′ north and have a width of 7° 12′ of longitude, since 7° 12′ of longitude is equivalent in actual length to 6° of latitude at the middle point between 30° 00′ and 36° 00′ north. Hence, these geodetic squares are true squares. The geodetic point of Persepolis, 30° 00′ north, 52° 50′ east, is north and west of the wide expanse of the royal buildings and is identified by the tomb of King Darius, around which there were built the tombs of his successors. At the geodetic point 30° 00′ north, 52° 50′ east, there could be erected tombs, but there was not the kind of ground on which there could be stretched a capital city.

The location of Memphis-Sokar had the advantage of being exactly 8° north of the point where meridian 31° 14′ east cuts again the course of the Nile at the Second Cataract. In a new imperialistic spirit, Egypt in a wide sense was understood to end at the Second Cataract.

5. According to the new conception which links Egypt with the sky, if Southern Egypt extends 6° from the tropic, Northern Egypt must extend only 1° to the north of the apex, in order to be in agreement with the order of the cosmos. Hence, the northern limit of Egypt was set at parallel 31° 06′ north.

This was achieved by identifying the northern limit of Egypt with the line that joins the two outer ends of the estuary of the Nile. This line extended 1° 24′ = 1.4° east and west of the axis 31° 14′ east. Hence, there was marked a triangle, which the Greeks called the Delta, with a base line extending from 31° 38′ to 29° 50′ east along parallel 31° 06′ north and a vertex at the long-established point of the apex of the Delta. This isosceles triangle is divided by meridian 31° 14′ into two right triangles of the type *mr*. In calculating the proportions of this triangle, one must keep in mind that at latitude 31° 06′ north, 1.4° of longitude corresponds to 1.2° in actual length, since the degree of longitude is shrunk by 1/7 at this latitude.

The base line of the mathematical triangle of the Delta fell perfectly at the eastern end. Here the corner of the Delta coincides with the well-defined natural boundary point Pelusium, along the shore. On the western side the corner of the Delta did not fall right on the shore, but at the middle of a coastal lagoon; even today the eastern boundary of the Western Desert province of Egypt passes through it.

The old geodetic center of Behdet was not completely ignored, since it could be fitted into the system by considering that it is 1.4° north of the apex of the Delta.

I have stated earlier that it was assumed that at latitude 31° 06′, the degree of longitude is 6/7 of the degree of equator. This calculation permitted the rationalization of the shift of the key positions of Egypt by 6′ to the north of the perfect latitudes 24° 00′ and 30° 00′ north. The shift was related to the polar flattening of the earth, which, according to the septenary order of the cosmos, was assumed to be 1/280. If the earth were a perfect sphere, the degree of longitude which is 6/7 of degree of equator would be at latitude 31° 00′ (cosine 31° 00′ = 0.85717; 6/7 = 0.85714).

Anticipating what I will explain in greater detail later, I must mention here that the dimensions of Egypt were recalculated in terms of a new unit of length, the royal cubit, which is obtained by adding a seventh hand to the usual six which compose a cubit. In terms of this longer cubit, the length of Egypt from 31° 06′ to 24° 00′ north was set at 1,500,000 cubits. The royal cubit summed the septenary spirit of the new geodetic system.

In hieroglyphic writing the name for Northern Egypt is *To-Meḥu*. Most Egyptologists, following the line of reasoning which I have mentioned in relation to Southern Egypt, have understood that *To-Meḥu* means "the land of the papyrus," but the name of the papyrus is *ḥly,* and the symbol for Northern Egypt cannot be compared with a papyrus plant by any stretch of the imagination. The name of Northern Egypt can be explained when we consider that it is similar to the name of the cubit (*maḥe* in Coptic), which comes from a root which means "to fill up." Hence, *To-Meḥu* may mean "the land which fills up the dimensions of Egypt." Northern Egypt corresponds to the seventh hand added to the cubit.

From what we have of early writing attempts from predynastic Egypt, it is absolutely clear that the symbol for Northern Egypt used to be the red straw hat. With the beginning of the dynastic period, the creation of hieroglyphic writing, and the new geodetic system, the symbol of Northern Egypt becomes a plant with three stems springing from one root. In some cases the reference to the triangularity of the Delta is emphasized by putting at the end of each stem a flower with a triangular calyx. In carefully drawn representations the plant springs from a rectangle either empty or filled with the wavy line for water, which is the symbol for the intermediary district, extending from 29° 51′ to 30° 06′ north.

At times the stems in the symbol for Northern Egypt are broken and bent at the top. This may be a reference to the fact that in the new geodetic system the northern limit was lowered from 31° 30′ to 31° 06′ north.

On the two sides of the throne of the Pharaoh there was a design which Egyptologists call "Unity of Egypt." We know it well because it appears in all statues of Pharaohs sitting on the throne; the series of such statues starts with the Fourth Dynasty, but occasional drawings indicate that the design "Unity of Egypt" is older. In the course of centuries the design varied somewhat and the artists who carved the throne stylized it according to different tastes; but on the basis of what I have explained above, one can always recognize that it represents the geodetic system of Egypt.

The center of the design is the hieroglyphic sign for the verb "to unite," which is a windpipe with two lungs.

However, in the design "Unity of Egypt" the windpipe is stretched, so that it looks like a long trunk of a tree, in order to indicate the main axis of Egypt; the lungs are reduced to a diminutive size. On one side of the windpipe there is the symbol for Northern Egypt and on the other side the symbol for Southern Egypt. But what is most significant is that the entire drawing is tied together by a system of ropes and knots, which indicate the geodetic lines and points of Egypt.

The design called "Unity of Egypt" is the standard decoration of the royal throne, because it symbolizes all that the Egyptians held fundamental in their political, ethical, religious, and cosmological conceptions, a cluster of ideas which they summarized by the word *maet,* a word with which I will deal in a following chapter. Nevertheless, this design has received only casual attention. The best way in which I can convey in brief how this design is pregnant with meaning is by referring to Hebrew Cabalistic literature. The Cabala is a Hebrew underground religion or philosophy. The starting point of Cabalistic doctrine is that God in creating the world began by creating the ten numbers and arranged them according to a diagram of points and connecting lines, which proves to be modeled on the design "Unity of Egypt." Actually, what gave me the first insights into the Egyptian geodetic system was the reading of the Italian Renaissance scientists who were influenced by Hebrew Cabalists.

The state of Israel has adopted as its national emblem the Cabalistic symbol of two overlapping triangles. These two triangles should be seen as inscribed in a circle: they represent the poles, the tropics, and the ecliptic, besides having the added meaning of the male and female elements coming together to generate the cosmos. The Founding Fathers adopted as the seal of the United States a pyramid; they wanted to convey the notion that a perfect society had been organized, and in order to convey it they adopted a symbol which, through the tradition transmitted by masonic societies, goes back to the Egyptian idea of *maet.*

6. The geodetic system established at the beginning of the Old Kingdom was modified in part with the advent of the Twelfth Dynasty, the most dynamic of the Egyptian dynasties as far as we know. The advent of this dynasty marks the beginning of what scholars call the Middle Kingdom period. But probably more significant in Egyptian terms was that the advent of this dynasty coincided with the beginning of the age of Aries. It became necessary to revise the system of cosmology, since the sun had moved out of the constellation of Taurus to enter into that of

Aries. The kings of this dynasty identified themselves with the god Amon, symbolized by the ram. The first king of the dynasty called himself Amenemhet, introducing the custom of theophoric names, that is, of personal names composed with the name of a god. The god Amon was made to spring from relative obscurity into the position of the main official divinity of Egypt. It seems that up to that time Amon was a local god of the desert area west of Thebes or that Amon was identified with a local god of that area.

The Twelfth Dynasty moved the capital and the geodetic center of Egypt to a more central position, Thebes. The longitude of the new capital was determined by the point where the eastern axis of Egypt (32° 38′ east) cuts the course of the Nile. The latitude was 2/7 of the distance from the equator to the pole (25° 42′ 51″ north). This latitude was marked by the central room of the temple of Amon, in which the god and the geodetic point most probably was indicated by the same object, the *omphalos*, "navel," which used to represent the god Sokar. What is certain is that when centuries later in the capital of Nubia, Napata, there was built a second temple of Amon in order to link Nubia with Egypt politically, in the center of this temple there was placed such an object.

Egyptologists have tried to torture Egyptian linguistics in order to explain why the Greeks should have given the name Thebes to a city which the Egyptians called Wast. The likely explanation is that the Greeks learned the name of the city from the Phoenicians, who in their own language called it *thibbûn*, "navel." There is textual evidence that in Hebrew, which is practically the same language as Phoenician, the word *thibbûn* is used to refer to a geodetic navel.

The choice of the latitude emphasized the septenary system of Egyptian geography. The ancients divided the space between the pole and the equator into seven zones. This is indicated not only by Greek writers of geography, but also by the ziggurats of Mesopotamia and the earliest pyramids of Egypt, which are step pyramids.

7. It was possibly on the occasion of the transfer of the capital and geodetic center to Thebes, which stresses the importance of the eastern meridian of Egypt (32° 38′ east), that something was done to rationalize the longitude of the First Cataract. The First Cataract happened not to be included in the rectangle of Egypt, being somewhat to the east of meridian 32° 38′, at 32° 53′ east. The lower edge of the cataract, at 24° 06′ north, 32° 53′ east, is 15′ north of the right position and 15′ west of it. It must have been

disturbing that the southern boundary of Egypt should not fit with the system of three meridians passing through the three angles of the Delta triangle. Hence, the area of the First Cataract was extended southward along the course of the Nile up to the point where meridian 32° 38′ east cuts the course of the Nile. This point happens to be at 23° 00′ north. The new point 23° 00′ north, 32° 38′ east was called Sacred Sycamore and was set as the legal boundary of Egypt. The stretch of the Nile from the Sacred Sycamore to the First Cataract was attached to the district of the First Cataract. In Hellenistic times this attached district was called Dodekaschoinos, which in Egyptian would be "twelve *atur*." The *atur*, as I will explain later, was a unit of length such that slightly more than 14 (14 in practical computations) went into a degree. If the distance of 51′ between 23° 00′ and 23° 51′ north, the correct line of the tropic, is calculated as 12 *atur*, it means that counting exactly a degree would be 14.11765 *atur*. The Egyptians used two types of *atur:* an *atur* of 17,000 geographic cubits (7848.8 meters) and an *atur* of 15,000 royal cubits (7862.2 meters). Now, 51′ at latitude 23° to 24° is about 94,135 meters, whereas 12 *atur* of the first kind is 94,186 meters and 12 *atur* of the second kind is 94,346 meters.

Even though the district Dodekaschoinos was attached to Egypt purely for mathematical reasons, it continued to be included in Egypt into the Roman period.

I suggest that the establishment of the supplementary district Dodekaschoinos with a new southern boundary of Egypt at 23° 00′ north was linked with the transfer of the capital to Thebes, because there is a text which gives the dimensions of Egypt from the sea at Pelusium (eastern corner of the triangle of the Delta) to the end of the district Dodekaschoinos, that is, all along meridian 32° 38′ east. The distance is divided into two-thirds from Pelusium to Thebes and one-third from Thebes to the Sacred Sycamore. If we round the latitude of Thebes from 25° 42′ 51″ north to 25° 42′ north, the calculation is perfect:

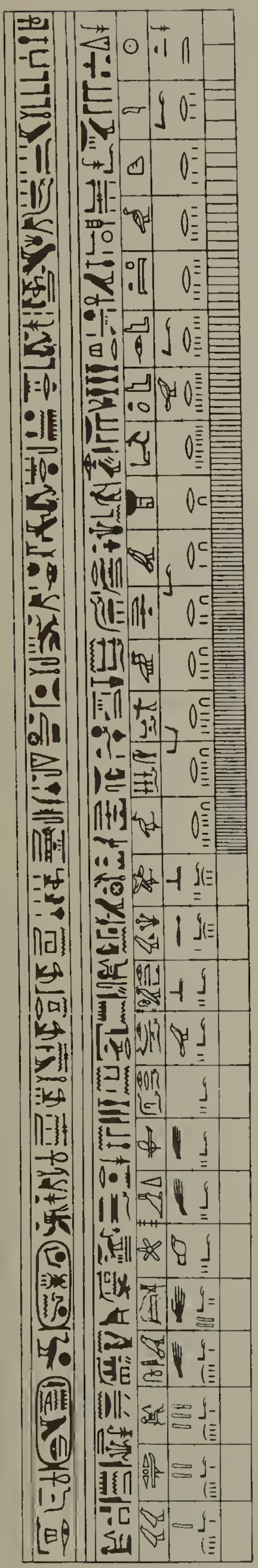
31° 06′ to 25° 42′ north = 5° 24′
25° 42′ to 23° 00′ north = 2° 42′

When the southern boundary of Egypt is moved to the Sacred Sycamore by adding the district Dodekaschoinos, the Temple of Amon in Thebes is in a rational position not only in relation to arc of meridian, but also in relation to the extension of Egypt.

The text that gives the information just mentioned indicates also that the latitude of Thebes has a further peculiarity: at this latitude the degree of longitude is 9/10 of degree of equator.

1. All the measures of length, volume, and weight of the ancient world, including those of China and India, constituted a rational and organic system, which can be reconstructed starting from a fundamental unit of length. I have not yet completed the gathering of data concerning the units of pre-Columbian America, because these are difficult to obtain, since the metrology of the American continent has received meager attention; but the figures that I have succeeded in establishing so far suggest that the American units agree with those of the Old World. The units used in Europe up to the adoption of the French metric system were the ancient ones or modifications of them introduced for specific reasons. The ancient system of measures continues to be used today in the form of English measures; we find the basic units of the English system, such as the pound of 453.8 grams, used in Mesopotamia in the third millennium B.C.

The effort to reconstruct the original and unitary system of measures was started by scholars of the Renaissance as a result of the beginning of the age of geographical discoveries. Their investigations, although they took the form of antiquarian research, had two practical purposes: to interpret correctly the data provided by ancient geographers and to establish an absolutely reliable and fixed standard of length. Although the major concern of Renaissance investigators of measures was to establish the exact value of the ancient Roman foot, they were also concerned with a tradition to the effect that all measures were derived from the Egyptian ones. This is the reason why John Greaves went to measure the Great Pyramid of Giza, in order to complete his researches on the length of the ancient Roman foot. In Egypt Greaves met with Burattini, who had gone to measure the monuments of Egypt, in order to establish the linear starting point (for which he coined the name *meter*) in his proposal for a new metric system which would be strictly decimal, like the one later adopted as the French metric system. Greaves had the advantage of having spent a long time in Rome measuring buildings, vessels, and weights and of being provided with accurate measuring tools, based on English units; Burattini had the advantage of having already measured a number of Egyptian buildings. Greaves and Burattini joined forces in measuring the Great Pyramid of Giza, which they hoped would provide a solution to their problems. After this survey Greaves returned to England, leaving his measuring tools with Burattini, who continued the study of Egyptian monuments. On his return Greaves published the results obtained at Giza,



Egyptian measuring rule carved out of wood showing various fingers, palms, and cubits (at present in the Turin Musem).

results which were later interpreted by Newton. But Burattini had the ill luck to be robbed of his notes by Hungarian brigands while on his way to Poland. As a result, when he published his proposal for a decimal metric system, for lack of a better alternative, he advocated that one should start with the English foot and divide the cube of this foot decimally in order to obtain the units of volume and weight.

The study of Egyptian measures received a new impulsion with the Napoleonic expedition to Egypt and the consequent decipherment of Egyptian hieroglyphs by Champollion. This decipherment had been unsuccessfully attempted by Father Athanasius Kircher, who had sponsored Burattini's expedition to Egypt. In the first half of the nineteenth century, it was established that the Egyptians had a septenary system of linear units.

In the ancient world one measured by feet and cubits. The cubit is equal to 1 1/2 feet. The cubit is divided into 6 hands of 4 fingers each (24 fingers) and the foot is divided into 4 hands (16 fingers). The division of the foot into 12 inches, with which we are familiar, became common only with the Romans. According to the Roman reckoning the cubit is 16 inches. The inch was considered to be the thickness of the thumb; generally in the ancient world one preferred to reckon by fingers, assumed to be the thickness of the other four fingers. It must be kept in mind, however, that terms like foot, cubit, finger, and inch were introduced in order to give a name to units obtained scientifically, units which correspond only vaguely to the natural units of the same name.

Scholars of Egyptology concluded that the Egyptians had started with a foot of 300 millimeters and a corresponding cubit of 450 millimeters, divided into 16 and 24 fingers as in the rest of the ancient world, but then had adopted as their linear basic unit a cubit, called a royal cubit, of 525 millimeters. The royal cubit is composed of 7 hands, or 28 fingers: it is an ordinary cubit with a seventh hand added.

2. One can find examples of septenary units also outside Egypt. The use of measuring rods of seven feet is common in medieval and early modern Europe. A typical example of septenary units is the Russian *sajen'*, which is composed of 7 English feet and is divided into 3 *arshin* of 28 inches. The *sajen'* was the basis of the Russian system of measures until the Soviet government adopted the French metric system in 1918.

The reason for the occurrence of septenary units is that they were convenient in practical reckonings. Agrarian units of surface were arranged in a series in which each was double of the preceding one. It was assumed in practical reckonings that a square with a side of 100 was the double of a square with a side of 70 and the half of a square with a side of 140. This implies that $\sqrt{2} = 1.414214$, taken as equal to 1.4. A typical example of this reckoning is the area of 5000 square cubits, within which a Jew can move on the Sabbath, which is described by the Talmud as "the square of seventy cubits." When greater precision was desired in practical reckonings, one averaged the results of considering the diagonal of a square as 10/7 of the side and as 14/10 of the side ($1.42857 + 1.4/2 = 1.41428$).

Septenary units were used also in order to facilitate other practical reckonings. The height of an equilateral triangle being equal to $\sqrt{3}/2$ of the side, the relation can be taken as 7:6, since $12/7 = 1.71428$ and $\sqrt{3} = 1.73205$.

According to the septenary system of reckoning, the circumference was considered 22/7 of the diameter; the approximation $\pi = 3\ 1/7 = 3.142857$ is still used today as an adequate approximation in many problems of engineering.

The figure 22/7 used to obtain the value of π in practical reckonings is related to the fact that the ancients used both septenary and undecimal (i.e., eleven-based) units in order to achieve easy computations in practical reckonings. Undecimal linear units were common in the ancient and early modern world; an example of them is the English chain of 66 feet. An acre, originally a square with sides of 70 yards, is now 10 square chains (4840 sq. yards).

An important practical problem involving the number π was solved by the use of undecimal units. Units of volume were legally defined as cubes, but measuring vessels were built as cylinders. All that an ordinary potter, who could be an illiterate person, had to know was that, in order to construct a cylinder equal in volume to a given cube, he had to take the height and width of the cube and use them as the height and diameter of the cylinder, provided he measured the cylinder by a ruler based on a unit of length increased by 1/10. The procedure results in a cylinder of slightly excessive volume. If we assume a cube with a side of 10 fingers, its volume is 1000 cubic fingers. A cylinder with a diameter of 11 fingers and height of 11 has a volume of 1045.4 cubic fingers. But this small excess was automatically corrected in practice, since a measuring vase must have a rim and cannot be filled to the brim. A filling line marked on the measuring vase slightly below the brim took care of the difference. I first became aware of this procedure in interpreting cuneiform mathematical texts, but later I found it referred to in Athenian inscriptions and applied concretely in Athenian measuring vessels.

By combining calculations by the factor 7 and calculations by the factor 11, one could solve practically a number of geometric problems involving irrational numbers. This practice is one of the reasons why the builders of the Great Pyramid began their plan with a height of 280 royal cubits and a side of 440.

A simple example of the combination of reckoning by septenary and undecimal units is the following. As I have said, in agrarian units it was assumed that a square with the side of 100 is the double of a square with a side of 70 and half of a square with a side of 140. This procedure would result in units of the following surface:

49,000
100,000
196,000

In order to make the series more regular, the middle unit was often taken as a square with a side of 99, so that the series became:

49,000
98,010
196,000

When Herodotus reports the surface of the sides of the Great Pyramid, he reckons by units of surface calculating by the second pattern.

Although the use of septenary units had been common in ancient times and later, in Egypt the septenary cubit became a national symbol related to the essential structure of Egypt and of the cosmic order.

3. In the second half of the nineteenth century, some scholars of ancient measures tried to derive them from the Egyptian units of length. Although in the last fifty years it has become fashionable among scholars of ancient cultures to deny that they had any knowledge of a scientific system of measures, all serious scholars of ancient and medieval measures have always known that all measures of volume and weight are derived from the units of length. Units of volume were obtained by cubing the units of length. Units of weight were obtained by filling the units of volume with rain water at ordinary temperature; this water has the same density as distilled water at 4° Centigrade adopted by the French metric system, since in the earlier procedure the impurities of the rain water compensated for the higher temperature.

Friedrich Hultsch, who was the most authoritative investigator of ancient measures in the later part of the last century, concluded his lifelong research by announcing just before his death that all ancient measures could be derived from the Egyptian foot of 300 millimeters and from the corresponding ordinary (not septenary) cubit of 450 millimeters. He also supported the view expressed by others that the Egyptian unit of weight called *qedet,* of 9 grams, is the basic unit of weight of the ancient world.

But Hultsch left a difficulty unsolved. If we cube an Egyptian foot of 300 millimeters, we obtain a cube of 27,000 cubic centimeters or grams, which is divided into 3000 *qedet* of 9 grams. If we cube an Egyptian ordinary cubit of 450 millimeters, we obtain a cube of 91,125 cubic centimeters or grams, which is divided into 10,000 *qedet* of 9.1125 grams. Sample weights indicate that both *qedet* were used in Egypt. A *qedet* of 9 grams relates to a *qedet* of 9.1125 grams as 80:81.

The same discrepancy occurs all over the ancient world. Prince Mihail Sutzu, Director of the National Bank of Rumania, having dedicated his life to the study of ancient weights, in 1930 concluded that the *qedet* of 9 grams is the *bazele fundamentale ale metrologiei ponderale din antichitate,* but, in order to explain the mentioned discrepancy in weights, supposed that there had been a gradual decrease from a unit of 9.20 grams established in the neolithic period.

But in presenting this explanation Sutzu contradicted one of his basic assumptions, which is the amazing stability of measures throughout history. From the very beginning of literate cultures, documents indicate an extreme concern with the preservation of exact metric standards. The concern with precision seems to have lessened in the course of history. Early modern Europe was less careful than medieval Europe. The Greeks of the Hellenistic age were less careful than those of the classical age. Even though the Greeks of the classical age seem to have been obsessed with the problem of correct standards, they did not reach the subtlety of Egypt and Mesopotamia. One of the reasons why the study of the history of measures was actively pursued in the late Renaissance was that by that time standards had started to waver.

There were two factors which determined extreme concern with absolutely exact standards: units of length were used to measure geographic distances, and units of weight were used to measure gold and silver used as means of exchange.

The amazing stability of measures is indicated by the circumstance that the kilogram was established by relating it to the Paris livre which was directly related to the Roman *libra*. The official definition of the kilogram is such that the livre equals 489.5058466 grams. Since the livre was divided into 9216 grains (16 ounces of 24 scruples of 24 grains), the Paris grain according to this definition is 0.05311478 gram. Historically the Paris livre was established by fixing the Paris grains as 1/6100 of the ancient Roman *libra,* the Roman *libra* being 324 grams (5000 English grains) or 36 Egyptian *qedet.* If the original standard had been preserved, the grain of Paris would have been found at the moment of adoption of the French metric system to be 0.05311475 gram and the livre to be 489.5055737 grams. In substance the standard of the Paris livre and hence of the Roman *libra* appear to have been well preserved, even though those who established the French metric system did not consider the theoretical foundations of the livre, but simply averaged several sample weights which were available. However, scholars of the seventeenth century complained that Paris measures were not very clearly defined and had concluded that English units of weight were more exactly defined.

The English grain has remained stable as 1/5000 of a Roman *libra*. English weight units have not changed at all since Sumerian times. The oldest weights of which I have found mention in an archeological report are those excavated at Tepe Gawra in Iraq, near the present oil center of Mosul. The lowest strata of Tepe Gawra embody the very first steps of the transition from village life to urban life. The earliest weights of Tepe Gawra precede by about a millennium the invention of writing. According to my interpretation these weights are fractions of the present English ounce avoirdupois of 28.350 grams (1/16 pound, which is 7/5 of a Roman *libra*).

4. Before explaining why there was a *qedet* of 9 grams and a *qedet* of 9.1125 grams, I must deal with a much more serious difficulty met by Hultsch.

He assumed that all measures of the ancient world can be derived from the Egyptian foot, but could not solve the absolutely essential problem of explaining how the Roman foot of roughly 296 millimeters could be derived from the Egyptian foot of 300 millimeters.

The key to the solution of this problem was provided to me when in 1942 the archeologist August Oxé, at the end of lifelong research, published a monograph explaining that almost all units of volume and weight of the ancient world exist in two varieties, related as:

12.5	25	50	62.5	75	100	125	150
12	24	48	60	72	96	120	144

He called the first series units *brutto,* and the second series units *netto*. The reason for the existence of the second series is that it is impossible from the practical point of view to divide decimally a cube into smaller cubes.

Developing the discovery of Oxé, I arrived at the logical consequence that units of length must usually occur in two varieties, one which is the edge of a cube containing a unit *brutto* and one which is the edge of a cube containing a unit *netto*. The two varieties of units of length are related as $\sqrt[3]{25}:\sqrt[3]{24}$. I call the first group of units of length by the name of *natural* units and the second group by the name of *trimmed* units.

From an Egyptian cubit of 300 millimeters we derive:

Basic talent *brutto* of 27,000 cubic centimeters or grams
1000 Roman ounces of 27 cubic centimeters or grams
3000 Egyptian *qedet* of 9 grams

It follows that the cube of the Roman foot (which the Romans called *quadrantal,* or *pes quadratus*) must be 24/25 of the preceding unit:

Basic talent *netto* of 25,920 cubic centimeters or grams
960 Roman ounces of 27 cubic centimeters or grams
2880 Egyptian *qedet* of 9 grams

The Roman quadrantal or basic talent *netto* is divided into 80 librae of 324 grams (12 ounces or 36 *qedet*). The libra is equal to 5000 English grains.

Accordingly I could establish that the Roman foot relates as $\sqrt[3]{24}:\sqrt[3]{25}$ to the Egyptian foot of 300 millimeters, and hence is a unit of 295.9454 millimeters, which is a figure in agreement with the empirical evidence.

Having established the theoretical basis of the Roman foot and of the Roman quadrantal, I could dispose of a difficulty which had bedeviled scholars since the Renaissance. By examining the empirical evidence it had been established that the Roman foot existed in two varieties, one shorter (called *pes Statilianus* by Renaissance scholars) and one longer (called *pes Aebutianus*). Correspondingly, there were two varieties of Roman libra.

The explanation for this difference is that units of volume and weight may occur in two varieties related as 80:81, with a difference which I call discrepancy komma. In 1909 Jean Adolphe Decourdemanche, at the end of his book on Arabic measures, added a proviso explaining that all Arabic units of weight and volume occur in two varieties related as 80:81. My teacher Angelo Segré, in studying the measures of Hellenistic Egypt, found that, although the cube of the cubit is 3 3/8 of the cube of the foot, given that $(1\ 1/2)^3:1^3 =$ 3 3/8:1, often this relation between the cube of the cubit and the cube of the foot is taken as a relation 3 1/3:1 for the sake of easy reckoning, with the result that there is a discrepancy of 1/80, since 3 1/3:3 3/8 = 80:81.

The most striking example of the discrepancy komma (1/80) is that next to the quadrantal (cubed Roman foot) of 80 librae there is a quadrantal of 81 librae. This larger quadrantal has an edge which constitutes a special Roman foot of 297.1734 millimeters (instead of 295.9454 millimeters), which was called geometric foot in the Middle Ages. The Roman foot of the geometric variety was the scientific foot of early modern science. Scientists began to calculate by the French *pied de roi* (which originally was the undecimal version, 11/10, of the Roman foot) after Picard used it in his famous calculation of the circumference of the earth, and Newton quoted Picard's figures in presenting the empirical proofs for the theory of gravitation. The *pied de roi* was used in calculating the length of the Paris meter, theoretically defined as 1/10,000,000 of the arc of meridian: the meter is 1/10,000,000 of 30,784,440 *pieds de roi,* which was then the assumed length of the arc of meridian from the equator to the pole.

By dividing the quadrantal of 81 librae into 80 librae, the Romans obtained a libra of 328.050 grams, which was called the *geometric libra* in the Middle Ages. The edge of the larger quadrantal, the Roman *geometric foot,* was the standard unit in the planning of most monuments of classical Athens.

The larger Roman quadrantal (81 regular librae = 80 librae of the geometric variety), cube of a Roman geometric foot 297.1734 millimeters, contains 26,244 cubic centimeters or grams. It survived up to recently as the Russian *chetverik* (this Russian term has the same meaning as the Latin *quadrantal*). The law of 1918 that introduced the French metric system in the Soviet Union fixed the *chetverik* at 26,239 cubic centimeters.

The reason for the small difference is that Czar Peter the Great, according to his westernizing policy, had the length of the Russian *sajen'* readjusted to make it equal to 7 of the feet used in England. But the exact standard of the English foot had been lost in the Elizabethan age, and the length of the English foot has wavered until in England there was established the Imperial Yard of 1824, which makes the foot equal to 304.79974 millimeters, and in the United States the foot was defined by the Paris meter as 304.8 millimeters (act of Congress of 1928). The reform of Peter the Great caused uncertainties in the definition of Russian measures. The action of one autocrat extended the damage caused by another. As far as I can understand the record, the problem of the length of the English foot arose when Queen Elizabeth, following her policy which aimed at reducing the power of the municipal body of London, downgraded the authority of the standard of Guild Hall (*pes Curiae Londinensis*), which was considered by scholars the best standard of English foot. Incidentally, Piazzi Smyth suggested that a way to reconstruct the authentic value of the English foot is to compare the actual dimensions of the King's Chamber of the Great Pyramid with the report of the survey conducted by Greaves.

On the other side, I have examined the reports about the dimensions of the Church of St. Sophia in Novgorod, the oldest stone monument of Russia, in order to establish what was the original value of the Russian counterpart of the English foot. From the point of view of my investigations, it is lucky that an effort has been made to restore this church exactly as it was before it was destroyed by the German army in World War II.

5. Once I was able to establish the relationship between the Roman foot and the Egyptian foot (the former being the trimmed version of the latter) and succeeded in clarifying the history of the units called Roman by distinguishing two varieties of libra related as 80:81, I came to the conclusion that the root of the ancient system of measures is not the Egyptian foot of 300 millimeters, but another unit which is the geographic foot of 307.7957 millimeters.

If we take 9/8 of a Roman quadrantal of 80 regular librae or 10/9 of a Roman quadrantal of 81 such librae, we have a unit of 90 librae, which metrologists call the *artaba*. Artaba is the Persian name of this unit. Metrologists employ it because after this unit was adopted as the official standard by the Persian Empire, the use of its Persian name became general in the ancient world: we find it in Greek, Latin, Hebrew, Syriac, and Arabic texts. But the unit itself is as old as any other known unit of the ancient world.

The artaba has the following contents:

29,160	cubic centimeters or grams
90	Roman librae
1080	Roman ounces of 27 cubic centimeters or grams
3200	Egyptian *qedet* of 9.1125 grams
3240	Egyptian *qedet* of 9 grams
450,000	English grains

The artaba was a unit of paramount importance in Egypt and several other areas of the ancient world, because it was the standard ration of wheat for a month. This was the ration for an adult free male; women, slaves, and children were assigned fractions of it. The artaba was also the standard monthly ration of rice in China.

In cuneiform mathematical and economic texts the most common unit of volume is a pint (*sila* in Sumerian, *gā* in Akkadian) of 486 cubic centimeters, which is 1/60 artaba. The pint of cuneiform texts is divided into 60 sheqels of 8.10 grams (9/10 of an Egyptian *qedet*).

The paramount importance of the artaba continued up to modern times. I have established that the key to the metric systems of medieval Europe is an ounce of 29.160 grams, which is 1/1000 of an artaba of water. This ounce was made important in Europe by the monetary reforms enacted by the Frankish Kings Pepin and Charlemagne. The artabic ounce was known in Europe as the Cologne ounce, because Cologne was the seat of one of the important mints of the Carolingian Empire. In England the artabic ounce was called ounce Tower, after the mint of the Tower of London.

In England the ounce Tower remained stable at 450 English grains (29.160 grams) or 16/15 of ounce Troy. The ounce Tower is no longer used today because it was used only to weigh coins. On the European continent the Cologne ounce remained less stable, because often it was computed as 451 grains (to my knowledge this figure is first mentioned in a document A.D. 1275). The reason for this shift was an effort to adjust the Cologne ounce to a shift in the Paris livre. The Paris livre was divided into 9216 grains (16 ounces of 24 scruples of 24 grains). For technical reasons of monetary economics, the Paris ounce had to be 22/21 of an artabic ounce. Hence, in the early Middle Ages the Paris ounce was 30.54857 grams and the Paris livre 488.77714 grams, with a grain of 0.0530357 gram. Since there were 6109.1 of these grains in the Roman libra of 324 grams, in the later part of the Middle Ages, in order to relate easily the Paris units to a well-established standard, the Paris grain was recalculated as 1/6100 of a Roman libra and the Paris ounce and livre were increased accordingly (livre of 489.50557 grams). The Paris grain (0.05311475 gram) came to be 50/61 of the English grain. This small and apparently reasonable readjustment of the Paris units was enough to create a spreading wave of uncertainty in the value of European weight units which did not come to rest for centuries. For instance, one can trace its consequences in metric and economic documents of the Low Countries, Scandinavia, and Russia.

Because of the increase in the Paris units, the Cologne ounce came to be often calculated as 451 English grains instead of 450. At the beginning of the nineteenth century, when the German states were taking steps toward national unity, it was thought expedient to try to unify the German coinage in terms of the Cologne ounce. A survey conducted in 1829 established that in Cologne itself the Cologne mark (8 ounces) was 233.8123 grams; 8 artabic ounces would be 233.280 grams and 8 ounces of 451 English grains would be 233.79840 grams. The standards of other German cities were found to be slightly different from that of Cologne, reaching a minimum with the mark of the mint of Bonn, which was

233.612 grams. On July 30, 1838, the German states signed a convention to establish a uniform monetary mark defined in terms of the French metric units as 233.855 grams; but the mine administration of Saxony continued to consider as correct the mark of Dresden, which had been set at 233.5804 grams in an assembly for the testing of monetary weights (*Münzprobationstag*) held at Regensburg in 1737. Apparently the assembly of Regensburg had followed the pattern of the medieval Assizes of Weights and Measures, who when called to resolve discrepancies between different standards of the same measure usually settled the matter by selecting an intermediary value. I may finally mention that when the French metric system was adopted in Spain, it was decreed that the pound of Aragon, composed of 12 ounces, would be thereforth considered equal to 350 grams; 12 artabic ounces is 348.720 grams.

6. The edge of the cube containing an artaba is a foot of 307.7957 millimeters (cubit of 461.6935 millimeters), which I call geographic foot, because it was the unit most commonly used in geographic measurements in all areas of the ancient world, Egypt being excepted for reasons that I will explain.

The multiple of the geographic foot is the stadium of 600 feet (400 cubits). The stadium is 1/600 degree, so that there are 360,000 geographic feet in a degree. It was assumed that a stadium (184.677 meters) corresponds to a double minute of march, implying that a man makes a step of 5 feet in a second. It was assumed that a man marching or a ship under oars covers 30 stadia (5540.3 meters) in an hour. Since it was assumed that a man can march or row for 10 hours a day, 300 stadia was considered the distance normally covered in a day. There are a great number of texts from Egypt and other areas of the ancient world which have not been understood, because they speak of 1,2,3,4, . . . days of march, when they mean a geographic distance of 30′, 1°, 1° 30′, 2°. . . . It was assumed that the speed of a ship under sail is 5/4 of that of a ship propelled by oars, so that a ship under sail covers 37.5 stadia in an hour and 900 stadia (1 1/2 degrees) in 24 hours.

In the ancient world the degree of latitude was usually reckoned as 360,000 feet (600 stadia). Sailors and travelers of the eastern Mediterranean and of the Middle East reckoned the degree of longitude as roughly 500 stadia, or 300,000 geographic feet (92,339 meters); this calculation is correct between parallels 34° and 35°.

The calculations of the degree of latitude as 360,000 geographic feet (240,000 geographic cubits) proves to be of Egyptian origin, since a degree of 110,806.5 meters proves to be correct at parallel 27° 45′ north, which is the middle latitude of Egypt according to the predynastic geodetic system, which counted 7° 30′ from Behdet to the southern limit of Egypt, latitude 24° 00′ north. According to the *Smithsonian Geographical Tables,* a degree at parallel 27° 45′ is 110,803.0 meters.

The Egyptians preferred to reckon by cubits (stadium of 400 cubits and degree of 240,000 cubits), because it is expedient to divide the circumference of the earth not only into 360 degrees but also into 24 hours. According to the second system a degree is equal to 4 minutes of time and a minute of degree is equal to 4 seconds of time. I shall deal with this matter more extensively later.

Two great scholars of this century who have dedicated their lives to the study of ancient measures concluded that these are so strictly defined and so rigorously organized that they must have a basis on some absolute natural standard. Since it is obvious from the reading of ancient texts that the ancients had a deep concern with cosmic time, with the movement of the vault of heaven, these two scholars concluded that the system of measures must have coordinated not only length, volume, and weight, but also time.

The first of these two scholars, Sir Flinders Petrie, whose major concern was Egyptian measures, thought that the starting point of ancient measures was the length of the pendulum. He advanced the theory that the Egyptians began with a pendulum that swings 100,000 times a day at the latitude of Memphis (29° 51′ north). Having established that this pendulum has a length of 740.57 millimeters, they would have taken as standard of length the side of a square the diagonal of which is the length of the pendulum. This would be the origin of the Egyptian royal cubit. Calculating by this procedure, the royal cubit would be 523.66 millimeters, but Petrie estimates it as about 524 millimeters.

Carl Friedrich Lehmann-Haupt, a scholar of ancient history who, after the death of Hultsch, took over the role of the great German specialist of ancient measures, making them his major concern up to his death in 1936, followed the same line of reasoning. Since he started his activities as one of the decipherers of the Sumerian language and was particularly competent in the reading of cuneiform mathematical texts, he argued that the ancient system of measures was organized in Mesopotamia from the pendulum that beats the second at latitude 30°. The early inhabitants of Mesopotamia would have taken the half of this length as their cubit (cubit of 491.16 millimeters according to Lehmann-Haupt).

The idea was not completely new: in the period of the adoption of the French metric system, there occurred to a scholar of ancient measures that the Roman foot might have been calculated as the length of the pendulum that beats the half-second.

Unfortunately, Petrie and Lehmann-Haupt were not so well informed about the history of measures as they should have been. Soon after Galileo discovered the law of isochronism of the pendulum, since scholars were debating among themselves the project for a new decimal system of measures, it was suggested by several of them that the new system should be based on the length of the pendulum, in order to link together time, length, volume, and weight. But in the course of the eighteenth century it was realized that the pendulum does not provide a reliable standard of length. First of all, it was established that the period of oscillation of the pendulum changes according to the latitude; this led to the discovery of the polar flattening of the earth. It was also successively established that the period of oscillation is influenced by the density of the earth and by any presence of large masses of matter, since the period depends on the gravitational pull. Hence, by the time of the adoption of the French metric system, it had been decided that the new decimal system should limit itself to coordinating length, volume, and weight.

When the Constitution of the United States was drafted, there was included a special clause to prepare the ground for the adoption of a new decimal system of measures, which was advocated by all enlightened people. When the French Revolution in one of its first steps put into law the decimal metric system, the Congress of the United States considered adopting the French system. But Thomas Jefferson, whom Congress respected as the authority on such matters, opposed the plan on the ground that the French system was inadequate, since it did not coordinate time with length, volume, and weight. This opposition from inside the camp of the progressive forces doomed the adoption of the decimal system in the United States.

Jefferson was correct in principle, and so were Petrie and Lehmann-Haupt. A truly desirable system of measures should coordinate time, length, volume, and weight, but what these people did not know is that the ancients had found an easy and reliable method to coordinate length with time. All that is needed is to relate the unit of length to the speed of the rotation of the vault of heaven, since this is the basis of our calculations of time. As I will explain later, today we calculate time by the length of the mean solar day, but since this is a highly artificial concept, astronomers set the length of the solar day by the apparent motion of the vault of heaven (sidereal time), which flows evenly.

The problem of coordinating time with the other measures is so important that after decades of research on ancient measures I was still fumbling for one element which would allow me to fit all my findings together, until Peter Tompkins ripped the veil from my eyes by pointing out to me that speed of rotation of the vault of heaven is 1000 geographic cubits a second.

The Egyptians set their standards of length in a manner that permits an easy correlation with time, but still the standard which was scientifically defined had to be the standard of length.

7. The tradition of what was the ancient procedure has been preserved by the scientist and mathematician Girolamo Cardano (1501–1576). Like other Renaissance scholars he was concerned with the establishment of an absolutely inalterable standard of length. In his book *De Subtilitate* (Chapter XVII, edition of Basel, 1553, p. 475) he discusses the length of the ancient Roman foot and passes from it to the problem of how to base length and weight on a *mensura perpetua*. He observes that such an absolute standard should be searched for in the heavens, but, since this is impossible for practical reasons, he declares that the standard is provided by the pyramids of Egypt, the Labyrinth of Thebes, cities like Cairo, and the river Nile. The meaning of this statement is perfectly clear, when we consider the geodetic system of Egypt, as I have reconstructed it; but its form is cryptic. This should not be surprising, since it is known that Cardano has been cryptic in announcing some of his major mathematical discoveries. It had been the practice of scientists and mathematicians up to the age of Newton to put into print the data which they considered of essential importance in a form such that the meaning would become obvious only after an explanation had been communicated orally, because this was the only method they had of protecting their copyright.

The Egyptians decided that the distance of 7° 30′ from Behdet to the southern boundary of Egypt should be reckoned as 1,800,000 geographic cubits. According to the *Smithsonian Geographical Tables* the interval from 31° 30′ to 24° 00′ is 831,091 meters. According to my findings 1,800,000 geographic cubits are 831,048 meters. The figures of the *Smithsonian Geographical Tables* are an estimate of the average length of the degree of latitude, based on the assumption that the earth is a regular geometric body. It would be necessary to consider what is the actual length of the degree in Egypt. Up to now I have deliberately avoided obtaining this information, because I did not want my interpretation of the texts to be influenced by the knowledge of the possible results.

In order to appreciate the nicety of the Egyptian figure, we must keep in mind that in the first French legislation the length of the meter was established by assuming that the arc of meridian is 30,794,580 *pieds de roi,* on the basis of the survey conducted in 1740. Later the length of the meter was revised to the present one, because according to the survey conducted in 1792–98 the arc of meridian is 30,784,440 *pieds de roi.* After this survey the meter was no longer revised, although it has been ascertained that the arc of meridian is about 2000 meters more than 10,000,000 meters.

8. From the geographic cubit, defined as 1/1,800,000 of the length of Egypt, there was derived the geographic foot of 307.7957 millimeters. By cubing this there was fixed the volume of the artaba as 29,160 cubic centimeters.

The artaba was divided into 64 pints of 455.6250 cubic centimeters, that is, into 64 cubes with a side of a hand (4 fingers = 1/4 foot). This unit is the standard pint of Egypt. The pint was divided into 50 *qedet* of 9.1125 grams, employed to weigh gold and silver used as a means of exchange. Sutzu is correct in concluding that, although the *qedet* of 9 grams is the more current unit of weight in advanced civilizations, the heavier *qedet* appears common in prehistoric or early times.

From the artaba there was derived a unit of 3 artabas, which is the cube of the Roman cubit. This is the origin of the Roman foot. There was also derived a unit which is the *brutto* version of the preceding one; since in the cube of the Roman cubit there are 9600 *qedet,* this second unit contains 10,000 *qedet* of 9.1125 grams. The edge of the cube which corresponds to this second unit is the ordinary Egyptian cubit of 450 millimeters. This cubit implies a foot of 300 millimeters. The cube of this foot is the talent of 27,000 cubic centimeters or grams, which was divided into 3000 *qedet* of 9 grams or 1000 Roman ounces of 27 cubic centimeters or grams. The *netto* version of this unit is the cube of the Roman foot (25,920 cubic centimeters or grams). Since the cube of the Roman foot is 8/9 artaba, this cube was divided into 80 librae of 36 *qedet* of 9 grams, whereas the artaba is composed of 90 librae. Three *qedet* of 9 grams makes the Roman ounce of which 1000 makes the cube of the Egyptian foot of 300 millimeters (27,000 cubic centimeters or grams). However, following the reckoning of a *qedet* of 9.1125 grams there continued to be in common use a larger quadrantal (Russian *chetverik*), the edge of which is the Roman geometric foot, and which contains 80 geometric librae

(81/80 of regular libra of 324 grams). This larger quadrantal is 9/10 of artaba.

The organization of the units according to this pattern had a practical purpose. The unit of 3 artabas was the cube of the cubit (443.9181 millimeter) called Roman, a unit of 87,470 cubic centimeters or grams. This was considered a unit *netto*, to which there corresponded a unit *brutto* (25/24) of 91,125 cubic centimeters or grams, which is the cube of the common Egyptian cubit of 450 millimeters. The units of 87,470 grams and of 91,125 grams, that is, the weight of the cubes of the Roman and of the common Egyptian cubits filled with water, are called by me basic load *netto* and basic load *brutto*. I have given them these names because they were considered the standard amount that could be carried by a pack ass. In Akkadian these units are called *imēru*, which means "ass." The Masoretic text of the Old Testament uses a different punctuation of vowels under the consonants to distinguish between the term *ḥmr* as referring to an ass and the same term as referring to the unit of measure, but there are puns in the Old Testament which indicate that one could confuse one meaning with the other. Since the language of measures is very international, there is a transfer of terms among Semitic, Indo-European, and Fenno-Ugrian languages, in which the same terms are applied at times to the measure and at times to the animal. Some easy examples are the following. In Hellenistic Egypt the ass was called *gomarion*, from *gomos*, "load"; the ass is called *gomari* in modern Greek. In Italian the ass is called *somaro*, from the Greek *sagma*, "pack saddle." The corresponding English word is *sumpter*, which corresponds to a German *Saumtier*, a term in turn corresponding to the Italian *bestia da soma*, "pack animal." In German *Saum* means "burden" and also refers to a large unit of measure. In Italian *salma* is both a large unit of weight or volume and a corpse carried on a stretcher, which has on the average the weight of what I call a basic load.

The cube of the foot was called talent in Greek or by equivalent terms in other languages of the ancient world. There was a basic talent *netto* of 25,920 grams and basic talent *brutto* of 27,000 grams, which were respectively the cube of the Roman foot of 295.9454 millimeters and the cube of the Egyptian foot of 300 millimeters. Names such as talent refer to the fact that these weights were considered half of the amount that could be transported by a man. It was assumed that a man transports burdens by suspending them at the two ends of a carrying yoke. At each end of the yoke there were weights, which ideally had to be identical; each of these weights was called a talent. It is evident that this is the origin of the idea of equilibrium and of the measuring scale. Incidentally, I may also mention that it was assumed that the carrying yoke has a length of 2 cubits or three feet.

9. Since the development of units from the artaba had started with the cube of the Roman cubit, which is equal to 3 artabas, there was developed a unit equal to 5 artabas. The edge of the cube containing 5 artabas is the origin of the Egyptian royal cubit. Five artabas were the volume of a basic load of barley (barley was assumed to have a specific gravity between 0.6 and 0.666).

The edge of the cube which contains 5 artabas was interpreted as the septenary version of the Egyptian cubit of 450 millimeters, that is, as a cubit of 7 hands (28 fingers) instead of the normal 6 hands (24 fingers). But, if we reckon exactly, the cube of the cubit of 525 millimeters contains 144,703.125 cubic centimeters, which is something less than 5 artabas = 145,800 cubic centimeters. A unit of 5 artabas should contain 16,000 *qedet*. By dividing the cube with an edge of 525 millimeters by 16,000 there is obtained a *qedet* of 9.043945 grams, which is intermediary between the *qedet* of 9 grams and the *qedet* of 9.1125 grams. The analysis of the distribution of the weights of Egyptian sample weights indicates that there were in use three standards of *qedet:*

9.000000 grams
9.043945 grams
9.112500 grams

Correspondingly, the study of the monuments and of the measuring rods indicates that there were three values of the royal cubit:

524.1483 millimeters
525.0000 millimeters
526.3231 millimeters

The first royal cubit is the edge of the cube containing 16,000 *qedet* of 9 grams. It is the standard of the Great Pyramid and of the immense complex of buildings erected by the architect Imhotep around the pyramid of King Zoser of the Third Dynasty. This royal cubit was the scientific unit of Egypt, employed in the calculation of geographic distances.

The second royal cubit was exactly 7/6 of the Egyptian cubit of 450 millimeters. It was the one most commonly used in ordinary life. It is the standard of the Second Pyramid of Giza.

The third royal cubit had the virtue of being the edge of the cube containing exactly 5 artabas (16,000 *qedet* of 9.1125 grams). It is the standard of the coffers of the mentioned two pyramids of Giza.

The royal cubit had the advantage of being a septenary unit, a type of unit which had been found convenient in the practical solution of problems involving irrational roots such as $\sqrt{2}$, $\sqrt{3}$, and π. But, when the reorganization of the Egyptian geodetic system with the unification of Egypt stressed the number 7 as the link between the dimensions of Egypt and the order of the heavens, the septenary royal cubit was raised to the status of a national symbol and became the official standard of the Egyptian monarchy.

It may be worth pointing out, in order to indicate how the great majority of scholars deal with these problems, that Eduard Meyer, whose ideas and method dominate contemporary history of antiquity and of Egypt in particular, explained the origin of the royal cubit by asserting that the Pharaohs demanded contractors to build by the cubit of 7 hands, but exercised their royal prerogatives by paying them as if they had employed the regular cubit of 6 hands (a discount of 37 percent). Let us not forget that the current opinions about the Egyptian ability to measure time astronomically are based on the calculations of Eduard Meyer.

10. According to the second geodetic system of Egypt, the length of Egypt, from the base line of the Delta (31° 06′ north) to the usual southern boundary at 24° 00′ north, was recalculated as 1,500,000 royal cubits of 524.1483 millimeters. This is the reason why the cubit of 524.1483 millimeters became the one used in geographic measurements.

This second calculation of the length of Egypt is derivative and, hence, is not as precise as the one that made the geographic cubit equal to 1/1,800,000 of the length of Egypt. The length of Egypt according to the dynastic system is 7° 06′; 1,500,000 royal cubits equals 786,222 meters. According to the *Smithsonian Geographical Tables*, the interval from 31° 06′ to 24° 00′ is 786,741 meters. There is a difference of about 1000 royal cubits.

For the sake of geographical calculations the royal cubit was given as multiple the *atur* of 15,000 royal cubits, so as to make Egypt equal to the perfect figure of 100 *atur*. The term *atur* literally means "river"; it could be translated as "river measure." It was understood that an *atur* (7862.2 meters) corresponds to an hour of navigation along the Nile.

The *atur* fitted the septenary spirit of the system of measures, since it could be assumed that a degree of latitude is 14 *atur*. This was a practical approximation, which was corrected by adding decimal points to the figure of 14 *atur*, reaching a maximum of 14.1 *atur* at the north of Egypt.

A degree of 14.1 *atur* is 110,857.4 meters. According to the *Smithsonian Geographical Tables,* degree 30°–31° is 110,857.0 meters.

The length of Egypt was divided into 14 *atur* for Northern Egypt and 86 *atur* for Southern Egypt. If we divide 100 *atur* by 7° 06′, we have a degree of 14.084507 *atur* = 110,735.6 meters, which is the length of the degree at parallel 23° 00′ (110,736 meters according to Helmert). A reason why the length of Egypt was extended south to the Sacred Sycamore, at 23° 00′ north, appears to have been that of giving a more exact scientific basis to the calculation of the royal cubit as being such that 211,267.605 royal cubits (14.0845 *atur*) makes a degree.

We shall see that the Pharaoh Akhenaten attacked the authority of the Temple of Amon at Thebes by questioning the scientific exactitude of the second geodetic system of Egypt and of the calculations by royal cubits. There is a possibility that the extension of the boundaries of Egypt from latitude 24° 00′ to latitude 23° 00′ north was part of the counterattack against the reforms of Akhenaten. The purpose may have been that of calculating the value of the royal cubit independently of the value of the geographic cubit.

III. COFFER OF THE GREAT PYRAMID

1. On the basis of my reconstruction of the Egyptian system of measures, it is possible to solve the riddle of the coffer placed inside the King's Chamber of the Great Pyramid.

Many investigators have tried to explain the dimensions of this coffer, but none has reached a positive conclusion. However, the majority of the investigators agree on two basic assumptions: the coffer embodies some numerical conundrum and the contents of the coffer corresponds to some standard of volume. According to my interpretation both of these assumptions are correct: the contents of the coffer is 8 cubic royal cubits = 40 artabas (1166.40 liters), and the walls were given a thickness such that the outside volume of the coffer is twice that of the contents, that is, 16 cubic royal cubits = 80 artabas (2332.800 liters).

The investigators who have preceded me have been hampered by not knowing that there were three possible values of the royal cubit. For this reason they could not realize that the standard of measure of the coffer is a royal cubit different from that employed in planning the King's chamber and the rest of the Pyramid. The King's Chamber was planned by the royal cubit of 524.1483 millimeters, because this is the standard of the Pyramid, chosen because this was the royal cubit usually employed by the Egyptians in calculating geographic distances. The coffer, on the other hand, was planned by the royal cubit of 526.3231 millimeters, because this was the unit employed in calculating the fundamental units of volume and weight.

Before the Cole survey of the dimensions of the Great Pyramid, the only datum available to scholars to determine the exact value of the cubit of the Pyramid was the dimensions of the King's Chamber. It was Newton who, on the basis of the survey conducted by Greaves, realized that the King's Chamber measures 10 by 20 cubits. Having established this fact, he calculated that the cubit of the Pyramid is 1732.5/1000 of an English foot and rounded the figure to 1732/1000. Calculating by the British Imperial standard foot established in 1824, the figures of Newton indicate a cubit of 528.0655 or 527.9131 millimeters. Newton was interested in the length of the Egyptian royal cubit, because he wanted to interpret the statement of Eratosthenes that a degree of latitude is 210,000 cubits.

Petrie proceeded to an extremely accurate survey of the dimensions of the King's Chamber, taking into account the fact that the blocks have been spread apart by the action of earthquakes. By deducting from the length of the sides the spaces which today separate the blocks, he concluded that the cubit of the King's Chamber is 20.632 ± 0.004 English inches $= 524.0523 \pm 0.1016$ millimeters. This empirical datum agrees with the figure of 524.1483 millimeters which I have obtained by considering the mathematical structure of the Egyptian system of measures and all the empirical evidence available.

The coffer is not calculated by the cubit of the King's Chamber, but the cubit of 526.3231 millimeters, because this cubit when cubed contains 145.800 liters = 5 artabas = 16,000 *qedet* of 9.1125 grams.

The reports about the dimensions of the coffer show some discrepancies, because the coffer was cut rather roughly. Petrie relates that an entire side was cut by the strokes of a huge saw, which at times was backed up after it had dented the stone as much as one inch out of plumb. However, by comparing the reports of Greaves, Piazzi Smyth, Petrie, and others, I have identified the intended dimensions of the coffer, since I have the advantage of knowing the exact value of the unit of measurement.

The coffer was computed in hands of 1/7 of the cubit of 526.3231 millimeters. Its inner dimensions are:

Width:	9 hands =	676.70 mm
Length:	26.3 hands =	1977.47 mm
Height:	11.6 hands =	872.19 mm

The corresponding figures in the reports of Greaves and Petrie are:

26.616 English inches = 676.15 mm	26.81 inches = 680.97 mm
77.856 English inches = 1,977.54 mm	78.06 inches = 1982.72 mm
34.32 English inches = 871.73 mm	34.42 inches = 874.27 mm

The report of Smyth agrees substantially with that of Greaves. Petrie's figures are slightly excessive, because he computed the inner dimensions by deducting the thickness of the walls from the outer dimensions, and he thought that it would be proper to measure the walls at the point of their minimum thickness.

The lateral walls were intended to be 2 hands thick, so that the outside dimentions are:

Width: 13 hands = 977.46 mm
Length: 30.3 hands = 2278.23 mm

Petrie's figures for these two dimensions are:

38.50 English inches = 977.90 mm
89.62 English inches = 2276.35 mm

The height of the outside was intended to be 2 cubits = 14 hands, but in order to establish a link between the coffer and the rest of the Pyramid these two cubits were calculated by the cubit of the Pyramid and the King's Chamber. Two cubits of 524.1483 millimeters is 1,048.29 millimeters. In terms of the cubit of 526.3231 millimeters, this means 13.9422 hands; possibly the figure was rounded to 13.9333 hands = 1,047.63 millimeters. I assume that the bottom of the coffer was given a thickness of 2.333 hands = 175.44 millimeters (Petrie reports 6.89 inches = 175.01 millimeters). I assume that the height was 13.9333 hands = 1,047.63 millimeters (Petrie reports 41.31 inches = 1049.27 millimeters).

According to Greaves's figures the contents of the coffer is 71,118 cubic inches = 1,165.428 liters. According to Petrie's figures the contents is 72,033 cubic inches = 1,180.405 liters; I have explained why Petrie overestimated the inner dimensions. According to my interpretation the contents is 2745.72 cubic hands. Now, 2744 cubic hands is 1,166.400 liters = 8 cubic cubits = 40 artabas.

If the outside of the coffer is 13 by 30.3 by 13.933 hands, its volume is 5488.3 cubic hands. Now, 5488 cubic hands is 16 cubic cubits = 80 artabas.

Since the two volumes of the coffer are 8 and 16 cubic cubits, it is not possible to be certain that a measurement by artabas was in the mind of the builders, although I cannot think of any other reason why the builders should have chosen the cubit of 526.3231 millimeters, unless they intended to choose the cubit which when cubed has a contents of exactly 5 artabas. A clearer proof that the calculation was intended to be by artabas is provided by the similar coffer of the Second Pyramid of Giza.

2. From the dimension of the sides of the Second Pyramid of Giza, it can be established that it was planned by the royal cubit of 525 millimeters. Nevertheless, as in the case of the Great Pyramid, the coffer was planned by the cubit of 526.3231 millimeters.

Petrie reports the following data about the coffer of the Second Pyramid, expressed in English inches:

	Length	Width	Height
Outside:	106.68 = 2,709.67 mm	41.97 = 1,066.04 mm	38.12 = 968.25 mm
Walls:	21.95 = 557.53 mm	15.28 = 388.11 mm	8.53 = 216.66 mm
Inside:	84.73 = 2,152.14 mm	26.69 = 677.93 mm	29.59 = 751.59 mm

As in the Great Pyramid, the coffer was planned in hands (1/7) of the cubit of 526.3231 millimeters. The dimensions are the following:

	Length	Width	Height
Outside:	36 = 2,706.80 mm	14.2 = 1,067.68 mm	12.88 = 968.43 mm
Walls:	7.4 = 566.40 mm	5.2 = 390.98 mm	2.88 = 216.54 mm
Inside:	28.6 = 2,150.41 mm	9 = 676.70 mm	10 = 751.89 mm

Petrie's figures imply an inside volume of 1,096.554 liters. According to my interpretation the volume is 2574 cubic hands = 1094.137 liters. If we assume that the volume was intended to be 2572.5 cubic hands = 1093.500 liters, the contents of the coffer corresponds to:

7.5	cubic royal cubits
37.5	artabas
12	basic loads *brutto*
120,000	*qedet* of 9.1125 grams
121,500	*qedet* of 9 grams

The contents of this coffer is 15/16 of the contents of the coffer of the Great Pyramid.

Because the Second Pyramid had been planned by the royal cubit of 525 millimeters, the coffer, although measured by the cubit of 526.3231 millimeters, indicates a volume expressed best of all in basic loads *brutto;* the basic load *brutto* is the cube of the cubit of 450 millimeters, which is the common cubit coresponding to the royal cubit of 525 millimeters.

Petrie's figures imply an outside volume of 2796.883 liters. According to my interpretation the volume is 6584.25 cubic hands = 2798.786 liters. If we assume that the outside volume was intended to be 6585.4 cubic hands = 2799.360 liters, the volume corresponds to:

19.2	cubic royal cubits
96	artabas
32	basic loads *netto*
307,200	*qedet* of 9.1125 grams
311,400	*qedet* of 9 grams

The outside volume of this coffer is 6/5 that of the coffer of the Great Pyramid.

The coffer of the Second Pyramid was planned so as to embody the key units of the Egyptian system of volumes:

Artaba of 29,160 cubic centimeters (cube of the geographic foot)
Basic load *netto* of 87,480 cubic centimeters (cube of the Roman cubit)
Basic load *brutto* of 91,125 cubic centimeters (cube of the Egyptian common cubit)

IV. DEGREES OF LATITUDE

1. The calculation of the dimensions of Egypt by royal cubits was less precise than that by geographic cubits, but it had the advantage of stressing the number 7 as the key to the dimensions of Egypt and as the link between the structure of Egypt and the order of the cosmos.

Following the septenary system of measurement, the stadium, a tenth of minute of degree, was reckoned as 350 royal cubits (183.45 meters). This stadium is somewhat shorter than the stadium of 400 geographic cubits (600 geographic feet = 184.68 meters). It implies a degree (600 stadia to the degree) of 210,000 royal cubits = 110,071.1 meters. But the calculation of the stadium as 350 royal cubits was considered a first approximation which could be employed in practical computations. Just as in the calculation by *atur*, a degree of latitude was considered basically equal to 14 *atur*, but in exact calculations a decimal point was added to the figure of 14, so in exact calculations a few cubits were added to the figure of 350 royal cubits to a stadium.

In round figuring the Egyptians calculated the stadium at the equator as 354 stadia; but more accurate figures were known. By this round figure they obtained an equatorial minute of degree (10 stadia) of 1855.485 meters, which is 88 millimeters more than the figure of the International Spheroid (1855.398 meters). A stadium of 354 cubits implies an equatorial circle of 76,464,000 cubits = 40,078,491 meters, whereas according to the International Spheroid the equatorial radius is 6,378,388 meters ± 18 meters, so that the equator would be 40,076,594 meters ± 113 meters. Since the Egyptians preferred to count by 90 degrees of equator, the figure of 354 cubit for a stadium of equator contains a numerical game, such as frequently occurs in ancient computations for mnemonic reasons. Ninety degrees of equator is 54,000 stadia of 354 cubits.

Assuming a stadium of 354 royal cubits, a degree of equator is 212,400 cubits, which is a good round figure. We shall see that the Egyptians estimated the exact figure as between 212,380 and 212,392 cubits.

An absolutely exact calculation of the length of the equator was a matter of scientific interest, whereas the Egyptians put much greater stress on the exact calculation of the length of the degrees of latitude, since the anchor of their geodetic conceptions was the course of the Nile.

For the stadium of latitude of the equator they used the figure of 351.6 cubits = 184.2905 meters, which is as exact as any modern calculation can be. According to the Clarke Spheroid a minute of latitude at the equator is 1842.787 meters; according to the International Spheroid it is 1842.925 meters. We shall see that the base of the Great Pyramid is calculated by a stadium of 351.6 cubits.

To those who may not be conversant with these matters, I must explain that, since the shape of the earth is irregular, modern scholars have tried to construct a regular geometric figure, called the spheroid, the dimensions of which fit as closely as possible the actual dimensions of the earth. Different scholars have constructed different spheroids, in part because they have based their work on surveys conducted in different areas of our planet. For instance, in the United States many agencies and institutions continue to use the spheroid calculated by the English geodesist Clarke in 1866, because its data fit rather well with the shape of the earth in North America. Many scholars prefer the computation published by the German Helmert in 1907. But the calculation most usually considered authoritative by scholars is that completed by the American Hayford in 1910, known as the International Spheroid. This calculation is based on a gigantic survey conducted under the auspices of the British Empire from the tip of South Africa to the Equator and then up to the Mediterranean along the Nile. This survey happens to overlap the Egyptian calculations along the course of the Nile.

The stadium of latitude increases as one moves to the north from the equator, reaching the value of 354 cubits, equal to the length of the stadium of equator, between parallel 55° and parallel 56°. It reaches a maximum estimated as 355 cubits at the pole. This figure of 355 cubits for the stadium of latitude at the pole, which indicates a minute of 1860.726 meters, was a convenient round figure which was refined in exact reckonings. A stadium of 355 cubits implies a polar degree of 213,000 cubits = 111,643.6 meters; if 1/2000 was the amount added to the latter figure we would have 213.106.5 cubits = 111,699.4 meters. According to the *Smithsonian Geographical Tables*, degree 89°–90° is 111,699.3 meters.

For navigation along the Nile, there was used the following formula for the length of the degrees of latitude:

211,500 cubits = 110,857 meters at latitude 31° 06′
211,300 cubits = 110,753 meters at latitude 24° 06′
211,100 cubits = 110,648 meters at latitude 15° 36′

Latitude 15° 36′ north is the latitude of the confluence of the White Nile with the Blue Nile.

2. One of the major difficulties of ancient mathematical science was that it could not rely on printed tables, although some numerical tables, such as exponents, roots, and logarithms, are occasionally found in cuneiform tablets. Even maps were so drawn that the key positions could be memorized. The lack of the printing press is the reason why in ancient mathematics we find a variety of formulas and mnemonic devices for obtaining trigonometric functions. In the same spirit the Egyptians had developed a simple formula for calculating the length of the degree of latitude at all parallels between the equator and the pole.

The scheme was based on the circumstances that the Egyptians used three values for the length of the degree of latitude at the equator—an exact value based on a stadium of 351.6 cubits and two rounded values:

A. Exact value. Stadium of 351.6 cubits, degree of 210,960 cubits = 110,574 meters.

B. Value rounded to degree of 211,000 cubits = 110,595 meters.

C. Value rounded to arc of meridian of 19,000,000 cubits, degree of 211,111 = 110.654 meters.

Value *B* was considered exact for a degree at 9° and value *C* for a degree at 16°.

The length of the degree was calculated by taking the second value, 211,000 cubits, and assuming that each degree is longer than the preceding degree by a number of cubits equal to the number of the degree.

Degree	Cubits added to degree	Cubits added to length of degree at 0°
1°	1	1
2°	2	3
3°	3	6
4°	4	10
5°	5	15
6°	6	21

This pattern was followed up to degree 36°, which is 36 cubits longer than the degree at 35° and 666 cubits longer than the degree at 0°. For six degrees, from 37 to 42°, the amount added to each degree is 37 cubits. For the following six degrees, from 43 to 48°, the amount added to each degree is 38 cubits. Then for six degrees, from 49 to 54°, the amount added is again 37 cubits. For the remaining 36 degrees, from 55 to 90°, the amount added is the same as that applied to the first 32 degrees but in the inverse order.

The scheme gives immediately the length of the degrees from 24 to 58°, that is, for 35 degrees. For the first 23 degrees and for the last 32 there are introduced simple corrections:

(1) For the first eight degrees, from 1 to 8°, the amount is added to the exact value of the degree (value *A*, 210,960 cubits to degree). From a degree at 9° one begins to count by value *B* (211,000 cubits), but 45 cubits is deducted from the amount added to this degree; this deduction is reduced by 3 cubits for each of the following 13 degrees, until 3 cubits is deducted from 23°.

3. At 90° the amount added according to the scheme is added to a basic degree calculated by value *C* (211,111 cubits). For the 32 degrees from 59 to 90°, an adjustment is

Degree	Cubits added to each degree	Cubits added to 0° degree	Correction	Egyptian ESTIMATE, meters	Helmert's ESTIMATE, meters
1°	1	1		110,575	110,573
2°	2	3		110,576	110,574
3°	3	6		110,577	110,575
4°	4	10		110,580	110,577
5°	5	15		110,582	110,579
6°	6	21		110,585	110,582
7°	7	28		110,589	110,586
8°	8	36		110,593	110,591
9°	9	45	−45	110,595	110,596
10°	10	55	−42	110,602	110,602
11°	11	66	−39	110,609	110,609
12°	12	78	−36	110,617	110,616
13°	13	91	−33	110,626	110,624
14°	14	105	−30	110,635	110,633
15°	15	120	−27	110,640	110,642
16°	16	136	−24	110,654	110,652
17°	17	153	−21	110,664	110,662
18°	18	171	−18	110,675	110,673
19°	19	190	−15	110,687	110,684
20°	20	210	−12	110,699	110,696
21°	21	231	− 9	110,712	110,709
22°	22	253	− 6	110,725	110,722
23°	23	276	− 3	110,738	110,736
24°	24	300		110,753	110,750
25°	25	325		110,766	110,764
26°	26	351		110,779	110,779
27°	27	378		110,793	110,794
28°	28	406		110,809	110,810
29°	29	435		110,823	110,826
30°	30	465		110,839	110,843
31°	31	496		110,855	110,861
32°	32	528		110,872	110,878
33°	33	561		110,889	110,895
34°	34	595		110,907	110,913
35°	35	630		110,926	110,931
36°	36	666		110,944	110,949

Degree	Cubits added to each degree	Cubits added to 0° degree	Correction	Egyptian ESTIMATE, meters	Helmert's ESTIMATE, meters
37°	37	703		110,964	110,968
38°	37	740		110,983	110,987
39°	37	777		111,003	111,006
40°	37	814		111,022	111,025
41°	37	851		111,041	111,044
42°	37	888		111,061	111,063
43°	38	926		111,081	111,083
44°	38	964		111,101	111,103
45°	38	1002		111,120	111,122
46°	38	1040		111,140	111,142
47°	38	1078		111,160	111,162
48°	38	1116		111,180	111,181
49°	37	1153		111,200	111,201
50°	37	1190		111,219	111,220
51°	37	1227		111,238	111,239
52°	37	1264		111,258	111,258
53°	37	1301		111,277	111,277
54°	37	1338		111,297	111,296
55°	36	1374		111,316	111,315
56°	35	1409		111,334	111,334
57°	34	1443		111,352	111,352
58°	33	1476		111,369	111,370
59°	32	1508	+ 3.5	111,388	111,388
60°	31	1539	+ 7	111,406	111,405
61°	30	1569	+10.5	111,423	111,422
62°	29	1598	+14	111,440	111,439
63°	28	1626	+17.5	111,457	111,455
64°	27	1653	+21	111,473	111,471
65°	26	1679	+24.5	111,488	111,487
66°	25	1704	+28	111,503	111,502
67°	24	1728	+31.5	111,518	111,517
68°	23	1751	+35	111,531	111,531
69°	22	1778	+38.5	111,547	111,544
70°	21	1794	+42	111,558	111,557
71°	20	1814	+45.5	111,570	111,570
72°	19	1833	+49	111,582	111,582
73°	18	1851	+52.5	111,593	111,594
74°	17	1868	+56	111,604	111,605
75°	16	1884	+59.5	111,616	111,616
76°	15	1899	+63	111,624	111,626
77°	14	1913	+66.5	111,633	111,635
78°	13	1926	+70	111,642	111,643
79°	12	1938	+73.5	111,650	111,651
80°	11	1949	+77	111,657	111,659
81°	10	1959	+80.5	111,664	111,666
82°	9	1968	+84	111,671	111,672
83°	8	1976	+87.5	111,677	111,677
84°	7	1983	+91	111,682	111,682
85°	6	1989	+94.5	111,687	111,686
86°	5	1994	+98	111,692	111,690
87°	4	1998	+101.5	111,696	111,693
88°	3	2001	+105	111,699	111,695
89°	2	2003	+108.5	111,702	111,696
90°	1	2004	+111.11	111,704	111,697

made for a transition from value *B* to value *C*. Thus, to a degree at 59° there is added 111.11/32 cubits, or practically 3.5 cubits ($32 \times 3.5 = 112$); to a degree at 60° twice as much is added; to a degree at 61° there is added three times as much.

This scheme gives values of the degree of latitude which differ most from the one we use today in the area near the pole. This could be connected with the fraction that the Egyptians used in calculating the polar flattening of the earth. I shall deal with this fraction in a following chapter. According to the scheme, the degree between parallel 89° and the pole is 213,115.11 cubits = 11,703.9 meters. According to the Clarke Spheroid the minute of degree of latitude at the pole is such that the corresponding degree is 111,699.36 meters; but in 1880 Clarke revised the figure to 111,702,06 meters. According to the International Spheroid the figure is 111,700 meters.

4. The scheme which I have presented provides excellent values for the length of the degree of latitude, but probably was intended to be only a practical device, not the most exact calculation. There is evidence which suggests that efforts were made to calculate the lengths of the degrees with greater mathematical refinement.

The Egyptians invented the column as an architectural element. If one observes the decoration of Egyptian columns with a scientific attitude, he will recognize that the column represents the map of Egypt: the capital is Northern Egypt and the shaft is Southern Egypt. This explains why among the Greeks, who learned the use of the column from the Egyptians, for the Doric order, the most conservative of the Greek orders, there was the rule that the shaft should be six units high and the capital one unit high. In the Greek orders the base of the column preserves the arrangement on three horizontal lines, which are the symbol of the tropic of Cancer (parallels 24° 06′, 24° 00′, and 23° 51′ north). The column basically represents the three meridians of Egypt and through its curvature suggests the extension of the system of meridians to the east and west of Egypt. But, since the column is circular, the structure of the column was related to the problem of presenting the map of Egypt as part of a cylindrical projection of the surface of the earth from the equator to latitude 31° 06′ or latitude 31° 30′ north. The elaborate numerical rules for the proportions of Greek columns, which archeologists treat as numerological superstitions, can be explained when one considers the two interrelated problems of describing mathematically the curvature of the earth and of projecting a curved surface on a flat map. The theory of conic sections, which is considered the highest achievement of Greek mathematics, may have been developed in order to solve these problems. Greek columns taper from the bottom to the top, but to the rectilinear line of the shrinking there is applied a curved line, so that the column seems to swell slightly toward the middle. If we consider the scheme I have presented for the calculation of the lengths of the degrees, a scheme in which a basic simple progression was modified by the addition of another progression, we can understand why Greek columns diminished in diameter from bottom to top according to a combination of two lines. In the case of the columns of the Parthenon, the added curvature, called *entasis* by the Greeks, is a hyperbolic curve, but in other temples we meet with more complex mathematical curves. It may be enough to say this much here: if one assumes that the bottom of the colonnade of the Parthenon represents the equator and its top the latitude of Athens, the proportions of the entire colonnade can be readily explained.

V. TEXTUAL EVIDENCE

For lack of space, it is impossible for me to present here the evidence for what I have stated to be the Egyptian estimates of the length of the degrees of latitude, since this evidence was obtained by gathering scores of scattered pieces of information, the interpretation of which often involves delicate issues of textual interpretation. But the preoccupation with geographical distances was so dominant in Egyptian civilization that one can find many documents the meaning of which is obvious; several of these documents are well-known texts. It has taken me a great deal of painstaking research to fit these documents together, in order to arrive at a unified view of what was the Egyptian system of geography; but the interpretation of single documents *per se* in many cases did not present difficulty. What is difficult to explain is why Egyptologists have stubbornly refused to accept these documents at their face value. In order to illustrate how Egyptologists operate in order to slough off the evidence, I shall present two examples of such nature that the issues involved can be understood by the non-specialist.

Inscribed Cubit Rules

1. In 1921 the famous Egyptologist Ludwig Borchardt wrote a report on three Egyptian measuring rules found at the Temple of Amon in Thebes. These three royal cubit rules

bear an identical inscription. The inscription appears to be a traditional one; for reasons of style the text of the inscription has been ascribed to the Old Kingdom, although the rules themselves belong to a later period. It is known that at times measuring rules were given a sacred meaning, although nobody has ever asked why; it should be evident to the reader of these pages why a measuring rule could be a sacred object for the Egyptians. The cubit rules studied by Borchardt, according to his report, seem to be of the type used as sacred objects rather than as instruments of actual measurement.

Borchardt did not test the length of these rules, but concentrated his attention on the inscription. The essential meaning of the inscription is open and clear, even though a professional Egyptologist may find difficulty with some of the hieroglyphs, as it often happens when archaic hieroglyphic texts were copied centuries later when the language and the writing style had changed. The inscription states that the distance between Behdet and Syene, the area of the First Cataract, is 106 *atur,* and divides this distance into 20 *atur* from Behdet to a place called Pi-Hapy, and 86 *atur* between Pi-Hapy and Syene.

Borchardt considered the evident possibility that the distances should be understood as differences of latitude, but dismisses it outright: "one must absolutely exclude the possibility that the ancients may have measured by degrees." No further words are added to justify this drastic pronouncement. Then he states that it must be a matter of measurements taken along the actual course of the Nile, the only measurements of which the Egyptians were capable. By referring to modern data about the length of the line of navigation along the Nile, he concludes that the inscription expresses a rough estimate.

He proceeds by remarking that the inscription provides an excellent opportunity to establish the value of the important Egyptian linear unit *atur*. He observes that by reading documents that contain calculations in *atur* one gathers that the value of the *atur* in royal cubits must be expressed by numbers such as 5000 or 10,000. Finally, he concludes that, given the length of the course of the Nile from one end to the other of the country of Egypt, the *atur* must be 20,000 royal cubits.

I have concluded that the *atur* is 15,000 royal cubits (7862.225 meters), and this inscription bears me out. The difference of latitude between Behdet and the southern limit of the First Cataract is 7° 30′. Now, 106 *atur* is 1,590,000 royal cubits = 833,395.8 meters. The distance between 24° 00′ and 31° 30′ is 831,091.6 meters according to the

Smithsonian Geographical Tables. The Egyptian figure is in excess by 2300 meters, or 2/7 *atur*. The excess is not surprising, since the calculation of the length of Egypt as ending at Behdet was originally related to the geographic cubit and not the royal cubit. I have explained that the geographic cubit was defined as 1/1,800,000 of the length of Egypt to Behdet. In *atur* of 17,000 geographic cubits, this length could be expressed as 106 *atur* (1,802,000 geographic cubits) = 831,971.7 meters, with only a small excess over the initial figure of 1,800,000 geographic cubits = 831,048.4 meters.

The calculation of the length of Egypt to Behdet as 106 *atur* of 15,000 royal cubits has the virtue of indicating the length of the arc of meridian from the equator to the pole; since the length of Egypt to Behdet is 7° 30′, it is 1/12 of this arc. Multiplying 106 *atur* by 48, we have a great circle of 5088 *atur* = 40,002,998 meters, which is an excellent figure (212,000 cubits to a degree); Helmert's figure of 40,008,268 meters differs by less than an *atur*.

The purpose of the inscription on the rules which were found at the Temple of Amon in Thebes is to stress the scientific value of the calculations by the septenary royal cubit, which was a matter of essential political interest to this temple, as I will explain in the second part of this chapter.

The calculation of the length of Egypt as 106 *atur* had also the purpose of indicating by one of the usual numerological games that the average degree of latitude is 212,000 royal cubits = 111,119.4 meters; 212,000 was the Egyptian round figure for the average length of the degree of latitude (stadium of 353,333 royal cubits). If the average degree is identified with the middle degree, the degree at parallel 45°, this figure is only 2 cubits short of the Egyptian estimate of 212,002 cubits = 111,120.5 meters for this degree. The estimate of the *Smithsonian Geographical Tables* is 111,121.0 meters.

2. The inscription on the rules divides the interval of 106 *atur* into 86 *atur* from Syene to Pi-Hapy and 20 *atur* from Pi-Hapy to Behdet. It occurs immediately that the two figures must refer to Northern and Southern Egypt. But the figure of 20 *atur* is slightly too much for Northern Egypt and that of 86 *atur* is slightly too little for Southern Egypt.

If the degree is calculated as 212,000 royal cubits, 20 *atur* = 300,000 cubits is too much for the interval between Behdet and the apex of the Delta, since 1.4° × 212,000 = 296,800 cubits. Conversely, 86 *atur* would be 1,290,000 cubits, whereas the distance from 24° 00′ north to the apex is 6.1°, and 6.1° × 212,000 = 1,293,200 cubits. In either case there is a difference of 3200 cubits. Hence, the breaking point in the calculations must be somewhat south of the apex of the Delta.

Even though Egyptologists ignore scientific geography, there are specialists of Egyptian toponymy, that is, the study of local names. These have wondered about the identification of the locality of Pi-Hapy, "House of the Nile," mentioned in the inscription we are discussing. They have observed that in Egyptian texts Pi-Hapy is usually mentioned together with Kher-aha, although Pi-Hapy is a different place. They have concluded that Pi-Hapy was on the right bank of the Nile about 2 kilometers south of Kher-aha. But specialists of Egyptian toponymy have failed to identify Kher-aha, which was a fundamental point of Egyptian geography; Kher-aha, called Kerkasoros by the Greeks, was the apex of the Delta, the point 30° 06′ north, 31° 14′ east, at the southern tip of the island al-Warraq. Pi-Hapy, called Nilopolis by the Greeks, was on the right bank of the Nile, facing the southern tip of the island al-Warraq. Since the Nile in its course comes to the island al-Warraq from the west, the point Pi-Hapy was on meridian 31° 14′ east and could be considered to be on the right bank of the Nile directly opposite the apex of the Delta, or point Kher-aha. The width of the Nile between Kher-aha and Pi-Hapy, measured along meridian 31° 14′ east, fits well with what I have calculated to be the distance between the apex and Pi-Hapy (3200 royal cubits = 1,677 meters).

The breaking of the distance of 106 a*tur* into a segment of 20 a*tur* by establishing a new reference point called Pi-Hapy may have been influenced by the calculation of the length of Egypt up to the base line of the Delta as 100 *atur* (1,500,000 royal cubits).

In the inscribed royal cubit rules, the original estimate of 106 *atur* of 17,000 geographic cubits was interpreted in terms of 106 *atur* of 15,000 royal cubits, in order to link more closely the dimensions of Egypt (1/12 of arc of meridian counting to Behdet) to the measurements of the arc of meridian. As I have stated, 12 × 106 a*tur* = 1272 a*tur* = 19,080,000 royal cubits = 10,000,749.6 meters is an excellent estimate of the length of the arc of meridian, obtained with an extreme economy of reckoning. Let us not forget that the French metric system was established on the assumption that the arc of meridian is 10,000,000 meters. Even today in practical reckoning we take 111,111.1 meters as the round figure for the average degree of latitude, whereas the figure of 106 a*tur* for the length of Egypt indicates a round figure of 212,000 cubits = 111,119.4 meters, which is more precise, and is almost perfect if we take 212,000 cubits to mean the length of the degree at the middle parallel.

1. Because Egyptologists have ignored the issue of geodetic points and of the linear units, the figure of the revolutionary Pharaoh Akhenaten has turned out to be the most mysterious and controversial in the long history of the Egyptian monarchy, although this Pharaoh was unusually articulate and self-expressive in his utterances. The archeologist Cyril Aldred, who is the author of the most recent study of the reign of Akhenaten, begins his book (page 11) with this observation.

> With the possible exception of Cleopatra, no ruler of Ancient Egypt has provoked a greater flow of ink from the pens of historians, archaeologists, moralists, novelists and plain cranks than the Pharaoh Akhenaten who governed almost half the civilized world for a brief span during the fourteenth century B.C.


The Pharaoh Akhenaten.

The reason why even "plain cranks" write interpretations of the historical role of Akhenaten is that professional scholars have given the example. Because they have resisted accepting the solidly documented facts, established scholars have devoted their energies to debating theories such as that Akhenaten was impotent, was a practicing homosexual, or a woman masquerading as a man; there are historians who profess to be informed about the intimate relations between him and his wife, the beautiful Nefertiti. Since the picture of Akhenaten has remained indefinite and blurred, scholars have used it to project their own emotions. Those who do not like Akhenaten present him as a psychopath and dispute about the clinical definition of his illness. In the middle are those who describe him as a playboy Pharaoh. Those who admire him have chosen to portray him either as some sort of Christian evangelist, an Anabaptist preacher thrown into the midst of the history of Egypt, or, at the opposite end of the psychological personality scale, as an *artiste* type, bent on freeing Egyptian culture from its formalistic tradition in order to release untrammeled individualistic self-expression. If one were to look for a common denominator among all the conflicting interpretations, one fact could be considered as universally accepted, in spite of the heated controversies, namely, that Akhenaten was as far as possible from being a rational scientific thinker. Nevertheless, the documentary evidence suggests a style of thought that today we would call scientific naturalism.

There is a phrase which occurs again and again in the pronouncements of Akhenaten and represents his effort to summarize his program by a slogan: "Living in *maet*." This is so obvious that Aldred declares (page 67):

> There is in Akhenaten's teaching a constant emphasis upon *maet*, "truth," as is not found before or afterwards.

It is agreed that *maet* was the central concept of Egyptian civilization and that the role of a Pharaoh was to be the defender and the living embodiment of *maet.* This concept was so basic in Egyptian culture that Aldred has no difficulty in explaining it in a few words (page 25):

> The king was the personification of *maet,* a word which we translate as "truth" or "justice," but has the extended meaning of the proper cosmic order at the time of its establishment by the Creator. For it was believed that the gods had first ruled Egypt after creating it perfect.

Akhenaten, his wife Nefertiti, and two daughters (Berlin Museum).

The reader can easily grasp what was meant by *maet* by referring to what I have said about the geodetic system of Egypt. But, having admitted what is indisputable, that Akhenaten saw himself as the Pharaoh who would truly uphold *maet,* Aldred stops cold and does not draw the implications. Like other interpreters, he wanders afar and regales us with a chapter entitled "The Pathology of Akhenaten."

2. If instead of trying to imagine what were the hieroglyphic notes of the psychoanalyst of the royal family, we consider the documented facts, the most important action in the revolutionary reign of Akhenaten proves to be the establishment of a new capital for Egypt, the city of Akhet-Aten, "Resting-point of Aten." The miles-long remains of the buildings of this city have been found and excavated in the locality today known as Tell el-Amarna. During the reign of Akhenaten a substantial percentage of the national resources was dedicated to the construction of this city.

Scholars of the last century, who had not yet adopted the psychologizing fashion, at least recognized the political meaning of the shift in the location of the capital of Egypt. Akhenaten intended to cut at the root the power of the priests of the Temple of Amon in Thebes, who through their control of the national oracle, identified with the god of this temple, had usurped the royal functions. But what these scholars did not know is that the Temple of Amon was the geodetic center of Egypt, the "navel" of Egypt, being located where the eastern axis (32° 38′ east) crosses the Nile, at the parallel which is at 2/7 of the distance from the equator to the pole (25° 42′ 51″ north), and that the god Amon was identified with the hemispheric stone which marked this point.

The new city which was intended to replace Thebes as the capital and geodetic center of Egypt was planted in a position which seems most undesirable in terms of what we would consider the function of a capital city. Some scholars have interpreted this fact as further evidence of the mental derangement of its founder. It was in an area of difficult access, where there had never been any known significant center; some scholars have doubted whether even villages had existed there. It did not provide large flat areas for a major urban development. When maintenance was suspended after the fall of Akhenaten, large sections of the new buildings were washed away by the rainwater rushing down torrentially from the surrounding cliffs. Even the climate was inferior to that of many other areas along the course of the Nile. Unless one assumes that there was a compelling mathematical reason for choosing this location, one must agree that there is justification in claiming that what is often called the "Tell el-Amarna Revolution" was the product of a playful young man, or a religious fanatic, or a degenerate obsessed with his sex problems. Akhenaten himself relates that his courtiers raised objections to the selection of the new site, although he states that it was pointed out to him directly by his father, the god Aten.

The new capital for the god Aten, who was raised to the status of the one true god, was set at latitude 27° 45′ north, at the middle point between the northernmost point Behdet and the southern limit of Egypt at latitude 24° 00′ north. The longitude could not be equally as significant, since the capital had to be on the banks of the Nile. It was one degree east of the western axis of Egypt, that is, 30° 50′ east.

The longitude, although it was not as crucial as the latitude, was significant according to the system that the Egyptians used to describe the east coast of Africa. In order to describe this coast, down to the equator, the

Aerial view of the Tell el-Amarna (RAF photo).

Egyptians used a system of right triangles, in which one side was one of the three axes of Egypt and the other a perpendicular to it; the hypotenuse usually indicated the course of a segment of the east coast of Africa. The most important of these triangles was one obtained counting from Behdet 19° 30′ south along the central axis of Egypt and then 19° 30′ to the east, to reach a point 12° 00′ north, 50° 44′ east, near Ras Alula (11° 59′ north, 50° 46′ east), a point which was considered the extreme limit of the Arabian Gulf. The ancients took the Gulf of Suez, the Red Sea, and the Gulf of Aden as a single entity, the Arabian Gulf, which at times they described as a river similar to the Nile. The geographical point in question is called Notou Keras, "horn of the East," by Strabo; it had a counterpart in the "horn of the West," the innermost point of the Gulf of Guinea on the west coast of Africa. The segment of parallel reaching the "horn of the East" from the meridian of Behdet marks the basic latitude 12° 00′ north, halfway between the equator and the basic latitude 24° 00′ north, and bisects Lake Tana, the source of the Blue Nile. The Nile was considered to have two sources, one at the equator (White Nile) and one at latitude 12° 00′ north (Blue Nile). This system of calculations for the geography of the area east of the course of the Nile has an importance which carries beyond ancient history, since the establishment of a geodetic point 10° south of Behdet and 10° east of the western axis of Egypt explains the origin of the religious importance of Mecca. The essence of this system of calculations was that points to the east of Egypt were identified by drawing perpendiculars to the course of the Nile. Considering this system in relation to the position of Akhet-Aten, if one counts east from it as much as it was south of Behdet, that is 3° 45′, one reaches the sea at a point presently called island Ghānim (off Cape Az Zaytīyah, called Drepanon Promontory by Ptolemy, which is at 27° 47′ north, 33° 35′ east); Cape Az Zaytīyah together with the island south of it was considered the southernmost limit of the Gulf of Suez on the Egyptian side; it was assumed that the line drawn from Behdet to this point gave the course of the coast of Egypt on the Gulf of Suez.

3. The most revealing pieces of evidence uncovered in the area of the new capital established by Akhenaten are the so-called "Boundary Stelae." Along the outskirts of the new city there have been found huge inscriptions, either cut on pillars or cut on the cliffs, which contain a text substantially identical in the fourteen samples which have been uncovered so far. These inscriptions proclaim what was for Akhenaten the leading idea behind the establishment of the new capital.

The inscribed text relates in detail the rituals performed in the establishment of Akhet-Aten, "Resting-point of Aten"; but the greatest emphasis is placed on the setting of two boundary pillars, one at the extreme north and one at the extreme south of the sacred territory of the city, at a distance of 6 *atur,* 3/4 *khe,* and 4 cubits from each other. After setting these pillars the King took a solemn oath, to be repeated at regular intervals, never to remove or displace them and to restore them in the same identical place in case they were moved or damaged.

It should be obvious that the figure of 6 *atur,* 3/4 *khe,* and 4 cubits, given with numerical precision, is the key to the reason for the establishment of the new capital. Nevertheless, only one Egyptologist has made an effort to interpret these figures. This effort was a half-hearted one; it ignored Egyptian geographical texts and parallel occurrences of the terms *atur* and *khe* in Egyptian writings. Nevertheless, ever since, scholars quote this interpretation if they bother to mention the dimensions of Akhet-Aten in dealing with its establishment. The interpretation took as a starting point the distance between the relatively northernmost and the relatively southernmost of the fourteen inscriptions which have been found, and divided this distance by 6 to conclude that an *atur* must be 4000 royal cubits. It can be objected

Boundary stelae at Tell el-Amarna.

that the pillars which in some cases were erected to carry the text of the inscription cannot be the boundary pillars of which the inscription is speaking, since the latter must be of such a nature and form that their position could be established to the inch. It stands to reason that when, after the collapse of the revolution, masons were sent to demolish or deface the monuments of the accursed Akhenaten, not sparing even the tombs of the members of his family, the work of destruction must have started with the boundary pillars; we are not likely to find them, unless broken pieces were scattered around. In any case, the Egyptian texts which mention distances measured in *atur* positively exclude that an *atur* can be as short as 4000 royal cubits (2097 meters).

As to the *khe,* the interpretation stated in a hit-or-miss manner that it is equal to 100 royal cubits. Nobody asked why Akhenaten should have selected a figure refined not only to 3/4 of *khe,* but also to 4 cubits. It was a matter of such precision that the inscribed text indicates that even knocking the limit markers or hitting them with stones would interfere with their function.

According to Egyptian practice, geographic distances could be measured either in geographic cubits or in royal cubits. The natural multiple of the geographic cubit was the stadium, called *khe* in Egyptian, of 400 geographic cubits (600 geographic feet), whereas the natural multiple of the royal cubit was the *atur* of 15,000 royal cubits. But the two systems were merged by using an *atur* of 15,000 royal cubits (7862.2 meters) and an *atur* of 17,000 geographic cubits (7848.8 meters), and a *khe* of 350 royal cubits (183.45 meters) and a *khe* of 400 geographic cubits (184.68 meters). In the case of the inscriptions of Akhet-Aten, the occurrence of the figure of 3/4 of *khe* suggests that a calculation by geographic cubits is involved, since 3/4 of a stadium of 350 royal cubits would be an odd figure. It is my understanding that the dimensions of the district of Akhet-Aten were:

	6 *atur* of 17,000 geographic cubits
	3/4 of a stadium of 400 geographic cubits
	4 geographic cubits
Total:	102,304 geographic cubits = 47,233.1 meters

4. Even without considering the exact value of the units mentioned by Akhenaten, the figure of 6 *atur* should have rung a bell in the mind of Egyptologists, calling to their attention the traditional figure of 106 *atur* for the length of Egypt. Akhenaten wanted to emphasize that the "Resting-point of Aten" was at the middle point of Egypt. By giving to the new geodetic center a dimension of 6 *atur,* he left 50 *atur* from it to Behdet and 50 *atur* from it to parallel 24° 00′ north. This was particularly significant since there was another basic estimate of the length of Egypt as 100 *atur,* from the base line of the Delta (31° 06′ north) to parallel 24° 00′ north.

Before proceeding any further I must remind the reader that the traditional figure setting the length of Egypt at 106 *atur* did not intend to convey information only about Egypt itself, but also to indicate the length of the arc of meridian, 12 × 106 *atur.*

Since the length of the geographic cubit was defined by considering the distance from Behdet to parallel 24° 00′ north equal to 1,800,000 cubits, if the district of Akhet-Aten had had an extension of 0° 25′ 30″, it would have had a length of 6 *atur* = 102,000 cubits. This length was increased to 6 *atur,* 3/4 stadium, 4 cubits = 102,304 cubits, in order to indicate that the average degree of latitude on earth is 240,715 cubits.

The figure of Akhenaten indicates that the average degree of latitude was estimated as 240,715 cubits, since 0° 25′ 30″ of a degree of 240,715 is 102,303.875 cubits. A degree of 240,715 cubits is 111,136.6 meters; the corresponding arc of meridian is 21,664,375 geographic cubits = 10,002,301 meters. Hayford's figure is 10,002,286 meters.

Akhenaten wanted to prove that Thebes could not properly claim to be the geodetic center of Egypt and that he had chosen the geodetic center conforming to an absolutely rigorous interpretation of *maet,* the cosmic order of which the dimensions of Egypt were an embodiment. In order to follow absolutely exact standards of measurement, he reverted to the predynastic geodetic system which counted in geographic cubits starting from Behdet. This system was more precise than the system which counted in royal cubits (septenary units) starting from the base line of the Delta, making Egypt equal to 100 *atur* of 15,000 royal cubits. Thebes could claim to be a geodetic center only in terms of the second system, which is septenary and makes the meridian of Thebes coincide with the eastern corner of the Delta. In terms of the system based on the predynastic capital of Behdet, there could be no question that Akhet-Aten is the "true and just" navel of Egypt.

This conclusion implies that one should reevaluate the entire historical role of Akhenaten, taking as the starting point what he himself considered the initial step in his program to establish true and just conformity with *maet.* There is a possibility that his revolutionary reforms, which extended from religion to art and family relations, were understood as a general return to predynastic ideas and practices.

5. Since the Egyptian monarchy set the style for the trappings of royal power thorughout the world, the prescriptions of Akhenaten about the dimensions of the territory of his capital did not remain without parallel in history. A striking parallel can be found in what may appear a most unlikely time and place, Saxon England.

Scholars are so bent on principle to interpret the history of measures and measurement in terms of the most crude primitivism, that in most works of history that deal with English measures one reads that the English foot was originally set by the length of the foot of an English king. The name of the king whose lower extremities were so decisive varies from scholar to scholar, although, when one thinks about it (which is not done in matters of measurement) kings of average human size should be excluded. There is agreement among scholars that the king in question reigned in the centuries following the Norman conquest, since it is assumed and often stated that before this time England did not have set units of measure. A variant of the fairy tale about the English foot is provided by the historians who tell us that it was not a matter of the foot but of the arm of a king which decided the length of the yard (three feet). Usually the length of the arm of King Henry I (1068–1135) is mentioned in this connection.

Such statements are made in spite of the fact that it is not necessary to be a specialist in the history of measures to find out that a foot equal to the English foot was the basic standard of Russia, from the time of the first available historical records to the Soviet revolution. I grant that it takes a specialized historical training to trace the linear standard of England and Russia to the ancient Orient, but I may also observe that there are well known Greek temples which have been planned in English feet, and that archeologists of English and American nationality have studied them without realizing what they had before their eyes.

Historians could have developed less benighted notions about the origin of English measures, even without extending their horizon beyond the British isles, because there is a law of King Athelstan (924–940) which defines the length of the English foot. The text of this law is included in the standard collections of medieval English laws. The words of law of Athelstan were repeated exactly in the legislation about measures issued by King Henry I. The law of Athelstan provides the most fundamental text for the study of English measures, but it has been ignored.

Athelstan prescribed that the king's girth shall extend from the royal residence for a distance of 3 miles, 3 furlongs, 9 acres, 9 feet, 9 palms, and 9 barleycorns. The King's girth was the area considered a direct extension of the King's place of residence and as such the area in which the King's peace was in force. This was the area in which attacks on private persons were crimes against the Crown.

The picturesque language of the law means that the King's girth extends for a radius of 18,250 feet, since it is a matter of the following units:

mile	5280 feet
furlong	600 feet
acre	66 feet
palm	3/4 foot
barleycorn	1/3 inch

The law employed a form of expression which had a particular numerological rhythm and at the same time defined the value of the multiples and submultiples of the foot.

My understanding of the law of King Athelstan is that the radius of the King's girth was defined as 3 minutes of latitude. The King's girth extended 6 minutes or 1/10 of degree from north to south. This implies that a degree was understood to be 365,000 English feet, which is the length of the degree at the latitude of towns like Winchester.

A more detailed analysis of the law of Athelstan belongs to a study of English measures. What is important to stress here is that the English foot was defined by length of a stretch of 1/10 latitude around the king's place of residence. The political conditions of the feudal society of Saxon England were very different from those of Pharaonic Egypt, but the method used by King Athelstan in order to relate his power to the system of measures and to the cosmic order bears a remarkable similarity to that adopted by the Pharaoh Akhenaten.

VI. DEGREES OF LONGITUDE

1. When the Egyptians fixed the value of their fundamental unit of length, the geographic cubit, they chose as standard degree the degree of latitude at 27° 45′ north, taken as the middle latitude of Egypt. When they recalculated the dimensions of Egypt in terms of royal cubits, they chose as the middle latitude 27° 33′ north. These latitudes were chosen taking into account the length of a degree of longitude at the equator. Latitude 27° 45′ is the half of latitude 55° 30′ and latitude 27° 33′ is the half of latitude 55° 06′. The Egyptians assumed that at the two higher latitudes a degree of latitude is equal in length to a degree of equator.

According to the *Smithsonian Geographical Tables,* a degree of latitude at parallel 55° 30′ is 111,324.7 meters, but probably the Egyptians calculated it as 361,680 geographic feet = 111,323.5 meters: this degree is equal to the fundamental degree of 360,000 geographic feet (600 stadia) plus 2.8 stadia or plus 1/214.28. According to the *Smithsonian Geographical Tables* a degree at parallel 55° 06′ is 111,317.3 meters. According to the Egyptian table of the lengths of the degrees of latitude which I have reconstructed, it is 212,378.5 royal cubits = 111,317.3 meters. This length could be expressed also as 361,660 geographic feet = 111,317.4 meters, that is, as 600 stadia plus 2.7666 stadia. This implies that the Egyptians estimated the equatorial circle either as 130,204,800 geographic feet = 40,076,478 meters or as

130,197,600 geographic feet = 40,074,261 meters. I suspect that they began with an estimate of 130,200,000 geographic feet (degree of 361,666 feet = 360,000 feet plus 1/216) = 40,075,000 meters, and then modified the figure in order to establish a relationship between the equatorial degree and the degree of the middle latitude of Egypt. The Egyptian estimate agrees with our current ones: the equator is 40,075,452 meters, according to the Clarke Spheroid and 40,076,596 meters according to the International Spheroid.

Very revealing is that a base line was marked along parallel 45° 12′ north on the north side of the Black Sea. This base line started from the mouth of the Danube, cut across the Crimea, and ended at the foot of the Caucasus. Beginning from this base, Russia was surveyed for a length of 10 degrees, along the three meridians which formed the three axes of Egypt, up to latitude 55° 12′ north. The river Dnieper was understood to be a symmetric counterpart of the Nile, running between the same meridians. Key positions along the course of the Dnieper were identified with corresponding key positions along the course of the Nile, up to the point of transferring Egyptian place names to Russia. The information about the existence of this geodetic system is provided by the description of a map of Russia which is based on it. The description of the map indicates that it was used at the end of the sixth century B.C., but the map may be older; in any case there are other sources of information about the base line which indicate that it was marked in very early times.

The figures of the geodetic system on which the map of Russia was based are most intriguing. The base line at parallel 45° 12′ north suggests that it was decided that it is at this latitude that the degree of latitude has a length equal to the average length of the degree of latitude. The fact that the meridians of Egypt were followed for 10° up to parallel 55° 12′ north suggests that it was decided that a degree of latitude at this parallel is equal to the length of a degree of equator.

The designation of 45° 12′ north for the location of the average degree indicates what the Egyptians assumed to be the degree of ellipticity of the earth. According to the *Smithsonian Geographical Tables,* the length of the degree of latitude at the point 45° 12′ north is 111,134.9 meters; from this figure we would get an arc of meridian of 10,002,141 meters. According to the Egyptian table of the length of the degrees of latitude that I have reconstructed, the degree at the point 45° 12′ north is 212,028.6 royal cubits = 111,134.4 meters; this length implies an arc of meridian of 10,002,099 meters. According to the *Smithsonian Geographical Tables* the degree ending at parallel 55° 12′ is 111,319.3 meters; if this is taken as the length of the degree of equator, the equatorial circle is 40,074,948 meters. According to the Egyptian table of the length of the degrees of latitude, the degree at 55° 12′ north is 212,381 royal cubits = 111,319.1 meters; this would indicate an equatorial circle of 76,457,160 royal cubits = 40,074,890 meters (stadium of equator = 353.96833 cubits).

2. In performing astronomical observations it is necessary to express differences of longitude in terms of units of time. The equator and all parallels are divided into 360 degrees, but considering the rotation of the earth it is expedient to divide the equator and all parallels into 24 hours. Given 360/24 = 15, a minute or a second of time is equal to 15 minutes or 15 seconds of degree.

In astronomical calculations, there are employed two different kinds of time, solar time and sidereal time. Solar time is our ordinary time. Solar time assumes that the day is the interval between two successive passages of the sun at the meridian. The length of the day so defined varies greatly according to the seasons of the year; it varies by more than 1/90. The reason for this variation is that the speed of the earth along its orbit around the sun is not constant and that the apparent motion of the sun around the earth does not follow the line of the equator, but of that of the ecliptic. Hence, in ordinary life we reckon by mean solar time, which is obtained by assuming that a fictitious sun moves along the celestial equator at a speed equal to the average speed of the sun along the ecliptic.

Mean solar time is a highly artificial concept and we can use it because we have mechanical clocks. The ancients calculated by sidereal time, which they could measure by observing the apparent movement of the vault of heaven. Sidereal time has the advantage of flowing evenly. There are small variations due to the nutation of the earth under the influence of the gravitational pull of the moon and the planets; but these variations are too small to be relevant to the calculations we are considering.

A sidereal day is the interval between two passages of a star at the meridian. A sidereal day is shorter than a solar day. If one observes a star at the meridian today, that star will be again at the meridian in less than a solar day. In other words, if one counts by solar time, the vault of heaven rotates about one degree more than a full circle in a day. The difference between mean solar time and sidereal time can be easily computed, because in a year the vault of heaven makes exactly one more circle around the earth than the number of circles made by the sun.

Hence the ancients could reckon:

$$\frac{\text{Solar time}}{\text{Sidereal time}} = \frac{366}{365} = 1.00273972$$

or more precisely:

$$\frac{\text{Solar time}}{\text{Sidereal time}} = \frac{366.25}{365.25} = 1.00273785$$

They did not need a formula more precise than the second one; today we reckon by the ratio 1.00273791.

The ancients simplified this complex matter by counting by the speed of movement of a point at the equator. That speed was taken by them as constant; the infinitesimal variations in speed of the rotation of the earth on its axis are relevant only to some calculations of modern astronomy.

The speed of a point at the equator in terms of mean solar time was obtained by dividing the length of the equator into 24 hours = 1440 minutes = 86,400 seconds. But the ancients were concerned particularly with the speed of a point at the equator in terms of sidereal time. A minute of time (solar time) corresponds to the length of 15 minutes of degree of equator. A minute of time (sidereal time) is equal to the same length multiplied by 365.25/366.25, that is, it is shorter.

3. When the Egyptians standardized their system of measures by establishing that the degree at the middle latitude of Egypt is 240,000 geographic cubits (360,000 geographic feet = 600 stadia) or that 1/48 of great circle measured from 24° 00′ north to 31° 30′ north is 1,800,000 geographic cubits, they must have had in mind the following equivalence:

1 second (sidereal time) = 1000 cubits
1 minute (sidereal time) = 60,000 cubits =
1/4 length of degree of latitude in Egypt

This calculation was convenient, but implied an equatorial degree (degree of latitude in Egypt × 1.00273785) of 111,109.8 meters, which is slightly too short; it is the length of a degree of longitude at about 3° 30′ from the equator.

In order to obtain the right length of the second and minute of sidereal time, one must take as reference a degree of latitude further north than Egypt. The degrees at the latitudes of Dodona and Delphi provided the correct values.

Classical Greece was not a unified country, being divided into cities proudly clinging to their absolute political independence; but, most incongruously, it had a national oracular center, just as Egypt, a strongly unified country, had a national oracular center at the Temple of Amon in Thebes. In Greece there were two centers which competed

Another Greek conception of an *omphalos* as derived from the Egyptians.

Omphalos of Delphi depicted with two pigeons (usually facing each other), evidently carrier pigeons used for establishing geographic distances. According to Greek legends, a central geodetic point was obtained by loosing two birds of equal strength and using the mean of the time employed in flight. This would allow for differences in wind current and other variables. By repeated flights even more accurate measurements could be obtained.

for the role of national oracle, Dodona and Delphi. The oracle of Dodona was considered more ancient and many Greeks considered it more authoritative, but it was at a practical disadvantage because it was located beyond the limits of solidly Greek territory in an area of most difficult access. In modern Greece, which extends more widely than ancient Greece, Dodona is near the Albanian frontier. The position of the oracle of Delphi, even though not as surprising as that of the oracle of Dodona, was peculiar; it was located in the mountains, north of all major centers of Greece.

The Greeks narrated that two doves flew from the temple of Amon in Egypt in order to establish the oracles of Dodona and Delphi. In ancient literature and iconography the flight of two doves is the standard symbol for the stretching of meridians and parallels.

Because the oracle of Delphi was less isolated, it received more attention and consequently we are better informed about it. Delphi was considered the geodetic center of Greece. The god of Delphi, Apollo, whose name means "the stone," was identified with an object, the *omphalos*, "navel," which has been found. It consisted of an ovoidal stone (the ovoidal shape indicated the lengthening of the degrees of latitude as one moves north) covered by a net. The net was the symbol of what even today we call the net of meridians and parallels. The *omphalos* of Delphi was similar to the object which represented the god Amon in Thebes, the "navel" of Egypt. In 1966 I presented to the annual meeting of the Archeological Institute of America a paper in which I maintained that historical accounts, myths, and legends, and some monuments of Delphi, indicate that the oracle was established there by the Pharaohs of the Ethiopian Dynasty. This is the reason why the Greek portrayed Delphos, the eponymous hero of Delphi, as a Negro.

The relevance of the latitude in the location of Delphi is indicated by a number of Greek accounts which associate Delphi with Sardis, the capital of the kingdom of Lydia in Asia Minor, which is on the same parallel (38° 28′ north).

The role of geography in the oracular importance of Delphi is indicated also by the method employed in obtaining oracular responses. Modern scholars who have been impervious to the rational elements of ancient thought and prefer to ignore that Apollo, the god of Delphi, was a god of reason and scientific thought, are generally inclined to think that the oracular responses were given by a priestess who, put in a trance by drug fumes, uttered gibberish. But there is abundant pictorial evidence which shows vividly how the oracle was consulted. An object which resembles a roulette

Egyptian *omphali* with twin birds. Carrier pigeons are depicted in Egypt as early as the Fourth Dynasty, and were evidently used to establish parallels and meridians from prehistoric times. Homing pigeons, which fly in a straight line (as the crow flies!), could cover the more than five hundred miles from one end of Egypt to the other in a single day.

wheel, and actually is its historical antecedent, was centered on top of the *omphalos*. The spinning of a ball gave the answers; each of the 36 spokes of the wheel corresponded to a letter symbol.

In studying ancient computing devices, I have discovered that they were used also to obtain oracular answers. This is the origin of many of the oracular instruments we still use today, such as cards and ouija boards. The psychological foundation of this phenomenon is simple. If I have a problem in interpreting an ancient text or an archeological report, I "consult" my calculating machine which "gives me the answer." By stretching this imagery further, one could assume that the calculating machine is an oracle. The roulette wheel of Delphi originally was a special kind of abacus for calculating in terms of angles.

The latitudes of Dodona and Delphi are significant. The length of the degree of latitude at the parallels of these two oracular centers gave the length of the minute or second of sidereal time, that is, the distance covered by a point at the equator in a sidereal minute or second of rotation of the earth.

Dodona is at 39° 32′ north. According to the *Smithsonian Geographical Tables* a degree at this parallel is 111,014.0 meters. This means that the degree must have been calculated as 360,673 geographic feet (360,000 plus 1/535) = 111,013.6 meters. If we multiply this length by 1.00273785, we obtain 361,660 geographic feet, the length of the degree of latitude at parallel 55° 06′, which is equal to the length of a degree of longitude at the equator.

If the figures employed in the reckoning of Dodona are rounded to a degree of 360,600 geographic feet and to a second of sidereal time of 1001.666 geographic cubits (that is, 1000 plus 1/600), we obtain the length of the degree of latitude at the parallel of Delphi, which is 38° 28′ north. A degree of 360,600 geographic feet is 110,991.1 meters; a degree at parallel 38° 28′ is 110,993.5 meters according to the *Smithsonian Geographical Tables* and 110,992.1 meters according to the Egyptian table of the length of degrees of latitude. Latitude 38° 28′ north may also have been chosen because it is at the standard distance of 6′ from latitude 38° 34′ north, which is at 3/7 of the distance from the equator to the pole, whereas the Temple of Amon in Thebes was set at 2/7 of this distance.

4. Metrologists of the past have wavered in establishing the value of the geographic foot (and hence of the artaba), because they confused this unit with a similar one, the Greek foot, which is about half a millimeter longer.

Roman writers mention a Greek foot which is 25/24 of the Roman foot and a Greek stadium which is equal to 600 Greek feet or 625 Roman feet. The Romans used the two units in conjunction. Roman roads were divided into miles of 5000 Roman feet, but at times between the milestones there were smaller markers which divided the road into 8 Greek stadia ($8 \times 625 = 5000$). In giving itinerary distances, writers of the Roman period usually reckon by Roman miles on land and by Greek stadia at sea.

Because Roman authors indicate that the degree is 75 Roman miles or 600 Greek stadia, since the Renaissance metrologists have been concerned with establishing the exact value of the Greek foot; but in examining the empirical evidence they met with data that appear conflicting, for the reason that they did not separate sources of information which apply to the geographic foot. Travelers and sailors of the eastern Mediterranean and the Middle East used to assume that a degree of latitude is 600 geographic stadia (110,806 meters) and a degree of longitude is 500 geographic stadia (92,339 meters); Greek and Roman travelers and sailors used to assume that a degree of latitude is 600 Greek stadia = 75 Roman miles (110,980 meters) and a degree of longitude is 500 Greek stadia = 60 Roman miles (92,483 meters). As a result scholars have confused information concerning two different types of units. The confusion occurs easily, unless one assumes high standards of precision and accuracy in ancient measurements, since we have:

Geographic foot	= 307.7957 millimeters
Geographic cubit	= 461.6935 millimeters
Greek foot	= 308.2764 millimeters
Greek cubit	= 462.4147 millimeters

A degree of latitude of 600 Greek stadia = 75 Roman miles is correct at parallel 37° 42′, which is the latitude of Mycenae. The system of calculation used by the Greeks and Romans goes back to the Mycenean ancestors of the Greeks.

Archeologists assume that, if the Greeks of the classical period measured badly, the Greeks of the Mycenean age did not measure at all. It is assumed that when the Myceneans erected their buildings they placed one stone on top of another without much of a plan. However, we know that the Myceneans were engaged in extensive long-distance trade and through it they accumulated huge quantities of gold of African origin; long-distance navigation and exchange of precious metals were the two activities which created for the ancients the most compelling need for exact standards.

By examining the dimensions of Mycenean citadels, I have established that they were planned by a foot which is 15/16 of the Roman foot, a foot of 277.4488 millimeters. This foot has been called Oscan or Italic by metrologists of the last century, who noticed its occurrence in pre-Roman Italy and in the earliest remains of Rome. I call this foot Mycenean.

The Mycenean foot not only is 15/16 of the Roman foot of 295.9454 millimeters, but also is 9/10 of the Greek foot of 308.2764 millimeters. The Greek foot is 25/24 of the Roman foot and $25/24 \times 16/15 = 400/360 = 10/9$.

A degree of 360,000 Greek feet (75 Roman miles), a degree of latitude at the parallel of Mycenae, is equal to 400,000 Mycenean feet. The occurrence of the factor 4 indicates that a calculation by time units is involved, since there are 4 minutes of time in a degree. A minute of time is equal to 100,000 Mycenean feet. Hence, by using the Greek cubit and the Mycenean foot, one could obtain the following easy formula:

Second of time = 1000 Greek cubits
Minute of time = 100,000 Mycenean feet

These units are slightly too short for a second and a minute of sidereal time. If we take the degree of 360,000 Greek feet = 400,000 Mycenean feet = 110,979.5 meters and multiply it by 1.00273785, we obtain a degree of 360,986 Greek feet = 110,283.4 meters, which is the length of a parallel circle at about 1° 30′ from the equator.

But the numerical structure of the units indicates how the exact length of the degree of equator was obtained by introducing an easy correction. One starts with these data:

1000 Greek cubits = 1 second of time
Day of 86,400 seconds = 86,400,000 Greek cubits
100,000 Mycenean feet = 1 minute of time
Day of 1440 minutes = 144,000,000 Mycenean feet

These figures can be modified as follows:

Equator = 86,666,666 Greek cubits = 40,075,939 meters
Equator = 144,444,444 Mycenean feet = 40,075,939 meters

Similarily, one may start with the Greek foot and obtain

100 Greek feet = 1 second of degree
Circle of 1,296,000 seconds = 129,600,000 Greek feet

The last figure can be modified to

Equator = 130,000,000 Greek feet = 40,075,939 meters

All that was needed in order to obtain the exact length of the equator was to assume that a circle is equal to 1,300,000 seconds of degree, instead of 1,296,000.

It is possible that this formula was used to calculate the actual length of the solar day in the different seasons of the year. Today almanacs assign the value of 1200 to the length of the mean solar day and list a figure greater or smaller than 1200 in order to indicate the actual length of the solar day for each day of the year. Possibly the ancients proceeded in a similar way, assigning the value of 1300 to the mean solar day.

Archeologists and historians assume that the Myceneans had no concern with science, but the most famous remains of Mycenean civilization proclaim otherwise.

Lion Gate at Mycenae.

The best known monument of Mycenae is the entrance gate which today is called the Lion Gate, because he who approaches the city is overpowered by a huge relief sculpture on the triangular capstone of the entrance; the relief consists of a column between two facing lions. The column is sandwiched between two sets of parallel horizontal lines. At the bottom the column rests on a support on which three parallel lines are strongly marked. These three lines are the same three lines which occur in the hieroglyphic symbol for Southern Egypt; they represent the tropic of Cancer, which was identified with parallels 24° 06′, 24° 00′, and 23° 51′ north. The column represents the three basic meridians of Egypt; the curvature of the column suggests the development of the system of meridians to the east and the west of Egypt. On top of the capital of the column (symbol for Northern Egypt) there rests what appears to be a segment of a floor. This segment of floor is on three levels. The bottom and the top levels are two horizontal lines, whereas the middle level consists of four circles. I have explained the significance of the factor 4 in the Mycenean system of linear units. The top part of the relief represents the parallel of Mycenae.

The grave circle at Mycenae excavated by Schliemann. A geodetic point for astronomical observation similar to the circular henges and mounds of the second millennium B.C. elsewhere in Europe.

The two lions which face each other on the sides of the column represent a circle closing on itself. The easiest way to convey the meaning of this symbol is to refer to pieces of ancient jewelry which consist of a bracelet open at one side with a head of a lion on each open end. The lions represent the summer solstice. The stance of the lions, with the front paws on the line of the tropic and their hind paws extending below it (this stance will later become the heraldic symbol of the lion rampant), indicates the spread of the zodiacal band north and south of the ecliptic. The ancients established their astronomical system when the spring equinox was in Taurus, which ceased to be true at the beginning of the second millennium B.C.; for them the point zero of the sky was between the two horns of Taurus. Today we count from the constellation of Aries, although the spring equinox has not been in Aries since the time when the Roman Emperor Antoninus Pius (A.D. 138–161) celebrated the end of the age of Aries and introduced new cults and religious beliefs in accordance with the beginning of a new cosmic age. When the spring equinox was in Taurus, the summer solstice was in Leo.

The cosmological meaning of the Lion Gate of Mycenae should not have been lost to archeologists, since next to this gate there is the second most impressive relic of ancient Mycenae, the so-called Grave Circle. It consists of a circular arrangement of stone blocks. If excavators had not been completely blinded by their belief in the primitiveness of the Myceneans, they would have immediately assumed that this circle must have some cosmological meaning. Instead the Smithsonian Institution spent time and energy to proceed to measurements of the skeletons found buried within the circle, arriving at the conclusion that they were bones of ordinary size men and not of giants. But the dimensions of the stone circle have not received attention; it may be enough to report here that the inner diameter of the circle is 100 Mycenean feet.

When the first circuit of walls of Mycenae was erected, the Circle was outside the walls directly in front of the Gate; the middle of the Gate is on the line of the north-south diameter of the Circle. Later the circuit of the walls was extended so as to include the Circle within the citadel.

5. A splendid illustration of the Mycenean system of linear units is provided by the Parthenon of Athens.

The Parthenon of Athens is the only Greek temple which has been surveyed with an adequate level of accuracy. But unfortunately for my investigation of the dimensions of Greek temples, the system of proportions of the Parthenon is an aberrant one. I have established the mathematical formula that determined the dimensions of Greek temples and the mathematical formula that determined the dimensions of Mycenean throne rooms; the Parthenon conforms to the latter and not to the former. The reason is that the Parthenon was built as a replacement on a larger scale of the Temple of Athena destroyed by the Persians, when they sacked Athens in 480 B.C. The old Temple of Athena in turn was built on top of a Mycenean throne room, some remains of which have been found by deep excavations. For this reason the Parthenon was planned in Mycenean feet, whereas most of the other monuments of the Acropolis of Athens were planned in Roman feet. However, the major dimensions of the outer colonnade of the Parthenon were so chosen that they could be expressed also in Greek feet, which was easy since Mycenean foot and Greek foot relate as 9:10.

For the study of the Parthenon we can rely on data that are satisfactory for some of the major dimensions, because at the middle of the last century an English architect and scholar of the history of architecture, Francis Cranmer Penrose, who was also an outstanding dilettante astronomer, on the basis of reports on the mathematical curvatures of the lines of the temple became convinced that the Parthenon

The so-called Treasury of Atreus at Mycenae built into a mound with corbeled roofing similar to the Maes-Howe mound.

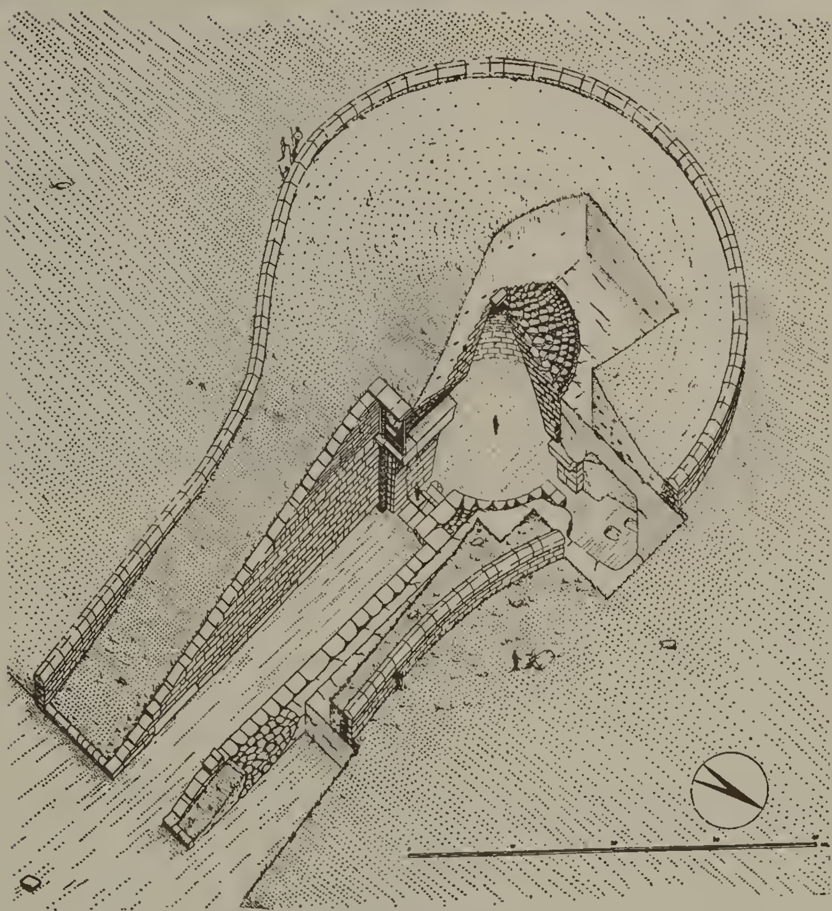
had been planned and executed with high standards of mathematical skill. In order to prove his point he measured it accurately with the precision of one-thousandth of an English foot.

Penrose, however, was ridiculed by archeologists, and no other Greek temple has been surveyed with comparable care ever since. The Archeological Institute of America does not support any survey or publication which does not assume that the maximum precision achieved in construction of reference foot rules by the ancient Greeks was a fifth or at the very best a tenth of centimeter. Naturally, the precision achieved in the construction of buildings was much less than the precision of the official reference rules.

Penrose was not able to convince scholars of his major contention, because he was obsessed as an architect with the notion that buildings should have perfectly square corners. He put this notion into practice when he planned the building of the British School of Archeology in Athens, of which he was director for two short periods, after its foundation in 1882. Because of this obsession, when Penrose found that the western front of the Parthenon is longer than the eastern front and that the south flank is longer than the north flank, he concluded that this was the result of mistakes in construction. His opponents were quick to point out that, if it is so, his major contention is disproved.

Penrose believed that the difference in the lengths of the sides of the Parthenon results from mistakes in the marking of the four corners which were intended to be perfectly square. In reality, the four corners of the Parthenon

Nineteenth-century view of the Parthenon.



The Treasury of Atreus at Mycenae (isometric view, after Hood), which has a striking resemblance to the Maes-Howe burrow and appears to have been designed for azimuth and zenith observation, like the subterranean chambers of the pyramids.

were not intended to be exactly square, but to deviate by set small amounts from a right angle, as is the case with the four corners of the Great Pyramid. I have established that the west front of the Parthenon was intended to be 1/48 of a Mycenean foot longer than the east front, and that the south flank was intended to be longer than the north flank by the same amount. The two longer sides join at the southwest corner, which is also higher in level over the other three corners. Taking these intended deviations into account, the actual findings of Penrose about the length of the sides agree almost perfectly with the theoretical dimensions obtained by mathematical principles.

Even with the intended lengthening of the west and south sides, the northeast corner, which joins the two most important sides, could have been a right angle, but instead it was acute by a figure close to a minute of degree. Unfortunately, Penrose measured the angle of this corner rather casually, because he thought that the lack of exact squareness was the result of a mistake in construction, and nobody else has tested the angle of this corner again in more than 120 years.

East end of the Parthenon.

There are many problems in the architecture of the Parthenon that cannot be solved, because archeologists prefer to go on building fanciful theories rather than establish the facts by an accurate survey. It is a basic principle of epistemology that our ability to reject erroneous theories increases in proportion with the precision and accuracy of the measurements; the converse is true, and this is what archeologists like, because, as they put it, it permits the spirit to soar. For instance, if one were to accept the loose standards of measurement dogmatically adopted by the Archaeological Institute of America, it would not be too difficult to present an argument to the effect the the surface of the earth is concave.

In the specific case of the Parthenon, I can point out that Penrose tested the orientation of the north flank, and that on the basis of his finding I could establish that the Parthenon is correctly oriented according to the latitude and longitude of Athens. But details of construction have led me to realize that the orientation of the inner part of the temple, the cella, was a trifle different. Since the difference of azimuth between the two longitudinal axes of the Parthenon has never been tested, I am left in the dark about the fine points in the orientation of the Parthenon.

An essential datum is that there are similarities between the mathematical structure of the Parthenon and that of the Great Pyramid. In both constructions the corners deviate deliberately from a right angle. I have established that the elevation of the fronts of the Parthenon was calculated by the factor φ and that the elevation of the flanks was calculated by the factor π. According to the data available, I have interpreted the elevation of the Great Pyramid to be such that the north side was calculated by the factor φ and that the west side was calculated by the factor π.

Here, I will deal only with the horizontal dimension, width, of the two fronts of the Parthenon, because it is directly connected with the Mycenean system of measures.

Before Penrose proceeded to a careful measurement of the sides of the Parthenon in the winter 1846–47 (the season of winter was deliberately chosen in order to reduce the effects of changes in temperature which may be macroscopic under the sun of Greece), an attempt at careful measurement was conducted in 1753, under unfavorable political and physical circumstances, by the painter James Stuart and the architect Nicholas Revett, who had become interested in the measurements of ancient buildings while studying in Rome. The expedition of these two English antiquarians had been carefully planned and created great stir in Europe at the time. One of their specific aims, indicated in the campaign for the raising of the necessary funds, was to ascertain the exact length of the Greek foot and by inference of the Roman foot, which is 24/25 of Greek foot. The Parthenon is called *Hekatompedon,* "one hundred foot temple," in Greek texts and these texts indicate also that its width was 100 feet. Earlier visitors to the Parthenon had concluded that the two fronts of the temple measured 100 Greek feet. For this reason Stuart and Revett provided themselves with highly reliable instruments of measurement and paid the greatest attention to the measurement of the two fronts.

They were so concerned with the length of the Greek foot that they reported the dimensions of the temple in such a way as to arrive at the results that were expected. Their figures for the length of the fronts are scanty. But they arrived at the conclusion that the value of the Greek foot is 12.137 English inches = 308.2795 millimeters, which agreed well with what scholars had estimated to be the length of the Roman foot (24/25 of Greek foot). According to my reckonings the Greek foot is 308.2765 millimeters.

Stuart and Revett used a yard rule prepared by the famous instrument-maker John Bird of London. A few years later (1762) Bird prepared a yard rule on behalf of the Parliamentary Committee appointed in 1758 "to inquire into the original standards of weight and measure of this kingdom." Although Bird had to follow the instructions of the committee, it can be presumed that the rule he built in 1762 did not differ in a manner significant for the present research from those he had built earlier. The Bird rule of 1762 was the main basis in the calculation of the Imperial Standard Yard made legal by Parliament in 1824.

What Stuart and Revett did not know is that the fronts of the Parthenon were intended to be slightly more than 100 Greek feet.

If the fronts had had a length of 100 Greek feet = 111.111 Mycenean feet = 111 1/9 Mycenean feet, they would have had a length equal to a second of degree of latitude at the parallel of Mycenae (37° 42′ north), whereas the latitude of Athens is 37° 58′ north.

The fronts of the Parthenon were planned to have a length of 100 1/5 Greek feet = 111 1/3 Mycenean feet. This length was increased by 1/48 of a Mycenean foot on the west front. Hence, the lengths of the fronts, according to my interpretation, was:

Eastern front = 30,889.3 millimeters
Western front = 30,895.1 millimeters

Penrose reported the following findings:

Eastern front = 101.341 English feet = 30,888.7 millimeters
Western front = 101.361 English feet = 30,894.8 millimeters

The western front is better preserved.

These figures prove how accurate was the planning of the Parthenon and how justified was Penrose in testing the dimensions of this temple with the greatest care of which he was capable.

But all the horizontal lines of the Parthenon have a parabolic curvature. The sides of the temple have a double parabolic curvature: they are curved upward and inward. The spacing of the columns proves that dimensions that were relevant were those measured along the parabolic line.

The two parabolic curvatures increased the length of the sides. What I have been able to establish with certainty is the effect of the combined double parabolic curvature on the edge of the sides, because of necessity the spacing of the columns which were placed all along the sides had to be based on the actual length of the edge of the sides. The two curvatures added 8/48 = 1/6 of foot to the length of the fronts, so that the eastern front measured 111 1/2 Mycenean feet = 100.35 Greek feet = 30,935.5 millimeters, when measured along the edge of the blocks. But in calculating the width of the temple one should consider only one parabolic curvature, the curvature upward, that is, in substance, the curvature of the floor. Before expressing exact conclusions I would like to see the results of a new survey of the curvatures of the Parthenon, but I can definitely state that the width of the temple measured along the curvature of the floor was halfway between 111 1/3 and 111 1/2 Mycenean feet, that is, close to 111 5/12 feet = 30,912.4 millimeters.

If we add to this amount the 1/48 foot added to the western front, we have a length of 111 7/16 feet = 30,918.2 millimeters. This length would indicate an equatorial degree of 111,305.5 meters and an equatorial circle of 40,069,988 meters.

It can be concluded that the width of the fronts of the Parthenon was intended to indicate the length of a second of degree of longitude at the equator. But further testing of the dimensions of the Parthenon is necessary in order to establish what was exactly the length of the second of degree that the builders had in mind.

As I have indicated, the Mycenean system of measures, which was followed by the Greeks of the classical age, assumed an equatorial circle of 144,444,444 Mycenean feet and hence a second of degree of equator of 111.45404 feet. This would imply a width of the Parthenon of 30,922.8 millimeters.

VII. DIMENSIONS OF THE GREAT PYRAMID

1. Since the dimensions of the Great Pyramid have been endlessly debated, and studies of them have often degenerated into mysticism, it is proper that in approaching the subject I clarify my method. The essence of my method is to be absolutely pedestrian. I have spent years of my life in trying to ascertain the exact length of the Roman foot, eliciting from the academy the reaction that it is a disgrace for a classical scholar to waste energy on such mechanical trivialities. Similarly, after reading scores of studies on the architecture of the Parthenon, I set myself two tasks: to determine the length of the foot employed in the construction, and to compare item by item all available modern

reports on the actual dimensions of this temple. I followed this line of research although I was warned by the learned that a person guilty of such *banausia,* which in Greek means behavior worthy of a manual wageearner, would always remain blind to the lofty mind of the ancient Greeks. In dealing with the geometry of the Pyramid, I have taken as starting points my conclusions about the length of the Egyptian royal cubit and the survey of the dimensions of the Pyramid conducted by Cole, who was not an Egyptologist but a professional surveyor.

Up to now the Cole survey has been neglected. Trust has been put on the survey conducted by Petrie, but, although Petrie considered himself an expert of measurements (he started his career as an Egyptologist under the guidance of his father, who was an engineer) and used all the diligence of which he was capable, his survey proves to have arrived at misleading results when compared to that of Cole.

In order to justify my method, I shall refer to another great scientific issue which, as we shall see, happens to be related to the problem of the dimensions of the Pyramid. In the *Principia* Newton argued that because of the centrifugal force generated by its rotation, the earth must be flattened at the poles. Reasoning purely on mechanical grounds, he concluded that the polar flattening is 1/230, which means that the polar radius is shorter than the equatorial radius by 1/230 of the latter. The calculation was based on the assumption, which is not true, that the earth is a homogeneous fluid body. Following the survey of Picard, for which Newton waited before publishing his *Principia* in 1686, other scholars of the French Académie des Sciences applied themselves assidiously to the problem of determining by geodetic surveys what was the actual shape of the earth. Their results were contradictory, but they were such that for seventy years after the publication of the *Principia* the empirical evidence could be understood to indicate that the earth, far from being flattened at the poles, was elongated. This caused most serious controversies in the field of physical theory. I have reexamined the records of this gerat debate to find that the French scholars were successful in advancing mathematical theory, in developing correct methods of triangulation, and in refining the techniques of astronomical observation, but had neglected the need of setting a reliable unit of linear measurement. The several surveys of the length of the degree of latitude, up to and including the famous survey conducted by Father Ruggiero Boscovich in Italy in 1751–53 (a survey which took as a starting point the Roman milestones of the Appian Way), kept using standards of the *pied de roi* which were different from each other.

The history of these surveys is a comedy of errors. This was sensed by the keen mind of Voltaire who, when Maupertuis announced triumphantly that his survey of the degree conducted in Lapland had proved that the earth is flattened at the poles, called him *le grand aplatisseur,* "the great flattener," building a pun on the extracurricular activities of Maupertuis with a Lappish maid.

The difficulties of scientists arose from the circumstance that the original standard of the *pied de roi* had been lost. The *pied de roi* used to be a fraction of the ancient Roman foot, and good reference standards of the Roman foot and of the *pied de roi* were kept by French trade guilds. But, the French absolute monarchy followed a policy of eliminating the public functions of the guilds. Finally the minister Colbert issued an ordinance prescribing that the only reference rule that could be used should be that kept at the Châtelet, the seat of royal administration and justice in Paris. But the standard of the Châtelet was poorly defined and badly protected from accidental damage. This is the reason why many scholars could arrive at the startling scientific conclusion that the earth is elongated at the poles. The intellectual confusion came to a rest because the engraver Langlois built his own private standard of the *pied de roi,* by assuming that the *pied de roi* is the edge of a cube that contains 70 Paris livres of water. Langlois's standard was used in establishing the Paris meter of the French metric system.

2. Although Petrie's survey of the length and orientation of the sides of the Great Pyramid proves to be unreliable, his survey of the dimensions of the King's Chamber proves to be superior to the several ones conducted since the seventeenth century. Since Petrie's survey of the King's Chamber has established that the royal cubit of the Pyramid measured 524.05235 $\pm$ 0.1016 millimeters, it permits the conclusion that the royal cubit employed in the construction was 524.1483 millimeters.

Cole began his survey of the length and orientation of the sides of the Pyramid by trying to establish the exact location of the corner points. By an extensive sounding of the foundations, he located the corner points with a possible margin of error which he estimated as follows:

West side:	30 millimeters at either end
North side:	6 millimeters at either end
East side:	6 millimeters at either end
South side:	10 millimeters at the west end
	30 millimeters at the east end

Next, Cole examined the alignment of the four sides and concluded that they meet to form angles which deviate as follows from a right angle:

Northwest corner:	−0° 00′ 02″
Northeast corner:	+0° 03′ 02″
Southeast corner:	−0° 03′ 33″
Southwest corner:	+0° 00′ 33″

I interpret these data to mean that the west side was drawn first and that the north side was intended to be perfectly perpendicular to it. The east side was intended to be at an angle of 3′ with the perpendicular to the north side, and the south side was intended to be at angle of 30″ with the perpendicular to the west side. In other words, the four corners were intended to deviate from a right angle according to the following pattern:

Northwest corner:	0
Northeast corner:	+3 minutes
Southeast corner:	−3 1/2 minutes
Southwest corner:	+ 1/2 minute

Having established the alignment of the sides according to the figures mentioned above, Cole calculated the length of the sides to be the following:

West :	230,357 millimeters
North :	230,253 millimeters
East :	230,391 millimeters
South:	230,454 millimeters

There is a contradiction in Cole's report about the length of the north side. In the summary of the lengths of the sides, Cole states that this side is 230,253 millimeters; but in an earlier part of his report he states that the north side is divided into a segment of 115,090 millimeters and a segment of 115,161 millimeters (total of 230,251 millimeters) and confirms these figures by explaining that the difference between the two segments is 71 millimeters. This contradiction is most unfortunate, because it is a conclusion of mine that the lengths of the two segments of the north side provide a key to the determination of the vertical dimensions of the Pyramid. I am inclined to infer that Cole found the north side to have a length of 230,251 millimeters.

I interpret Cole's figures to mean that the basic length of the side was 439 1/2 cubits = 230,363.18 millimeters. According to Cole the average length of the sides is 230,363.25 millimeters. Each side was intended to have a length of 1 1/4 stadia according to the stadium of 351.6 cubits; for the Egyptian this was the stadium (1/10 minute) of the degree of latitude at the equator. The perimeter of the Pyramid was intended to be 1758 cubits = 921,452.71 millimeters; Cole reports a perimeter of 921,453 millimeters. The perimeter was intended to be equal to 1/2 minute of latitude at the equator. The length of the minute of degree of latitude at the equator was calculated 3516 cubits = 1842.905 meters; it is 1842.925 meters according to the International Spheroid.

In the calculation of the Pyramid the royal cubit was divided into 24 fingers, each finger being 21.8395 millimeters. Egyptian measuring rods indicate that the royal cubit, which in principle is composed of 28 fingers (fingers such that 24 make an Egyptian common cubit), at times was divided into 24 fingers according to the ordinary division of the cubit. There are Egyptian measuring rods in which the royal cubit is divided into 28 fingers on one face and 24 fingers on the other face.

The west side was drawn first and then the north side was drawn perpendicular to it. The south and the east sides were at an angle different from a right angle with the two neighboring sides. This caused variations in the length of the sides, but steps were taken in order to assure that the average length of the sides remained 439 1/2 cubits.

The south side was intended to be at an angle 90° 00′ 30″ with the west side. Reckoning by tangent 0° 00′ 30″, this would cause a lengthening of the east side of 33.494 millimeters. Apparently this lengthening of the east side was computed as 1 1/2 fingers = 32.758 millimeters. The lengthening of the east side was compensated in part by shortening the west side by 1/4 of finger. In other words, the south side was moved backward by 1/4 of finger. The west side came to be 439 1/2 – 1/96 cubits = 230,363.1778 – 5.4597 millimeters = 230,357.72 millimeters. The east side was lengthened by 1 1/4 fingers, so that it came to be 439 1/2 + 5/96 = 230,363.1778 + 27.2994 = 230,390.48 millimeters.

The western side was rotated at the middle point by 3 minutes, so as to shorten the north side and to lengthen the south side. Multiplying the length of half of a side by tangent 0° 03′ 00″, there would be a shortening and a lengthening of 100.519 millimeters, which could be understood as 4 5/8 fingers = 101.008 millimeters. Since the east side had been lengthened by 1 1/4 fingers and the west side had been shortened by 1/4 finger, there remained an increase of a finger to be compensated. Hence, the north and south sides were shortened by 1/2 finger each. In other words, the east side was moved backward by 1/2 finger.

The length of the north side came to be 439 1/2 cubits – 4 5/8 fingers – 1/2 finger = 439 55/192 cubits = 230,251.250

millimeters. The length of the south side came to be 439 1/2 cubits + 4 5/8 fingers − 1/2 finger = 439 129/192 cubits = 230,453.266 millimeters. The difference between the two sides is 74/192 cubits = 202.016 millimeters.

This analysis of the method followed in planning the base of the Pyramid arrives at the striking conclusion that my estimates of the lengths of the sides, based on theoretical principles, do not differ by a millimeter from those obtained empirically by Cole (length of sides expressed in millimeters).

	My estimate	Cole's report
West side:	230,357.72	230,357
North side:	230,251.25	230,251
East side:	230,390.48	230,391
South side:	230,453.27	230,454
	921,452.72	921,453

3. In his survey Cole paid attention to a detail which in my opinion provides the key to the entire geometrical structure of the Pyramid. The Egyptologist Borchardt had noticed that, at about the middle of the north side, a small line is marked on the pavement which extends outward from the bottom of the Pyramid. Cole measured the position of this line and found it to be at a distance of 115,090 millimeters from the northwest corner and 115,161 millimeters from the northeast corner, with a difference of 71 millimeters between the two distances. He stated that this line is "probably the original line of the axis." Cole apparently did not pay much attention to this detail, since he reported also that the north side has a length of 230,253 millimeters. Reginald Engelbach, in presenting Cole's findings to the academic world, failed to notice the discrepancy in Cole's figures. I suspect that the figure of 230,253 millimeters for the length of the north side crept into the Cole report as a result of a mistake of 2 millimeters in placing the end of the tape against the pin that marked the position of the line of the axis.

If the north-south axis of the Pyramid is off center, it follows that the apex was off center. Petrie, when he surveyed the slope of the Pyramid, on the basis of preliminary tests suspected that each face of the Pyramid had a different slope, but did not try to establish whether this suspicion was justified. Instead he concentrated his efforts on establishing the slope of the north face, which is the best preserved one. As far as I know, none of those who tried to interpret the geometry of the Pyramid on the basis of Petrie's report considered the possibility that the four faces of the Pyramid had different slopes. Nobody has ever utilized Cole's survey in order to interpret the geometry of the Pyramid. If the four faces have different slopes, it follows that the apex is off center.

I have concluded that the north side had a length of 439 55/192 cubits = 230,251.250 millimeters. Hence, I understand Cole's figure to mean that the line which divided the north side into two parts is at a distance of 219 137/192 cubits = 115,162.479 millimeters from the northeast corner, and a distance of 219 55/96 cubits = 115,088.771 millimeters from the northwest corner. The difference between the two segments is 27/192 cubits = 73.708 millimeters. I suspect that there was a mistake of 2 millimeters in setting the end of the tape against a pin at the middle of the north face; this is the reason why Cole reports that the north side has a length of 230,253 millimeters with an excess of 2 millimeters. This type of mistake is common in surveying.

A great number of those who have tried to explain the geometry of the Pyramid can be placed into one of these two categories: those who conclude that the Pyramid was calculated by the factor π, and those who believe that the Pyramid was calculated by the factor φ. In my opinion both explanations are correct, in the sense that the slope of the west face was calculated by the factor π and the slope of the north face was calculated by the factor φ. The inclination of the other two faces was affected by the fact that the angles at the northeast and the southwest were more than right angles.

For reasons that I shall explain below, I have concluded that the height of the Pyramid was either 279.53 cubits = 146,515.174 millimeters or a figure very close to 279.53 cubits.

According to what I have said above, the distance of the apex from the west side was 115,088.771 millimeters. If the west face was calculated by the factor π, the height of the Pyramid had to be $\pi/4$ of the base of the meridian triangle of the west side. Now, 146,515.174 millimeters relates to 115,088.771 millimeters as 0.78550752, which would imply $\pi = 3.142030$. If π was reckoned as 3.1420, the height would have been 146,516.522 millimeters. By the exact value of π, the height would have been 146,535.569 millimeters.

Because of Cole's report we know the distance of the apex from the west side, but we do not have direct information on the distance of the apex from the north side. However, it can be presumed that the west-east axis was not displaced from the middle position. It can also be presumed that the line of the west-east axis was set according to the basic length of sides, before the length of the sides was altered by the widening of the southwest and northeast corners. Since the basic length of the sides is 439 1/2 cubits = 230,363.178 millimeters, it can be presumed that the apex was at a distance of 219 3/4 cubits = 115,181.589 millimeters from the north side. If this is the length of the base of the meridian triangle of the north face, and the height of the Pyramid is 279.53 cubits = 146,515.174 millimeters, the base of the meridian triangle of the north face is 0.78614103 of the height. If the north face was calculated by the factor φ, the height should have been equal to $\sqrt{1/\varphi}$ of the base of the meridian triangle. If one had recokoned by the exact value of φ, the height would have been 146,513.250 millimeters. If the height was 146,515.174 millimeters, as I tentatively assume, and the northern half of the north-south axis was 115,181.589 millimeters, $\sqrt{1/\varphi}$ was reckoned as 0.786141 (the exact value is 0.7861514) and hence $1/\varphi$ was reckoned as 0.61801767.

If $1/\varphi$ was reckoned as 0.6180, the height would be 146,517.274 millimeters, which would imply $\pi = 3.141985$. Therefore, I would conclude that the height possibly was reckoned as 279 15/28 cubits = 279.53714 cubits = 146,518.169 millimeters. According to Petrie the slope of the north face is 51° 50′ 40″ ± 1′ 05″. If the north face had been calculated by the exact value of φ, the slope would have been 51° 49′ 38″. This angle can be easily calculated, because if the meridian triangle of the north side is calculated by φ, the secant and the tangent of the angle of the slope must be equal to each other, that is, must be equal to $\sqrt{\varphi}$. If the west side had been calculated by the exact value of π, it would have had a slope 51° 51′ 14″.

4. Most interpreters agree that the Pyramid had a height of 280 cubits. Even Borchardt, who is so opposed to the idea that Egyptians had any knowledge of mathematics that he calls Herodotus an "idiot" for having said that the Pyramid was calculated by φ, agrees that the Pyramid had a height of 280 cubits.

In general one could establish a consensus of the responsible interpreters to the effect that the meridian triangle of the Pyramid was the following:

Height:	280 cubits
Base:	220 cubits
Apothem:	356 cubits

In my opinion, this triangle was purely the starting point of the calculations. It was chosen in order to indicate the relation π and the relation φ, since 22/28 is the value of $\pi/4$ used in practical reckonings ($\pi = 3\ 1/7$), and

$356/220 = 89/55 = 1.6181818$ is an approximation to the value of φ according to the initial terms of the Fibonacci series. But the initial meridian triangle was modified for several reasons, the first one being that it is impossible to construct a right triangle with sides 280, 220, and 356, since we have:

$$280^2 = 78{,}400$$
$$220^2 = 48{,}400$$
$$356^2 = 126{,}736$$

We have seen that the basic length of the sides was reduced to 439 1/2 cubits (semiside of 219 3/4).

In my opinion, the height of 280 cubits was chosen in order to indicate the polar flattening of the earth. The Egyptians calculated the polar flattening as 1/280, but this was a round figure adopted on the assumption that the order of the cosmos must be septenary.

Information about the Egyptian estimate of the size and shape of the earth is provided by Chapter LXIV of the *Book of the Dead*. This chapter was the most important one: reciting it was considered almost as effective as reciting the entire book. In one of the papyri of the *Book of the Dead* there is an annotation to the effect that this chapter was found in the shrine of the solar boat during the reign of Udimu, the fourth or fifth Pharaoh of the First Dynasty. Chapter LXIV states that the spirits of the Nether World (that is, all that is below the surface of the earth) are 4,601,200 and that each is 12 cubits high. The occurrence of the factor 12 indicates that it is a matter of geographic cubits. Now, $12 \times 4{,}601{,}200$ cubits $= 55{,}214{,}000$ cubits $=$ 138,036 geographic stadia, is equal to two diameters of the earth. In order to explain the figure of 138,036 stadia, one must assume that the Egyptians reckoned as if the polar flattening occurs only in the northern hemisphere. On the basis of this assumption the figure of 138,036 stadia can be decomposed into the following four earth radii:

34,538 stadia = 6,378,388 meters = equatorial radius
34,538 stadia
34,538 stadia
34,422 stadia = 6,356,966 meters = polar radius
138,036 stadia

These figures imply that the flattening of the North Pole is $116/34{,}538 = 1/297.74$.

With extreme economy of numerical expression the Egyptians had arrived at values which are as good as the best modern ones. The figure for the equatorial radius happens to coincide to the meter with that calculated by Hayford. But Hayford calculated the polar flattening as 1/297. Helmert, however, set the polar flattening at 1/298.3, a figure which has been adopted in several of the recent surveys and calculations of the size of the earth which aim at achieving the maximum possible exactness.

At the beginning of the dynastic period the above mentioned figures were revised in order to make them fit into the septenary system of measures and cosmic order. The polar flattening was set at 1/280. This was achieved by decreasing slightly the polar radius and increasing slightly the equatorial radius. The equator which used to be reckoned as 217,000 geographic stadia = 40,074,999 meters, was calculated by a stadium (1/10 of minute) of 354 royal cubits, which made it 40,078,476 meters. It is conceivable that the data mentioned in the *Book of the Dead* was reinterpreted as follows:

34,540 geographic stadia = 6,378,758 meters = equatorial radius
34,540 geographic stadia
34,540 geographic stadia
34,416 geographic stadia = 6,355,858 meters = polar radius
138,036 geographic stadia

The figure of 1/280 for the polar flattening was adopted because it fits into septenary reckoning also in a second and more subtle way. If the polar flattening is 1/280, the arc of meridian is 0.7840 of equatorial diameter. Now, $0.784 = 280^2/100{,}000 = 78{,}400/100{,}000$. This is the reason why Herodotus put emphasis on the fact that the surface of each face of the Pyramid is 78,400 square cubits, being equal to the square of the height, which is 280 cubits. However, the figures reported by Herodotus apply only to the initial plan of the Pyramid. When the figures were further refined the height was calculated as 279.53 cubits. If the polar flattening is 1/297.74, the arc of meridian is 0.7408 of equatorial diameter. This means that an arc of meridian is $0.78408/\frac{1}{4}\pi = 279.53/280$ of a fourth of equator. Hence, the height of the Pyramid in the final plan indicated the correct figure for the polar flattening.

VIII. ADDITIONAL REMARKS ON THE DIMENSIONS OF THE GREAT PYRAMID

1. Herodotus provides only two pieces of information about the dimensions of the Great Pyramid. He states that the surface of each face is equal to the square of the height, which means that the Pyramid was calculated by the Golden Section (by the factor φ). He states also that this surface of each face is equal to 8 Egyptian acres. The Egyptian acre is a square with a side of 1000 royal cubits (2747 square meters). The Egyptian acre, the amount plowed in a day, is similar to the Roman acre (*jugerum*), which is 2524 square meters. Herodotus's figure indicates that he had in mind a

height of 280 royal cubits. He reckoned by half acres, which, as I have explained earlier, were taken to have sides of 70 cubits. If the Pyramid has a height of 280 cubits, the square of the height is 16 half acres (78,400 square cubits). If Herodotus assumed a side of 440 cubits, in order to have this surface the faces should have had an apothem of 356.4 cubits; but if he assumed a side of 439 1/2 cubits the apothem should have been 356.8 cubits. But Herodotus's figure for the surface of the faces was not intended to be exact.

The Roman geographer Pomponius Mela (I,9) paraphrases Herodotus in these terms: *quatuor fere soli jugera sua sede occupat, totidem in altitudinem erigitur,* "it occupies almost four acres with its base, and it rises as much in height." Mela expresses himself awkwardly, but the main point is clear. In order to make the reckoning more easily comprehensible he counts by double acres which have sides of 140 cubits. If the Pyramid had a height of 280 cubits, it would be immediately clear that the square of the height is 4 (double) acres. But Mela states that the surface of the faces and the square of the height is *almost* 4 acres. It was a current practice in all ancient cultures to double units of measure, while continuing to refer to them by the name of the simple unit. Mela erroneously speaks of the surface of the base, whereas it is a matter of the surface of the faces. The error probably originated through an inept translation from a Greek author who used the technical term *epipolēs,* which means "in elevation, by the lateral surface," but may also mean "in surface." The same error occurs in Pliny. It is likely that the error in translation originated with Varro, who almost certainly was the common source of Mela and Pliny. The polymath Varro, who lived in the first century B.C., proves inept in mathematical matters, and Mela and Pliny were certainly no more adept in these matters. But, the text of Mela, in spite of its shortcomings, supports my contention that the height of 280 was merely an initial figure in the calculation of the Pyramid, a figure which was reduced in the course of the development of the calculation.

I have analyzed all other ancient authors who provide information about the dimensions of the Pyramid. By a careful collation of their words and phrases, I have established that they all draw, directly or indirectly, on a single source. These authors wrote in Greek or in Latin during the first century of the Roman Empire. They are the historian Diodorus of Sicily (I, 63), the geographer Strabo (XVII, 1, 33), the encyclopedist Pliny the Elder (XXVI, 12, 78–80), and the engineer Philon of Byzantium (*Wonders of* *the World,* II). Their common source is the Greek grammarian Agatharchides of Cnidus, who toward the end of the second century B.C. was guardian to one of the Ptolemy kings of Egypt. Quotations from Agatharchides' lost works indicate that he wrote extensively on the geography of Egypt, with particular emphasis on natural science.

The interesting feature of Agatharchides' report about the dimensions of the Pyramid is that he excludes the pyramidion from the reckoning. We know from the descriptions of other pyramids that the very top of the structure was a small pyramid of metal, usually a precious metal such as gold or silver, which shined in the sun. From Agatharchides' account one gathers that the Great Pyramid of Giza was topped by such a pyramidion, "small pyramid," as the Greeks called it. In the case of this Pyramid, at least, the pyramidion was used to achieve a mathematical result.

In ancient mathematics extensive recourse was made to a mathematical procedure which we no longer use, but which was extremely convenient. If the square root of a number cannot be expressed by an integer, the number is conceived as the product of two integers of which the second is the same as the first, but increased or decreased by a small quantity, usually the unit. Similarly, if the cubic root of a number cannot be expressed by an integer, the number is conceived as a cube in which one side is longer or shorter than the others. For instance, the number 8400 is conceived as a cube with sides 20, 20, and 21. This procedure is called *basi* in Sumerian. I have established that the calculation by what I call near-squares and near-cubes was common not only in theoretical mathematics but also in architecture, land surveying, and the construction of measuring vessels.

The procedure just described was applied in geometry by removing a small part of a figure. For instance, a problem of geometry could be solved by cutting off a slice from a side of a parallelogram. Most commonly the procedure was applied by cutting off a corner of a triangle; this is the reason why the part cut off is called *gnōmōn* in Greek. Most usually *gnōmōn* means "pointer of a dial" in Greek; hence, the term applies perfectly in our case in which the top of the Pyramid was conceived as cut off in the computation presented by Agatharchides.

An essential point of Agatharchides' account is that he describes the Pyramid as having an apothem which measures a stadium up to the pyramidion and having a side which measures 1 1/4 stadia. The term stadium has a double meaning: it refers to 1/10 minute of degree and it refers to a specific unit of measurement. Agatharchides uses the term in both senses.

I have already indicated that the base of the Pyramid has a length of 1 1/4 times 351.6 royal cubits, which for the Egyptians was the length of the stadium (1/10 minute) of the degree of latitude at the equator. From the authors who drew on Agatharchides we gather that he said that the perimeter is 5 stadia, that is, 1/2 minute of degree.

One would have expected the perimeter of the Pyramid to have been calculated by the length of the degree of longitude at the equator, but the builders instead calculated by the degree of latitude, because their concern was the length of the arc of meridian. From Agatharchides we learn that the apothem up to the pyramidion had a length of a stadium, that is, 1/10 of a minute of degree. This permits us to understand what was the specific function of the pyramidion. Since the degrees of latitude increase in length from the equator to the pole, the apothem of the Pyramid up to the pyramidion gave the length of the shortest degree of latitude, the degree at the equator. The pyramidion may have been graduated, giving the length of all the degrees from the equator to the pole. According to Egyptian reckonings, the stadium of the degree of latitude at the equator is 351.6 royal cubits and increases to a length which at the pole the Egyptians assumed to be 355 cubits in practical reckonings and slightly more than 355 cubits in exact reckoning. The apothem of the full Pyramid came to be something less than 356 cubits.

Agatharchides interprets the dimensions of the Pyramid also by taking the word stadium as referring to the stadium of 600 geographic feet. The geographic stadium was the unit most commonly used by the ancients in calculating geographic distances. A stadium was 600 geographic feet, and 600 stadia made a degree. This calculation was correct for the degree of latitude at the middle latitude of Egypt, for the latitude of the capital built by the Pharaoh Akhenaten. According to Agatharchides the side of the Pyramid is 1 1/4 stadia or 750 feet (230,847 millimeters), and the apothem is a stadium or 600 feet. The side of the base of the pyramidion is 9 feet. The figures indicate that Agatharchides was not concerned with presenting the actual dimensions of the Pyramid, but in illustrating the mathematical principles according to which the Pyramid had been conceived.

The figures quoted from the text of Agatharchides by later authors suggest that he began his analysis of the meridian triangle of the Pyramid by presenting a triangle with the following dimensions:

Height:	480 feet
Base:	377 feet
Apothem:	610 feet

This approach gives excellent values of φ and π.

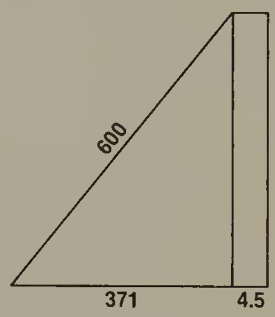
$$\varphi = 610/377 = 1.6180371 \text{ (exactly } \varphi = 1.6180339887)$$
$$1/\varphi = 377/610 = 0.6180328 \text{ (exactly } 1/\varphi = 0.6180339887)$$
$$\pi/4 = 377/480 = 0.785\,41666$$
$$\pi = 3.14166$$

It is impossible to construct a right triangle with sides 480, 377, and 610, since we have:

$$480^2 = 230{,}400$$
$$377^2 = 142{,}129$$
$$610^2 = 372{,}100$$

But the calculation I mention is less off the mark than the calculation by the triangle 280, 220, and 356, which was the one with which the builders of the Pyramid actually began.

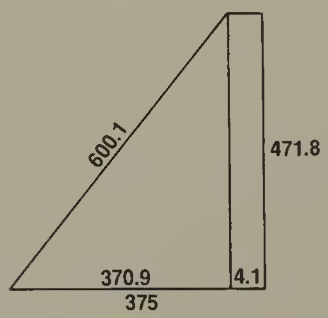
Having started with the mentioned meridian triangle, Agatharchides cut off the side so as to reduce the apothem to 600 feet and the base to 371 feet, excluding the part of the base below the half of the pyramidion.



Since Pliny in quoting Agatharchides does not give the length of a side of the pyramidion (which another author describes as being 9 feet), but the combined length of two sides, I have concluded that the pyramidion had an average side of 9 feet, but had different lengths of different faces.

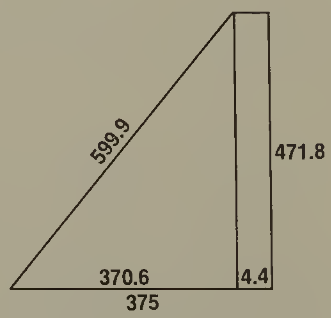
I presume that Agatharchides presented two different meridian sections of the Pyramid, one calculated by the factor φ and one calculated by the factor π.

By φ:



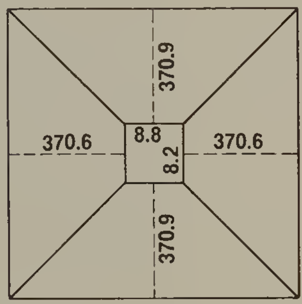
$1/\varphi = 0.61806368$

By π:



$\pi = 3.1420090$

The two possible meridian sections were combined so as to obtain two faces calculated by π and two faces calculated by φ. The Pyramid seen from above would have had the following dimensions:



Like Herodotus, Agatharchides was not concerned with reporting the exact dimensions of the Pyramid, but with presenting the general principles of the mathematics of the Pyramid. This was the point which was of the greatest interest to a Greek audience.

I do not pretend to have reconstructed the authentic reckoning of Agatharchides, but I feel confident that I have understood the general drift of his interpretation. It seems to me that he intended to improve on the presentation of Herodotus, who had only mentioned the factor φ, by stressing the roles both of the factor φ and of the factor π. Agatharchides wanted also to emphasize that the dimensions of the Pyramid were related to the length of the degree of latitude. This was a point of essential importance which had not been mentioned at all by Herodotus.

2. The Egyptians ascribed the invention of the art of building with stone to Imhotep, vizier and architect of King Zoser, who reigned about fifty years before the building of the Great Pyramid. And in fact there has not been found any important building made only of stone blocks which dates before the reign of Zoser. The Egyptians described Imhotep as a sort of Leonardo da Vinci of Egypt, mathematician, scientist, engineer, and architect. Not many years after his death he was made into a demigod, son of Ptah, the god of craftsmen and technicians. Up to recently there were Egyptologists who insisted that Imhotep was a legendary figure. One argument was that there is no other instance in Egyptian history of an ordinary person having bene divinized. But more basic was the argument that a person with all the gifts ascribed to Imhotep could not have existed in the Old Kingdom. It is only in the last few years that it has been definitely accepted that Imhotep was a real person, since it has been possible to gather some specific details of information even about his physical appearance. His genius was recognized even during his life, since King Zoser

covered him with all sorts of honors, although he was a man of humble origin.

But, even though it is now granted that the Egyptians were not living in dreams when they idolized the genius of Imhotep, Egyptologists have failed to investigate what were the scientific achievements of Imhotep other than that he was the first one to have designed a pyramid, the step pyramid of Saqqara. This pyramid is just one element in an enormous group of buildings which is known as Zoser's Complex. This group of buildings is not only so extensive but also so elaborate that nothing of the sort was produced again in the long history of Egypt. In spite of this, not one Egyptologist has tried to investigate this monument and other constructions directed by Imhotep in terms of what the Egyptians said were his talents. Scholars are willing to grant that a man with the name of Imhotep walked on the land in Egypt, but they are not yet willing to grant that Egypt could have produced a mind like his.

The French archeologist Jean Philippe Lauer has dedicated many years to the study of Zoser's Complex. He is a highly competent archeologist and essentially factual and realistic. Actually he has been criticized for insisting too much on technical problems of architecture. For instance, the German Egyptologist Herbert Ricke has disputed point by point Lauer's interpretation of the monuments of Zoser's Complex, claiming that the architecture must be understood in terms of the conflict between the psychological attitudes of nomadic hunters and that of sedentary agriculturists. But Lauer has learned how far the academic community is willing to go in tolerating rational thought in the area of ancient studies. In 1944 he published a short paper in which he tried to deal with the geometry of the pyramids and enlisted the cooperation of a professional mathematician, Paul Montel. But, four years later, when he published the book, *Le Problème des pyramides,* he backtracked and dismissed any mathematical interpretations.

In reporting about Zoser's Complex, Lauer keeps stumbling into mathematical problems, but ignores them. For instance, he found that the wall that surrounds the entire Complex forms a rectangle 544.90 by 277.60 meters. He concludes that it is a matter of a dimension of 1040 by 530 cubits. I would understand that the intended dimensions were 545,114 by 277,799 millimeters, according to the cubit of 524.1483 millimeters. Lauer is surprised at meeting with the figure of 1040 cubits, whereas he would expect 1000 cubits, and explains it away by assigning arbitrarily 40 cubits to the thickness of the walls. But in another part of his work he points out that the same proportions occur in some First Dynasty royal tombs which have dimensions of 54 by 27 meters. It may be enough to point out here that the dimensions of the enclosure of Zoser's Complex are based on the near-square with sides 52 and 53, a mathematical entity of which I have spoken earlier. It is a matter of two near-squares with sides of 520 and 530 royal cubits. It is relevant to what follows that such a near-square has a diagonal of 742.49579, which is 6 times 123.749.

Lauer notices in Zoser's Complex four instances of the occurrence in important positions of the anomalous dimensions of 123 cubits, whereas in the Complex dimensions are generally decimal multiples of the cubit. One of the most impressive remains of the Complex, the monumental entrance gallery, has a length of 123 cubits. Lauer suggests that the Egyptians may have been fascinated by a magic number composed by the first three integers. This is a way of shunting off a problem by appealing to that undefinable entity called magic and by implying, at the same time, that the Egyptians, and their hero Imhotep in particular, were frivolous in matters of mathematics.

Lauer did not realize that the number 123 is an expression in terms of integers of the number $2/\varphi = \sqrt{5} - 1 = 1.236068$. In his book on the pyramids Lauer had denied the occurrence of the factor φ in their architecture.

It is a matter of the right triangle with an angle of 36° which the Egyptians called *mr.* I have suggested that the name *To-Mera,* which the Egyptians gave to their country, was a reference to this triangle. If a right triangle has an angle of 36° and the longer side is 100, the hypotenuse is $2/\varphi\ 100 = 123.6068$, the other side being 72.6542.

Since I have argued that the Great Pyramid was calculated both by the factor φ and by the factor π, I might point out here that there is a close relation between these two numbers, which goes beyond the fact that there is a numerical similarity between $\pi/4 = 0.7853981$ and $\sqrt{1/\varphi} = 0.7861514$. The number φ was used to obtain the value of circular functions, since we have

$$\begin{aligned}
\sin\ 18° &= \cos\ \ 72° = 1/2\varphi \\
\sin\ 54° &= \cos\ \ 36° = \varphi/2 \\
\sec 36° &= \operatorname{cosec} 54° = 2/\varphi \\
\sec 72° &= \operatorname{cosec} 18° = 2\varphi
\end{aligned}$$

In practical reckonings the right triangle with an angle of 36° was taken as a triangle with a side of 100 and a hypotenuse of 123. The side opposite the angle of 36° was taken as being 72; this permits us to calculate in terms of half degrees all the trigonometric functions of the angles between 0° and 36°. Since the angle of 36° is 2/5 of a right angle and 1/10 of a full circle, one can calculate from the mentioned triangle the trigonometric functions for all angles.

This is the reason why the triangle *mr* was considered the basic constituent of the cosmic order.

In order to recognize the importance of the right triangle with an angle of 36°, one may start by considering how much attention it received in Euclid's *Elements*. It plays an even greater role in early Greek mathematics. The symbol of the Pythagorean sect, the five-pointed star, was a combination of such triangles.

I have explained that the right triangle with a hypotenuse of 123 was a practical simplification of the triangle of 36° built according to the Golden Section. A further simplification was the right triangle with sides related as 3:4:5. If this triangle is enlarged to the scale of the one with hypotenuse of 123, it has sides 120, 100, and 75, instead of 123, 100, and 72.

I need to point out that the Great Pyramid incorporates the relation 4:5 in the proportion between the length of the apothem up to the pyramidion and the length of the side. This provides a point of transition to an analysis of the dimensions of the Second Pyramid.

The Great Pyramid tried to compress a great number of mathematical relations, whereas the Second Pyramid limited itself to embodying the triangle *mr.*

The basic idea of the Great Pyramid was that it should be a representation of the northern hemisphere, a hemisphere projected on flat surfaces, as is done in mapmaking. This was the principle according to which was built the ziggurat of Babylon, the biblical Tower of Babel, and according to which were built the earlier pyramids. The Great Pyramid was a projection on four triangular surfaces. The apex represented the pole and the perimeter represented the equator. This is the reason why the perimeter is in relation 2π with the height. The Great Pyramid represents the northern hemisphere in a scale 1:43,200; this scale was chosen because there are 86,400 seconds in 24 hours. But then the builders became concerned with the problem of indicating the ratio of polar flattening of the earth and the length of the degrees of latitude which depends on the ratio of this flattening. Next, they incorporated into the Pyramid the factor φ as the key to the structure of the cosmos. The Second Pyramid, on the contrary, limits itself to embodying the trangle *mr,* which is based on the number φ, at least as far as I have been able to establish up to the present moment.

According to Petrie's survey the sides of the Second Pyramid have the following lengths:

West: 215,278 millimeters
North: 215,186 millimeters
East: 215,269 millimeters
South: 215,313 millimeters

The royal cubit of this pyramid is that of 525 millimeters. The basic length of the sides is 410 cubits = 215,250 millimeters.

The meridian triangle of the pyramid is a triangle with proportions 3:4:5. The base is 205 cubits, the height is $4/3 \times 205 = 273.33$ cubits, and the apothem is $5/3 \times 205$ cubits $= 341.66$ cubits.

Reckoning by third of cubits, we have:

Base: 123×5
Height: 164×5
Apothem: 205×5

Possibly the pyramid was calculated by a rod of 5/3 of a cubit, which is called *nbyw* (*nebiu* in Coptic).

It is clear that this pyramid was intended to incorporate the number 123 as a round figure for $2/\varphi$.

The slope of the pyramid is the same as the angle of problems 67–69 of the Rhind Papyrus. The tangent $164/123 = 1.3333$ corresponds to a slope 53° 07′ 48″. The angle of the apothem with the height is 36° 52′ 12″. This angle was intended to be an approximation to the perfect angle 36°

The geometry of the Second Pyramid could be considered crude in relation to the sophisticated one of the Great Pyramid, but it emphasizes the importance that the Egyptians attached to the triangle *mr.*

3. Petrie's survey of the Second Pyramid helps in clarifying the problem of the orientation of the sides of the Great Pyramid.

Petrie reported that the four sides of the Second Pyramid are oriented as follows:

West	side:	0° 04′ 21″	west of true north
North	side:	0° 05′ 31″	north of true east
East	side:	0° 06′ 13″	west of true north
South	side:	0° 05′ 40″	north of true east

Petrie warns that the triangulation of Egypt existing at his time did not permit him to establish the direction of north with absolute certainty. Hence, his figures can be taken only as an indication of the angle of the sides in relation to each other.

Petrie's figures prove that the deviation from the right angle in three of the four angles of the Great Pyramid was intentional and not the result of mistakes in construction, as claimed by professional archeologists. The north side of the Second Pyramid is shortened in relation to the south side, as it occurs also in the Great Pyramid. But in the Second Pyramid the shortening of the north side and the lengthening of the south side was achieved by constructing a more regular figure. The base of the Second Pyramid has the shape of a trapeze or a trapezoid. The north and south sides were drawn parallel to each other. Possibly the west side was intended to be at an angle of one minute with the north-south axis, and the west side was intended to be at an angle of half a minute with the north-south axis.

In any case the approximate findings of Petrie indicate that, if one proceeded to a new survey of the Second Pyramid and then surveyed the orientation of the sides of other pyramids and possibly of other major constructions of the Old Kingdom, one could recognize a pattern on the basis of which it could be established what was the purpose in making the angles of pyramids and possibly of other major constructions different from a right angle. It is impossible to formulate a reliable explanation for the differences among the angles of the base of the Great Pyramid without establishing what was the general practice in establishing the angles of the base of pyramids.

I have come across the same difficulty in dealing with the dimensions of Greek temples. I have ascertained that the four angles of the Parthenon were intended to deviate slightly from a right angle. Further, in the case of the Parthenon the north side is shorter than the south side, as in the case of the two major pyramids of Giza. But it is impossible to advance hypotheses in order to explain the differences among the angles of the Parthenon, as long as the angles of other temples are not surveyed so as to make possible the identification of a regular pattern.

There is one further problem to be considered in relation to the orientation of the faces of the Great Pyramid. The west face, which in my opinion was drawn first and is the basic face, is not oriented to the north, but is oriented 2′ 30″ west of true north.

This deviation from orientation to the north is the result of the precession of the equinoxes.

From cuneiform texts one gathers that in Mesopotamia there was a distinction of roles between the mathematician who formulated the general plan of a building and the architect who executed the plan. Whether this distinction existed in Egypt or not, it can be assumed that in the construction of a pyramid the first step was the drawing of a mathematical plan. This plan would include the alignment of the stars to be observed in establishing the direction of the north. If my interpretation of Egyptian sky charts is correct, the line that indicates the north used to be marked so as to pass through the celestial pole and through the pole of the ecliptic.

In any case, it appears that there was drawn a plan of the Great Pyramid which included the calculation of the stars to be observed in order to obtain the direction of the north. After this plan was drawn, the ground of the Pyramid had to be cleared in order to proceed to the ceremony called "stretching of the cord," which for the Egyptians was the equivalent of our laying of the first stone. This ceremony had the purpose of establishing the direction of true north and, as the Egyptians saw it, suspending the building from the sky by tying the building with an imaginary string to the axis of rotation of the vault of heaven.

If there had passed exactly three years from the drawing of the plan to the ceremony of the "stretching of the cord," the clustering of stars, which gave the exact north of the moment of the drawing of the plan, would give an orientation 2′ 30″ west of north, because of the precession of the equinoxes, which displaces the star taken as the polar star in practical calculations to the west at a rate of about 50″ a year.

The Second Pyramid too is oriented west of true north, but unfortunately Petrie's figures for the orientation of this pyramid are not exact, as he himself warns.

The question to be asked is whether the incorporation of the rate of the precession of the equinoxes into the dimensions of the Great Pyramid and of the Second Pyramid was accidental or intended. I am inclined in favor of the second alternative, since in the case of the Great Pyramid the angle corresponds exactly to three years in the precession of the equinoxes. In their book *Hamlet's Mill* de Santillana and Dechend have used mythological and iconographic evidence in order to prove that all ancient cultures of the world were deeply preoccupied with the phenomenon of the precession of the equinoxes. They intended to prove that the movement by which the celestial pole in about 25,920 years (Platonic year) makes a full circle around a point called the pole of the ecliptic was conceived as the basic movement in the life of the universe. This cycle determined all other movements, including biological developments, and determined the length of human life (taken as equal to 72 years, or the time that it takes the celestial pole to move a degree) as well as historical events. The authors of *Hamlet's Mill* have kept their conclusions vague, probably in the hope that thereby their findings would be less readily attacked by the academy. They open their book with the statement: "This is meant to be only an essay. It is a first reconnaissance of a realm well-nigh unexplored and uncharted." This is a most gentle way for a professor of the history of science at the zenith of his career to present a thesis which, if accepted, should have the impact of a Copernican revolution on current conceptions of the development of human culture. Since the essence of my method is quantitative, I cannot indulge in the luxury of such linguistic niceties. I have collected a mass of numerical evidence which shows that the inhabitants of the ancient world were acquainted with the rate of the precession of the equinoxes and attached a major significance to it. But in order to deal with this evidence, I would have to open an entirely new topic. I beg the indulgence of the reader in asking him to remain satisfied for the moment with the mere hint that there is yet another lesson about the level of Egyptian science to be drawn from the stark nakedness of the Great Pyramid.

GLOSSARY OF NAMES AND TERMS

Abd-al-Latif (1179–1231) — Arab historian who taught medicine in Baghdad. Author of one of the early Arab histories of Egypt: *Relation de l'Égypte*. In 1220 he explored the Great Pyramid, reporting that he came out of it "more dead than alive."

Abdullah Al Mamun (d.833) — Caliph of Baghdad, son of Harun al-Rashid. Patronized literature and science; built an astronomical observatory outside Baghdad; ordered a degree of latitude to be measured across the plain of Palmyra. Is reputed to have broken into the Great Pyramid in 820 in search of treasures, but to have come away empty-handed after opening the way to the King's Chamber.

Agatharchides of Cnidus — Greek historian and geographer who lived in the time of Ptolemy Philometor (181–146 B.C.) and dealt with the geography of the Near East.

Akhnaten (1388–1358 B.C.) — Revolutionary pharaoh of the Eighteenth Dynasty who changed his name from Amenophis IV, and broke with the priests of Amon at Thebes. He built a new capital, Akhtaten, between Thebes and Memphis near the site of Tell el-Amarna. Of his religious reform, which was monotheistic and recognized the sun as the symbol of living energy, Petrie remarked: "no such grand theology had ever appeared in the world before."

Akhtaten (Resting point of Aten) — Capital built by the young pharaoh Akhnaten at the predynastic geodetic center of Egypt, halfway between the Tropic and the Mediterranean coast, near the site called Tell el-Amarna. The city, which was decorated with splendid temples and palaces, was destroyed after Akhnaten's death.

Ali Gabri (1830–19?) — Arab guide, sometimes referred to as Alee Dobree, who was an assistant to Howard-Vyse, Piazzi Smyth, Sir Flinders Petrie, and Moses B. Cotsworth over a period of nearly seventy years, helping them explore and measure the Great Pyramid.

Alvarez, Luis Walter (1911–   ) — Nuclear physicist. Professor of physics at Lawrence Radiation Laboratory, Berkeley, California. Nobel Prize winner for physics in 1968. Developer of radar. Helped develop A-bomb and flew in B-29 observer following the plane that bombed Hiroshima. One of the youngest members to be elected to the National Academy of Science. Author of several scientific articles. Adapted spark chamber to X-ray the pyramids with cosmic rays.

Amèlineau, Emile (1850–1915) — Studied Egyptian and Coptic under Maspero. Did much excavating but was criticized by Petrie and Maspero for unscientific methods. Professor of history of religions in École des Hautes Études in Paris, where he died in 1915. Author of several volumes on ancient Egyptian history and science.

Amenemhet — Four Pharaohs of the Twelfth Dynasty, the first of which reigned from ca. 1991 to 1962 B.C.

Amon	A god who was related to the wind, promoted to an imperial divinity at the beginning of the Twelfth Dynasty as Amon-Ra. Amon was considered the creator of other gods, and to have had no beginning and no end.
Ancient Empire	From the Third to Sixth dynasties, variously estimated, but approximately 2780 to 2280 B.C. There is little historical data on this period, most of the relevant papyri having disappeared. Under the influence of King Zoser and his architect Imhotep, brick structures gave way to stone. The political center was at Memphis
anomalistic year	365 days, 6 hours, 13 minutes, 48 seconds. The time it takes the earth to return in its elliptical orbit to the point nearest the sun —about 4¾ minutes longer than the sidereal year.
apothem (of a pyramid)	The distance from the apex down one face to the center of a base side.
Arya-Bhata (b. 476–?)	Hindu astronomer and mathematician, author of Aryabhatiya which gave the rules of mathematics as known in his time. Most of his work deals with astronomy and spherical trigonometry. Gave a value for π of 3 177/1250, or 3.1416. Taught that the daily rotation of the heavens was an appearance due to the earth's rotation on its axis.
Aten	God of the solar orb, raised to a prime position by Akhnaten. Represented by a golden disc radiating rays that end in hands. Was considered a universal deity who could have held sway over a universal empire.
azimuth	Angle of arc around the horizon, or angular distance of an observed point from geographic north (or other fixed point).
Ballard, Robert T.	Australian engineer who made a study of the pyramids in 1882 which he wrote up in "The Solution of the Pyramid Problem; or, Pyramid Discoveries with a New Theory as to Their Ancient Use."
Barnard, Professor F. A. P. (1809–1889)	President of Columbia University (1864) and president of the American Association for the Advancement of Science. An authority on weights and measures, he took issue with the conclusions about the Pyramid drawn by Piazzi Smyth and other pyramidologists.
Behdet	Town in lower Egypt which was the capital of Egypt in predynastic times. In Ptolemaic times it was the capital of a nome and was known to the Romans as Hermopolis Parva. In Stecchini's reconstruction of the ancient geography, Behdet was the northern limit of Egypt, 7 1/2° north of the Tropic.
Belzoni, Giovanni Battista (1778–1823)	Italian explorer and adventurer. A large and powerful man, six feet seven inches, who exhibited himself in feats of strength. He came to Egypt to demonstrate a hydraulic machine he had invented, but when the machine proved unsuccessful he turned to archeology and discovered several tombs as well as the entrance to Kephren's pyramid. A narrative of his exploits was published in 1820.
Biot, Jean Baptiste (1774–1862)	French physicist, professor of mathematics at Beauvois and professor of physics at the Collège de France. A prolific writer, he covered a wide field of physical science, becoming a member of the Academy of Sciences and a commander of the *Légion d'Honneur*. He was especially interested in the astronomy of the ancient Egyptians.

The Book of the Dead	An Egyptian collection of hermetic inscriptions and papyri purportedly providing funerary and ritual texts.
Borchardt, Ludwig (1863–1938)	German Egyptologist. Studied Egyptology at Berlin University under Professor Johan Erman. Worked at Philae in Egypt in 1895, and conducted many excavations in subsequent years. Inaugurated the great Catalogue of Cairo Museum with Professor Gaston Maspero. Founded German Institute of Archeology in Cairo. A bibliography of his many writings was issued in 1933.
Bouchard, Pierre-François-Xavier, Captain (1772–1832)	Engineer working on Fort Julien near Rosetta, 70 kilometers east of Alexandria, in 1799 found the Rosetta Stone as part of an old wall.
Brugsch, (Pasha) Karl H. (1827–1894)	German Egyptologist sent to Egypt by the Prussian government in 1853. Consul general in Cairo, 1864, then professor of Egyptology at Göttingen, 1868. Director of School of Egyptology in Cairo. Published a demotic grammar, a hieroglyphic dictionary, and a history of Egypt.
Brunés, Tons	Danish consulting engineer and Freemason who devoted a score of years to resolving the problems of ancient geometry. In 1967 he published a six-hundred-page two-volume book, *The Secrets of Ancient Geometry,* in which he attempted to substitute a "Sacred Cut" for the Golden Section or phi relation.
Budge, Sir Ernest Alfred Wallis (1857–1934)	Orientalist. Keeper of Egyptian and Assyrian Antiquities at the British Museum. Large published output including popular and semipopular works. Compiled an Egyptian dictionary, and a full edition of *The Book of the Dead.*
Burattini, Tito Livio (16?–1682)	Italian follower of Father Athanasius Kircher. Made several trips to the Great Pyramid and took measurements with Greaves which were used by Newton in his first calculations for the theory of gravitation. A Venetian by birth, Burattini spent the better part of his maturity in Poland. Author of works on standards of measure and the use of pendulums.
Cabala	A system of mystical interpretation of Scriptures practiced by certain medieval Jewish rabbis and certain Christian sects, on the assumption that Scriptures have an occult meaning.
Campbell, Patrick, Colonel (1779–1857)	Army officer and diplomat. British consul general in Egypt, 1833 to 1840. Associate of Colonel Howard-Vyse in exploration of pyramids, who named for him one of the construction chambers above the King's Chamber in the Great Pyramid.
Cardano, Girolamo (1501–1576)	Milanese doctor, mathematician, and astronomer, author of several books. His works in mathematics include treatises on arithmetic and algebra. He referred to ancient traditions as indicating the Great Pyramid incorporated an earth commensurate unit of measure of great exactness.
cardinal points of the compass	North, east, south, west.
cartouche	An oblong figure containing a Pharaoh's name.
Cayce, Edgar (1877–1945)	American clairvoyant whose thousands of readings while in trance are filed in a foundation created in his memory at Virginia Beach, Virginia. Had many memories as a being at the time of Atlantis and the construction of the Pyramid, but readings lack solid data.
Cassini, Gian Domenico (1625–1712)	French astronomer and geodesist of Italian origin, founder of a family of geodesists. He measured meridian arc through Paris.

Was assisted by his son Giacomo (1677–1756), who was assisted by his grandson Cesare Francesco (1714–1784). His great-grandson, Giacomo Domenico, also a geodesist and astronomer, was born in Paris in 1747 and died 1845.

Caviglia, Giovanni Battista (1770–1845)	Genoese mariner, owner and master of a trading vessel in the Mediterranean based on Malta. Regarded himself as a British subject. Explored the pyramids and the Great Sphinx, from whose base he had great quantities of sand removed. An ingenious excavator, he discovered the outlet to the well in the Great Pyramid and was in charge of several hundred men excavating for Colonel Howard-Vyse until they quarreled. Caviglia was given to occultism and mysticism, and spent his final years in Paris as a protégé of Lord Elgin.
celestial equator	A great circle produced by projecting the earth's equator outward to the celestial sphere.
Champollion, Jean-François (1790–1832)	At 16 at the Academy of Grenoble, Champollion presented a thesis in support of Father Athanasius Kircher's idea that Coptic was a degeneration of ancient Egyptian. The discovery of the Rosetta Stone by Napoleon's troops helped Champollion to decipher the system of ancient Egyptian hieroglyphs.
clinkstone	Compact grayish rock which clinks like metal when struck.
clinometer	A device to measure angle of slope.
Cole, J. H.	British surveyor who carried out the official survey of the Great Pyramid for the Egyptian government in 1925. His measurements made it possible to know the dimensions of the base of the Pyramid to within a few millimeters, and put an end to years of controversy.
corbeled masonry	An arrangement of stones in which successive courses project beyond those below.
Cotsworth, Moses B. (1859–1943)	British legislative enthusiast who wrote a series of pamphlets and books advocating a more rational almanac and demonstrating how the pyramids, obelisks, Druid circles, and mounds were erected as yearly almanacs. Expatriated to Canada, where he died during World War II.
Cottrell, Leonard (1913–)	British author of several books on Egyptian history and the pyramids. Writer and producer for radio and television.
Davison, Nathaniel (?–1783)	Accompanied Edward Wortley Montagu on his travels in the East. Arrived at the Great Pyramid in July of 1765, where he discovered the first construction chamber over the King's Chamber, which has since been named for him. Was later British consul general at Algiers until his death in 1783.
decans	Ten-day periods marked by the passage of constellations by which the Egyptians divided the year into thirty-six units.
declination	Angular distance of a heavenly body north or south of the celestial equator; analogous to latitude on the stellar vault.
Dendera	Ancient site of a Ptolemic temple compound about 60 kilometers north of Luxor on the east bank of the Nile dedicated to Hathor and Isis. Several temples are believed to have been constructed on the site, attributed to Cheops, Pepi I, and earlier monarchs. A zodiac on the ceiling of an upper room was removed and is now on display at the Louvre where it has been the object of heated controversy as to its age and significance.

Denon, Baron Dominique Vivant (1747–1825)	French antiquary and man of letters. Joined Napoleon's expedition and made many remarkable drawings. Published *Voyage dans la basse et la haute Egypte,* 1802, which was an instant success; translated into German and English. Appointed director-general of French Museums.
Didoufri	Fourth Dynasty king who succeeded Cheops and preceded Kephren.
Diodorus Siculus	Greek historian of the first century B.C. Published a history, or *Bibliotheca historica*, the first surviving book of which deals with Egypt, to which he traveled about 60 B.C. In his geography he quotes various lost sources.
diurnal pattern	The apparent movement of the stars in each rotation of the earth.
Dümichen, Johnnes (1833–1894)	German Egyptologist. Professor of Egyptology, Strassbourg, 1872–1894. Several publications. Traveled frequently to Egypt.
dynasties	Thirty dynasties of Egyptian kings were listed by the priest Manetho, from Menes to Ptolemy II Philadelphus. Though erratic, the list has formed the basis of Egyptian history for succeeding Egyptologists.
Edfu	Ancient temple said to have been built during the Third Dynasty. Capital city of second nome of Upper Egypt on the west bank of the Nile, 100 miles downstream from Thebes. Site of huge sandstone temple dedicated to Horus, constructed in Ptolemaic times, and found half buried in the sand by Napoleon's forces during their campaign in Upper Egypt.
Edwards, I. E. S. (1909–)	British author and Egyptologist. Keeper of Egyptian Antiquities British Museum since 1955. Visiting professor at Brown University, 1953–1954.
Egyptian mysteries	Secret knowledge of the cosmos possessed by initiates.
Elephantine	Island in the Nile just north of the first cataract, which was used as a geodetic point. Known as the city of the elephants, capital of the first nome in Upper Egypt on the border of Nubia. Opposite Syene, the modern Aswan.
Engelbach, Reginald (1880–1946)	British engineer and Egyptologist. Assisted Petrie in several digs. Appointed Chief Inspector in Upper Egypt for the Services des Antiquités. Keeper of Cairo Museum 1931. Published work on obelisks and Egyptian masonry.
equinox	Time at which the sun crosses the equator in March and September (vernal and autumnal) when day and night are of equal length all over the earth.
Fibonacci, Leonardo Bigollo (1179–1250)	Italian mathematician, known as Leonardo da Pisa. His *Liber Abaci* (1202) was for years a standard work on algebra and arithmetic. In *Practica Geometriae* (1220) he organized and extended material in geometry and trigonometry. The Fibonacci series, which he popularized in Europe in the thirteenth century, appears in the construction of the Great Pyramid several millennia earlier.
Fibonacci series	A sequence of numbers in which each is the sum of the two previous numbers—1, 2, 3, 5, 8, 13 . . . The limit of this series gives the exact value of φ.
Firth, Cecil Mallaby (1878–1931)	British Egyptologist. Served thirty years in Service des Antiquités.
geodetic gnomon	A vertical pillar whose shadow can be used to determine time, distance, and latitude.

Golden Section (ϕ proportion)
Division of a line (or geometric figure) so that the proportion of the smaller section to the larger is the same as that of the larger to the whole. For example, in the line below, the Golden Section is such that AB:AC = AC:CB.

Greaves, John (1602–1652)
Mathematician and antiquarian. Son of Rector of Colemore in Hampshire. Educated at Baliol College, Oxford. Professor of geometry at Gresham College, London. Traveled to the East to collect Arabic and Persian manuscripts. Made the first accurate survey of the Great Pyramid during a trip to Egypt in 1639. Author of *Pyramidographia*. Appointed Savilian professor of Astronomy in reign of Charles I; dismissed by Roundheads.

Hapy
The animating spirit of the Nile, self-engendered; lord of the fish represented by an androgynous divinity crowned by a papyrus reed.

Hathor
Egyptian goddess, originally a personification of the sky. In the Dendera cult, Hathor was considered the wife of Horus. The Greeks identified Hathor with Aphrodite.

heliacal rising (or setting)
Observation of a star as close as possible to the rising or setting of the sun.

heliocentric pattern
The arrangement of the planets in orbits around the sun.

Heliopolis (or On or Annu)
Northeast of Cairo on the edge of the desert; believed to be the capital of a prehistoric state. City of the Sun, embellished by a series of kings from the Third Dynasty on, it was the seat of temple of priests who numbered as many as twelve thousand. Ancient center of theological learning. It was reduced by Alexander the Great in the fourth century B.C. One of the earliest obelisks was found still standing at Heliopolis.

Herodotus (484–425 B.C.)
Greek historian born in Asia Minor. Visited Egypt towards the end of the first Persian domination. In his *History* he devoted a book (called Euterpe, after the muse of lyric song) to Egypt, giving many interesting and accurate details of geography.

Herschel, Sir John (1792–1871)
Astronomer, only son of astronomer Sir William Herschel. Made a fellow of the Royal Society at twenty-one for a brilliant mathematical investigation. Author of books on mathematics and astronomy considered among the elevating influences of the century.

Horus
Prehistoric Egyptian sky god in the form of a falcon whose eyes were the sun and moon; also called the "Behdetite" in the form of a winged sun-disk. Later incorporated in the Osiris cycle. Identified by the Greeks with Apollo.

Howard-Vyse, Colonel (later Major General) Richard William (1784–1853)
Son of General Richard Vyse and grandson of Field Marshal Sir George Howard. Retired as Colonel of Second Life Guards, 1826. Equerry to the king of Hanover. Member of Parliament. Traveled to the Middle East in 1835, where he organized excavation of the pyramids in 1837, employing Caviglia and hundreds of other workers. Discovered original casing stones and found chambers above Davison's. Author of *Operations Carried on at the Pyramids of Gizeh in 1837.*

Hyksos
Asiatic kings who invaded Egypt and formed the Fifteenth and Sixteenth dynasties. They were chased out of Egypt by Ahmosis I who founded the Eighteenth Dynasty.

ibn-Batuta (ca. 1352)	Mohammedan traveler. Said the pyramids were built by Hermes, who is the same person as the biblical Enoch, to preserve the arts and sciences, and other scientific acquirements, during the flood. Said dream occurred to King Surid that the Pyramid would be opened on the north side, so he deposited a sum of money equal to the expense of excavation.
Imhotep (ca. 2800 B.C.)	King Zoser's architect, who is accredited with the building of the stepped pyramid of Saqqara, of limestone. He is reputed to have been an author, diplomat, architect, and physician.
Ka	Metaphysical part of human being. Lived only on the essence of foods and was satisfied with facsimiles of food and mock buildings which had only façades.
Lepsius, Karl Richard (1810–1884)	German Egyptologist. Led Prussian expedition to Egypt and Nubia. Published seventeen folio volumes of *Denkmäler,* mostly epigraphic material. Keeper of Egyptian collections of Berlin from 1873.
Lieder, Rudolph Theophilus (1797–1865)	German missionary. Member of the Egyptian Society of Cairo, 1836. Collected antiquities.
Lindsay, (Lord) Alexander William Crawford (afterwards 25th Earl of Crawford and 8th Earl of Balcarres) (1812–1880)	Traveler and writer on art. His *Letters from Egypt,* etc., contain particulars on Caviglia.
Lockyer, Sir Joseph Norman (1836–1920)	English astronomer, educated on the continent of Europe; knighted for his work in spectroscopy and for identifying helium in the sun. The author of several books on the astronomy of ancient peoples, he was the first to demonstrate convincingly how ancient Egyptian temples were used as solar and stellar observatories and almanacs.
Luxor	Part of the ancient site of Thebes. A huge temple dedicated to the god Amon was built in the reign of Amenhotep III, and altered by succeeding Pharaohs, especially by Rameses II, who had many colossal statues of himself erected on the grounds.
Mandeville, Sir John (fl. 1356)	Fabulous writer of traveler's guidebooks. Most of his data were available in contemporary travel books and encyclopedias. His "voyages" are believed to be the work of a notary in Belgium who never traveled abroad.
Manetho	Egyptian priest and annalist in the reign of Ptolemy I who wrote a history of Egypt in Greek, only fragments of which remain. His division of the kings of Egypt into thirty dynasties is still the basic structure underlying Egyptian history.
Mariette, (Pasha) Auguste (1821–1881)	French Egyptologist. Traveled to Egypt to collect Coptic manuscripts and engaged in excavations. Appointed Conservator of Egyptian Monuments by the Khedive and settled in Egypt, where he made numerous finds which became the nucleus of the Cairo Museum.
Maspero, Sir Gaston Camille Charles (1846–1916)	French Egyptologist of Italian origin. Professor of Egyptology at Collège de France. Succeeded Mariette as director of the Services des Antiquités. Wrote many scientific memoirs and a large number of popular books and reviews.
mastaba	An oblong masonry structure with sloping sides and a flat top, usually above a deep pit.

Menes (fl. 3400 B.C. [3500?])	First historic ruler of the First Dynasty of ancient Egypt, who is reputed to have united the southern and northern kingdoms and settled on a new capital on the Nile at the point of juncture at Memphis.
mensuration	The science of measurement.
meridian	A great circle passing through the poles of the celestial sphere and the zenith of a fixed point on earth.
Meroe	Village in the Sudan on the Nile north of Khartoum which still has ruins of temples and pyramids.
Middle Kingdom	Twelfth to Fourteenth dynasties, from 2000 to 1600 B.C. Follows first intermediate period of chaotic conditions. The capital was at Thebes.
Minutoli, Johann Heinrich Carl, Freiherr von (1772–1846)	Prussian officer of Italian origin. Collected large quantities of antiquities. Published *Mes souvenirs en Egypte*.
New Kingdom	Covers Eighteenth and Nineteenth dynasties, 1580–1350 and 1350–1200 B.C. The Hyksos invaders were crushed and a military state embarked on wide conquest from as far as Cush to the Euphrates.
nilometer	An instrument for measuring the height of the Nile.
Nubia	Ancient region, originally called Cush, extending from the Nile Valley near Aswan southward to the modern Khartoum, east to the Red Sea and west to the Libyan desert.
obelisk	A tapered four-sided pillar used for measuring shadow length, usually inscribed with hieroglyphs proclaiming the achievements of a Pharaoh.
omphalos	Navel, or a central point on the surface of the earth.
Pepi	Two pharaohs of the Sixth Dynasty.
Perring, John Shae (1813–1869)	British civil engineer. Assistant to manager of public works for Khedive Mohammed Ali. Assisted Colonel Howard-Vyse in survey and exploration of the pyramids. In 1839 wrote and drew pictures for a large folio, *The Pyramids of Gizeh from Actual Survey and Measurement on the Spot.*
Petrie, Sir (William Matthew) Flinders (1853–1942)	Egyptologist, son of William Petrie, a civil engineer, and Anne, daughter of Matthew Flinders, the explorer of Australia. Surveyed ancient British sites such as Stonehenge before making first scientific survey of Giza hill. Founded the British School of Archaeology in Egypt. Responsible for many excavations and numerous books. He is considered the father of modern scientific archeology.
ϕ (phi) proportion	See Golden Section.
π (pi)	The constant by which the diameter of any circle may be multiplied to give its circumference.
Picard, Jean (1620–1682)	French astronomer, noted for having made the first accurate modern measurement of a degree of the earth's meridian. His figures enabled Newton to calculate the force of gravitation. Occupied the chair of astronomy in the Collège de France in 1655. Largely responsible for the establishment of the Paris Observatory and the appearance of *Connaissance des temps,* the first two volumes of which he authored.
Pococke, Richard (1704–1765)	Traveler and divine, bishop of Ossory (1756–1765). Ascended the Nile as far as Philae. The manuscript journal of his travels is in the British Museum.

precession of the equinoxes	Each year at the spring equinox the constellation in the sky where the sun rises due east appears to have fallen back about twenty minutes. This phenomenon, or precession, is caused by a slow toplike wobble of the earth on its axis which takes about 26,000 years to cycle.
Proctor, Richard Anthony (1837–1888)	English astronomer and popular writer on scientific subjects. Founded the popular scientific magazine *Knowledge*. Lectured in the United States and Australia. Author of many books on science and astronomy. Developed the theory that the Great Pyramid had been designed and used as a great astronomical observatory while still a truncated body at the level of the King's Chamber.
Ptah	Called Hephaistos by the Greeks. Egyptian god of the city of Memphis, portrayed as a human figure in a tight mummy wrapping. Considered the creator of the world who produced visible phenomena through thought and the word. The protector of artisans. His high priest was the doyen of master craftsmen.
Pylon	A double tower with rectangular base pierced by central door to a temple. The temple of Karnak had ten pylons.
Pythagoras' theorem	The square of the hypotenuse of a right triangle is equal to the sum of the squares of the other two sides.
Ra	The sun, later deified. Creator of the world, was said to be swallowed at night by Nut and recreated fresh each day.
Reisner, George Andrew (1867–1942)	American Egyptologist (Ph.D., Harvard University, 1893). Director of the Hearst expedition to Egypt 1905–1907. Excavated for Harvard University for many years in Egypt, particularly at Giza. Professor of Egyptology at Harvard (1914–1942). Curator of Egyptian Department, Boston Museum of Fine Arts (1910–1942). Author of several books on archeological excavations.
Rhind, Henry Alexander (1833–1863)	Scottish lawyer and traveler. Owing to ill health was obliged to winter in Egypt. Excavated at Thebes and bequeathed collection to National Museum of Antiquities, Edinburgh. Noted for the Mathematical Papyrus (BM10057–8), which was sold to the British Museum, and is considered the oldest manuscript dealing with Egyptian mathematics.
right ascension	The arc along the celestial equator which separates a star from an arbitrary zero point; analogous to longitude around the stellar vault.
sacred triangles	Right triangles with sides in such proportions as 3–4–5 or $2–\sqrt{5}–3$, which were credited with magic or esthetic properties.
Saqqara	Situated 28 kilometers south of modern Cairo, just west of Memphis and south of Giza. Ancient burial site named after Sokar, the god of measure. Graves date from the First Dynasty. Pyramids attributed to the Fifth and Sixth dynasties. Site of the stepped pyramid built for King Zoser of the Third Dynasty by the architect Imhotep.
Schwaller de Lubicz, R. A. (?–1961)	Philosopher, archeologist, and author who spent twelve years at Luxor reconstructing the philosophical and theological system of the ancient Egyptians. Born in Alsace, he was granted the title Chevalier de Lubicz by O. W. de Lubicz Milosz for his help after World War I in obtaining independence for the Baltic States.
sextant	An instrument for precise measurement of angular distances to determine latitude and longitude.

sidereal year	The time it takes the earth to revolve around the sun so that an observer will see a given star reappear in the same position—about 20 minutes longer than the solar year.
Sneferu (ca. 2700 B.C.)	First king of the Fourth Dynasty. Father of Cheops. Built bent pyramid at Medûm.
solar parallax	The angle formed by the semidiameter of the earth as regarded from the sun, or 8.80″.
solar year	The time between two successive equinoxes 365 days, 5 hours, 8 minutes, 49.7 seconds 365 days, 5 hours, 48 minutes, 46 seconds
solstice	The two points—in summer and winter—when the sun is at its greatest declination north or south of the equator.
Sothic year	365 days, 6 hours—introduced in ancient Egypt to correct the civil calendar year of 365 days. A "Sothic cycle" began when civil and Sothic new year coincided.
Syene	Site of the modern Aswan. The southern limit of Egypt at the First Cataract of the Nile, close to the Tropic of Cancer. Nearby quarries supplied the hard granite monoliths for the King's Chamber in the Great Pyramid and for the tall Egyptian obelisks used for measuring shadows.
Taylor, John (1781–1864)	Devoted his early years to publishing in London, becoming editor of the *London* Magazine. An amateur astronomer and mathematician, he was also a student of Scripture and devoted much time to mastering Old English, Welsh, French, and Italian. His *The Great Pyramid: Why Was It Built & Who Built It?,* published in 1854, established the π proportion in the pyramid, but his theory, that the Great Pyramid had been built under divine guidance, caused his work to be disputed and he was given little recognition.
Thebes	Ancient city in upper Egypt renowned in antiquity for its hundred gates. Became prominent with the Eleventh Dynasty (c. 2160 B.C.) for the worship of Amon. Went into decline when the locus of power shifted to the Nile Delta. There is a nearby large necropolis where kings and nobles were entombed. It was sacked by the Assyrians in 661 B.C. The remains of the temples of Luxor and Karnak are still among the most impressive in the world.
theodolite	A telescopic instrument for precise measurement of horizontal angles, used in land surveying.
Thoth	Lunar god in form of Ibis, patron of scribes and calendars. The Hermes of the Greeks.
triangulation	By carefully measuring a base line and the angles formed by either end of it with a distant point, the distance of the point may be calculated by trigonometry.
vernier	A small moveable scale attached to a large scale for obtaining finer fractions of measurements.
ziggurat	The stepped-pyramid temples of Mesopotamia.

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For E. B. V. and H. B. T.

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Preface

Deep in the jungles of Mexico and Central America, in the tight embrace of root and vine, clawed by jaguar or caressed by rattler, lie the remains of perhaps thousands of ancient pyramids, pyramids on pyramids, many still undiscovered, abandoned by unknown builders at an unknown time for unknown reasons. In their secret places may lie more of the precious codices and hieroglyphic writings—celestial mathematics sculptured into geometric form—which make it possible to reconstruct the brilliance of a civilization which the Church of Rome did all in its power to obliterate. Under the axe and torch of Spanish conqueror the ancient wisdom was reduced to superstition.

For centuries this brutal story lay buried in the archives; when it surfaced it was disbelieved. Mesoamericans were described as ignorant and brutish.

Just as Egyptologists could not believe that in ancient Egypt someone had accurately measured the circumference of the earth, placing geodetic markers by astronomical observation as accurately as surveyors do today, orienting their buildings within seconds of true north, so Americanists were reluctant to recognize or admit that in their ancient glyphs and codices the Maya showed astronomical computors so sophisticated they could and still can be read by a schoolboy. The Maya, it is now clear, constructed calendars of the synodic return of the planets laced with the cyclic phenomena of solstices, equinoxes, and eclipses of the sun and moon.

Though the Aztec calendar stone has become the shopworn memento of a tour of modern Mexico, there is still reluctance in the academies to acknowledge that its superlatively aesthetic and intricate design is a perpetual cosmic clock accurately marking for the layman cycles of the visible bodies of our solar system not only in the present but deep into the future and the past.

There is no science without measure. The Maya saw their supreme deity, *Hunab Ku,* as sole dispenser of movement and measure, whose symbol, the compassed circle and the square, was identical with that of the Great Architect of modern Masonry. In the Middle East the ancients adopted the second of arc, of which they counted 1,296,000 to a circle ($360 \times 60 \times 60$), and the second of time, of which they counted 86,400 to the circuit of a day ($24 \times 60 \times 60$).

From the first second they derived their foot (of .3079 meters). One hundred such feet, they said, will be one second of arc. From the second second they derived their cubit (of .4618 meters). One thousand such cubits, they said, is the distance traveled by the earth at the Equator in one second of time.*

With these units Middle Easterners measured the cosmos and its cycles, incorporating the results, along with the mathematical constants of its structure, into their architecture—as in the proportions of the Tower of Babel and the Pyramid of Cheops. Middle Americans did likewise, as can now be extrapolated from their pyramids.

One look at the passages of the Egyptian temples was enough for astronomers Proctor and Lockyear at the end of the nineteenth century to conclude that the structures had been designed and used in antiquity for astronomical observation and for the recording of such vital data as the equinoxes and the soltices. One look at the pyramidal structures of Yucatan and Chiapas, with their corbelled walls rising to single moveable capstones (like the Grand Gallery at Ghiza, or the "tombs" of Mycenae, or of Maes-Howe), is enough to show that they were built for astronomical observation, with frets and cockscombs that could function as markers for the rising, transit, and setting of heavenly bodies.

As with the Great Pyramid of Ghiza, the Sun Pyramid at Teotihuacan was used to mark the solstices, zenith days, and equinoxes. The stelae of Guatemala, intricately carved or stuccoed, clearly served the same function as the intaglioed obelisks of Egypt, by means of which the ancients accurately measured the size of the earth, mapped it, and chronometrically ticked off the cyclic passage of the ages.

* Both units are truly earth-commensurate fractions of the earth's circumference in that $129{,}600{,}000 \times .308$ or $8{,}640{,}000 \times .462 = 39{,}916.80$ kilometers—very close to the 40,000 kilometers adopted as the circumference of the earth by the devisors of the meter in the eighteenth century.

The study of the extraordinary effects on this planet of the comings and goings of other planets in conjunction with each other and with the sun and moon, only to be monitored by constant and accurate observation and the most sophisticated coding, has been derided by moderns as "astrology"; yet, with blinding science, we treat our nursing mother earth as dirt beneath our feet, and the living cosmos as a bottomless pit for our onanistic spaceshots.

We live in a Dark Age, and have, for several thousand years. It is time for a renaissance—with the wisdom of the past.

Architecture, says architect Robert Stacy-Judd, consists of frozen symbols, which can be thawed into a palatable language, "where measures and motifs are words and sentences." Augustus Le Plongeon calls architecture an unerring standard of the degree of civilization reached by a people, "as correct a test of race as is language, and more easily understood, not being subject to change." If it is true that a nation's capital reflects its standards of architecture, we risk being judged by the phony cyclopean walls of the Office Building of the U.S. House of Representatives unless we engender architects sensitive to the cosmic values of geometry, such as R. Buckminster Fuller would envisage.

The ancient civilizations attached great importance to numbers as an exact language in which physical and spiritual ideals could be expressed and preserved; hence, they built their numbers into buildings.

As John Michell has pointed out, their monuments contain, both in their dimensions and their relative geographical positions, the whole vocabulary of the sacred language of the past. Michell believes such buildings as the Great Pyramid of Cheops were built by men who knew something of the laws which govern the intergalactic flow of living energy and their application to the development of life on earth. "The enormous task of building the Great Pyramid, the crowning achievement of prehistoric science," says Michell, "could only have been undertaken by men whose faith in the value of their labours derived from a certain knowledge of universal law. The key to every art and science may one day be rediscovered within the effortless harmony of the Pyramid's numerical scheme." To which he adds: "Written across the face of the country in letters of earth and stone the cosmic knowledge of the ancient world is now within reach."

PART

SETTING THE STAGE

1. Return of the "Gods"

Hernan Cortes shortly after the fall of Mexico.

A freebooter who had betrayed his superiors in Havana, Cortes was 34 years old when his armada of eleven ships landed at Veracruz on the east coast of Mexico in April of 1519. Syphilitic and bowlegged from an injury acquired in a fall from a room during an amorous quest, Cortes was described by his countrymen as robust, with a deep chest and broad shoulders. His hair and beard were black and thin. Considered a good horseman, swordsman, and a great infighter with a knife, he was also renowned as licentious, gluttonous, fond of dice, and avid for women and gold. Born in the Estremadura region of Spain, Cortes had an inborn genius for treachery and could be unbelievably brutal and cruel, boasting to Charles V of Spain that he had massacred unarmed women and children in order to impose his will upon the natives.

In the Mexican highlands, in a pocket valley protected from the cold north wind by the bulk of an extinct volcano, lie the monumental remains of an ancient civilization. These weird and majestic ruins, dominated by two pyramidal mounds, lay undisturbed for centuries. First seen by Europeans when Hernan Cortes and his rabble army invaded Mexico in 1519, they have remained a source of conjecture to succeeding generations. Only now, since the beginning of the twentieth century, is the riddle of their nature beginning to unravel.

While William Prescott and others have told the story of the Conquest of Mexico in detail vivid enough to dazzle, the more sinister story of the burial, destruction, and vilification of the lore enshrined in these pyramids has largely gone untold. Intertwined, the stories reveal a struggle between two powerful forces vying for the souls of men.

Native historians described the arrival of the conquistadores as a succession of grim fatalities.

Though all the omens had foretold their coming, and an impending destruction of the Aztec empire, the actual landing of the Spaniards was so astounding to the first eyewitness that despite the loss of all his toes he climbed seven thousand feet to Mexico's highland capital of Tenochtitlan to inform King Montezuma II that towers and small mountains were floating in the sea, bearing strange beings from an unknown world with very light skin, long beards, and hair only to their ears.

Montezuma, a slender aristocratic man with a long spare face, was aware from the sacred texts of the Mexica that Quetzalcoatl, man or god, had promised to return from the East in the year 1-Reed. And this was the year 1-Reed.

In his fifties when Cortes landed in Mexico, Montezuma II looked more like forty and was described by the Spaniards as of good height, well proportioned, slender and spare, with a brown complexion and hair that just covered his ears. His beard was thin, black, and well shaped, giving his face an expression of both tenderness and gravity. He was considered very neat and clean and affected the Spaniards by the airs and gestures of an accomplished prince. His name was an honorary title meaning "our angry-looking lord," because an Aztec ruler was admonished "never to laugh and joke again as he had done previous to his election, and to assume the heart of an old, grave and severe man." He was considered a temporary representative and mouthpiece of an invisible, impersonal dual divinity. "You are the image of our lord god and represent his person. He reposes in you and he employs you like a flute through which he speaks, and he hears with your ears." Considered a learned astrologer and philosopher who was skilled in the arts, Montezuma succeeded to the Aztec throne in 1502 at the age of 36, elected by a Council of Six from among members of his predecessor's family, chosen because of his high attainments. Head of the army and of the church, with the official title of First Speaker, Montezuma governed through a Council of Three: the commander of the army (known by the title of "Snake Woman"), the high priest, and the governor of Tenochtitlan. Montezuma is reported to have ruled well and administered impartially and rigorously. To investigate how his ministers executed their offices he would disguise himself and move about his realm incognito. Montezuma told Cortes his forefathers had come from a land far away called Aztlan, where there was a high mountain and a garden inhabited by the gods.

As Cortes moved toward the Mexican capital with his gang of four hundred Spaniards, supported by thousands of native tribesmen happy to rebel against what they considered Montezuma's tyrannical rule, more messengers reached Tenochtitlan describing the newcomers as supernatural creatures riding on hornless deer, preceded by wild animals on leashes, dressed in iron, armed in iron, fearless as gods.

Spaniards say that when Cortes reached the city of Cholula, with its hundreds of whitewashed temples over which loomed the remnants of the largest pyramid in the Americas, his ambassador, whom he had sent ahead to seek peaceful surrender of the city, was returned with severed wrists dangling from flayed elbows. True or not, Cortes massacred six thousand Cholulans.

Cortes advanced on Mexico with fourteen horses and many cannon, neither of which had ever been seen by his Mexican opponents.

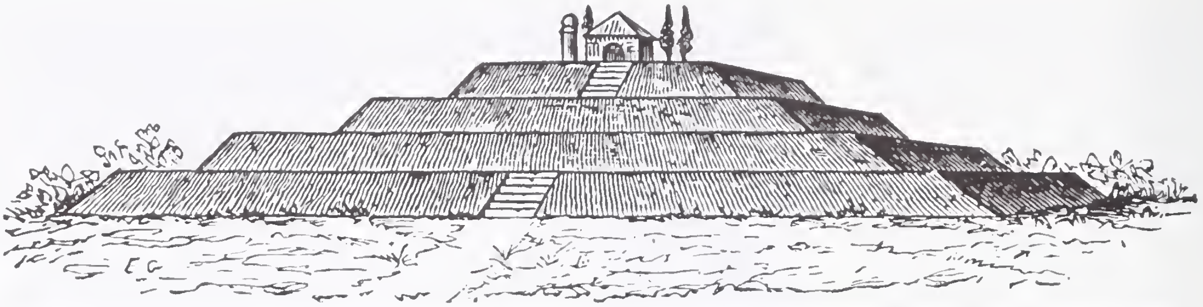
To reach Tenochtitlan entailed crossing two passes 10,000 feet high where hail fell and an icy wind drove down from the snowy mountains; it also meant crossing a desolate plateau of volcanic ash forty miles wide. Cortes, outnumbered thousands to one, hoped to seize the Aztec capital by guile rather than force.

The prime weapon in his arsenal, apart from the thousands of rebellious natives who supported him, was psychological. Their legends told the Mexica that white gods from the East would return to conquer Mexico, and there was no struggling against their fate.

Shocked by the news, Montezuma vacillated between defiance and surrender. Cortes and his followers were described to him as advancing in battle array, the dust rising like whirlwinds, their spears glittering in the sun, their pennons fluttering like bats, their armor rattling in the cold November wind.

At the Pass of the Eagle, by the snowcapped volcanoes of Popocatepetl and Iztaccihuatl, Montezuma's envoys knelt before the Spaniards and adored them as the Sons of the Sun, their gods. Had not the divine Quetzalcoatl dressed in black velvet as did Cortes? And, they whispered, judging from the size of the latter's stuffed codpiece he had the makings of a god.

Ahead of Cortes stretched the Valley of Mexico, a lovely plateau half filled with shallow lakes, called "Of the Moon," alive with fish and waterfowl, its clear waters mirroring the surrounding mountain forests, its shores brightened by the villages and cities of the Mexica.



At Cholula, Cortes was greeted by girls singing, dancing, and playing on instruments, while others brought bread and fowl. Nobles, chieftains, and common folk, "unarmed, with eager and happy faces, crowded in the great courtyard of the Temple of Quetzalcoatl to hear what the white men would say." The Spaniards then closed the entrances and at a signal fell upon the Cholulans. "Those of Cholula were caught unaware. With neither arrows nor shields did they meet the Spaniards. Just so they were slain without warning. They were killed by pure treachery; they died unaware."

Montezuma planned to recognize Cortes, by sending him—along with many fine presents—the insignia of the God Quetzalcoatl, whom he believed him to be. This way Montezuma hoped to keep Cortes from Mexico City.

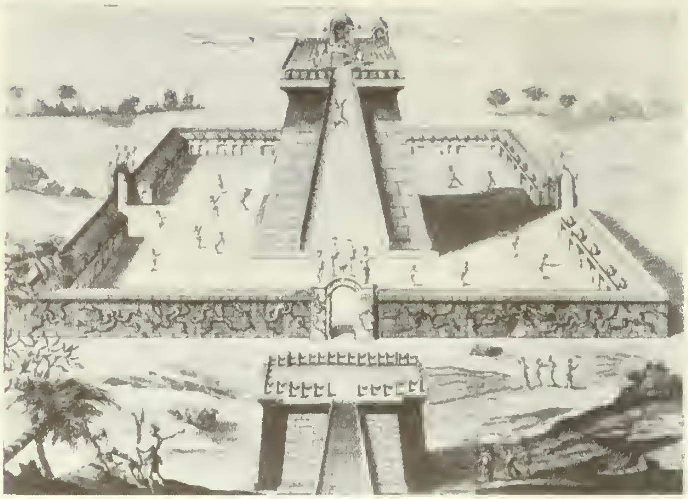
The ambassadors were told to tell Cortes that the treasures were "all priestly ornaments that belonged to him." Among the presents were two circular calendars as large as cartwheels, one of gold, the other of silver, both elaborately engraved with hieroglyphs, and both of which were melted down for ingots. Some of the presents reached the Emperor Charles V and were greatly admired by Dürer.

With Montezuma's ambassadors went a group of enchanters and witchmasters to try to keep Cortes away.

In his famous speech to Cortes, which the latter carefully reported to the Emperor Charles V, Montezuma stated that: "We [the Mexican rulers] were brought here by a lord, whose vassals all of our predecessors were, and who returned from here to his native land. He afterwards came here again, after a long time, during which many of his followers who had remained, had married native women of this land, raised large families and founded towns in which they dwelt. He wished to take them away from here with him. But they did not want to go, nor would they receive or adopt him as their ruler, and so he departed. But we have always thought that his descendants would surely come to subjugate this country and claim us as their vassal."

Nahuatl pyramids usually had two stairways leading to two temples, as with the central Aztec pyramid in Tenochtitlan, dedicated to Tezcatlipoca, believed to have been built six years before Columbus rediscovered America.

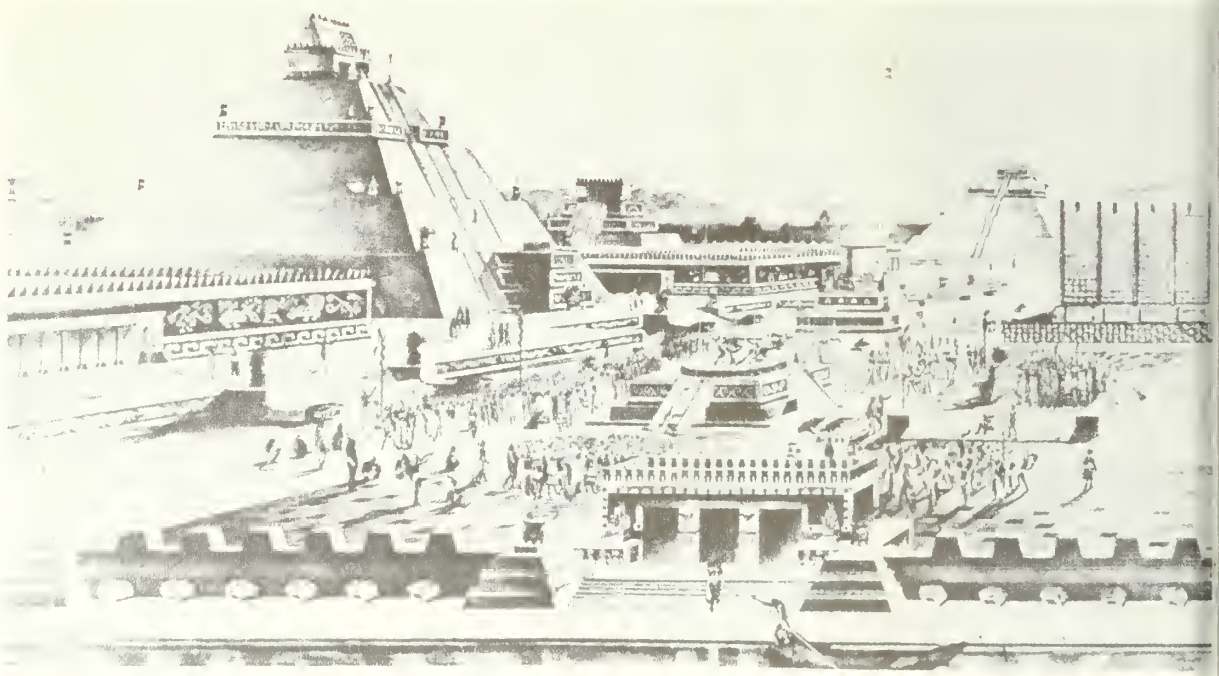
Bernal Diaz said it was 54 meters high with 114 steps, and that it measured 97 meters at the base. In the interior of the top sanctuary there existed a small stepped pyramid dedicated to the sun, known as the Cuauhcalli, "House of the Eagles." Here the steps represented the heavenly planes, the highest level corresponding to the hour of zenith or midday.



The city of Tenochtitlan, divided into four quarters, each of which had five subdivisions (*calpullis*), actually consisted of two distinct parts. One of these was Tenochtitlan proper, where the Great Temple stood and where Montezuma and the lords resided; the other was Tlatelolco, where the lower classes dwelt and the merchant class prevailed.

A large temple occupied the center of Tenochtitlan, a city, according to Cortes, of five hundred palaces, well built of stone, whose walls were crowned with battlements and ornamented with serpents.

Cortes said there were "forty very high houses in the enclosure of the Great Temple" and that they were all "sepulchres of the lords." The more substantial houses occupied the central sections of the capital, where the land was higher and firmer. Canals, bright green with water vegetables, encircled and crisscrossed the city, which an Aztec poet described as spread out in circles of jade, radiating flashes of light like quetzal plumes.



According to Bernal Diaz' eyewitness report, when the great Montezuma came forth in state to meet Cortes, he was conveyed on a sumptuous litter with a baldaquin over his head adorned with light greenish-blue feathers, gold, pearls, and jade to represent "the verdant or blue sky." He was supported by his four principal lords; and the golden soles on his sandals prevented his feet from coming into direct contact with the ground. Other lords preceded him, "sweeping the ground and spreading blankets upon it so that he should not tread upon the earth. All of these lords did not dare to think of raising their eyes to look at his face—only the four lords, his cousins, who supported him, possessed this privilege." On state occasions Montezuma, like his predecessors, was the only person privileged to sit on a throne or raised seat with a high back.

When the Spaniards first glimpsed the island capital of Tenochtitlan—glimmering like an exotic Venice at the end of a wide causeway, with stunning palaces, temples, and pyramids, stuccoed pink with volcanic ash, rising from the cerulean waters of the lake—they thought they were dreaming.

Though many had seen the splendors of Rome and Constantinople, they were amazed at a city of 300,000 inhabitants fed by fresh-water aqueducts, laced with canals and carefully paved streets, adorned by arcaded squares twice as big as Salamanca's, serviced by a market place where 70,000 Indians daily bought and sold a thousand different products, from filigreed jewelry to mountains of polychrome feathers, including those from the rare quetzal bird.

The Spaniards were enchanted by such luxuries as botanical and zoological gardens, by elegantly towered palaces, higher than the cathedral of Seville, surrounded by large and beautiful private houses with fragrant gardens shaded by bright cotton awnings where courtly nobles feasted on fruits and vegetables, sauces and soups, fish and meat, cakes and pies, varied by such delicacies as maguey grubs with hot chili, winged ants with savory herbs, and rats in chocolate sauce.

According to Aztec tradition, the city of Tenochtitlan was modeled after the lost capital of their original homeland, situated on an island in the middle of a lake surrounded by rings of canals and interconnecting dams.

Migrant Chichimecs serving in the Toltec army, who called themselves Aztecs after their mythical home in Aztlan, built the city of Tenochtitlan on a marshy island in the Lake of the Moon in A.D. 1345. The city was connected to the mainland by three causeways: north to Tepeyacac, west to Tlacopan, and south with two branches to Ixtapalapa and Coyoacan. The city, including Tlatelolco, covered some 7 1/2 square kilometers built around temples and public buildings. According to the Aztec legend, their god, Huitzilopochtli, sometimes in the guise of a hummingbird, had urged them on until they reached the island, which was said to have the same magical properties of their homeland in Aztlan.

Searching for a mote in the Mexican eye, the Spaniards claimed to be horrified by the native indulgence in unbridled sodomy, by their orgies of ritual sacrifice in which priests, each with his own penis slit to achieve pure chastity, would roast alive or rip out the pulsing hearts of an estimated 50,000 human victims a year to feed the local gentry and satisfy the theory that their solar divinity needed human blood lest it vanish from exhaustion.

On the excuse of bringing to the natives a better form of religion, the Spaniards, tough, mean, and hungry for gold, massacred without warning the unarmed cream of their hosts' warrior nobles who were innocently celebrating a feast day with a dance.

Blood-encrusted Aztec priests were accused by the Spaniards of performing 50,000 human sacrifices a year. Diaz accused them not only of human sacrifice but of cannibalism, sodomy, incest, and such drunkenness that when they could no longer stand "they lay down and did have the liquor injected by squirt into the breach." Diaz gives a description of Aztec priests half roasting a man, pulling him off the coals with grappling irons to cut out his still beating heart. He says the walls of the temple were splashed and encrusted with blood whose stench was unbearable.

Montezuma was reputed to have been fed on the little fingers of small boys as a delicacy. But Cortes stated that he never actually saw a ritual sacrifice, that the only human sacrifices he witnessed in Tenochtitlan were the normal executions of prisoners of war during the siege. Voltaire believed the Spaniards to have fabricated or grossly exaggerated the charges of Aztec human sacrifice to justify their own brutality.

Later historians have attributed subtle metaphysical motivations to Aztec sacrifices, pointing out that the Aztecs believed the earth to have already been through four cataclysmic periods, and that the only way to stave off a fifth was by human sacrifice. As "Sons of the Sun," the Aztec priests saw the earth as metaphysically nourished by a sun which in turn needed the sacrifice of human blood for its nourishment. Hence the hearts of victims—perhaps by the thousands—were ripped out to stave off cosmic disaster.

This act of infamy brought such retribution from Montezuma's braves that on what came to be known as "The Night of Sorrows" Cortes lost the better part of his army and had to flee the city. Pursued by the braves of Tenochtitlan, Cortes escaped along the river north of Lake Texcoco into a gentle valley dominated by the peak of volcanic Cerro Gordo. There, in the shadow of two pyramidal mounds, the remnants of Cortes' forces, all of them wounded, faced the greatest number of enemy warriors ever mustered for a single battle in the Indies. Tens of thousands of Indians from Otumba, Texcoco, and the cities around the lakes crowded into the valley waving shields, banners, and plumed helmets, convinced they had come to witness the death of every Spaniard.

With no hope of retreat, Cortes and a small group of horsemen charged the center of the enemy forces, where they killed their captain general, the "Snake Woman," causing such panic in the guard that it spread to the hordes of Indians, who retreated, leaving Cortes to live another day. Decimated, bedraggled, and in fear of their lives, the Spaniards paid little attention to the amazing sight around them of a great sleeping city dominated by two gigantic mounds. No one could tell them who had built the great ceremonial center, whence the builders had come, or whither they had gone. All they could learn was that two centuries earlier, when the Mexica had arrived in the valley, they had found the mysterious city already in an abandoned condition, covered with earth and vegetation. Because of the legend that the gods had used the center in antiquity, the Mexica

La Noche Triste.

On the night of June 29, Cortes and his men slipped out of Tenochtitlan along the Tacuba causeway carrying a portable bridge to cross the eight bridges destroyed by the Aztecs. Attacked by Montezuma's followers, Cortes lost half his forces, many being drowned by the weight of the gold they had looted. All would have succumbed had the Aztecs not taken time out for a ritual sacrifice of the captured Spaniards atop their sacred pyramids. In this hiatus Cortes and his surviving wounded forces managed to reach the plain of Otumba by the pyramids of Teotihuacan.

had named the spot Teotihuacan, which they interpreted as meaning either "the burial place of kings" or "the place where the lords of the people woke from the dream of life to become gods."

The greater mound, venerated by the Mexica till the arrival of the Spaniards, was called "Tonatiuh" in the native Nahuatl, meaning "House of the Sun." The smaller mound was called "Metzli Ytzaqual," or "House of the Moon." The great avenue which joined the two pyramidal mounds was called "Huicautli," or "Way of the Dead" because of the smaller mounds which flanked it, assumed by the natives to be tombs.

Claiming that only giants could have constructed the larger mounds, the Mexica said they must have been built in remote antiquity when giants and sages inhabited the earth. As evidence they showed the Spaniards the femurs of elephants or mastodons dug up in the neighborhood which they believed to be the bones of giants. But the Spaniards, intent upon their own survival, paid no heed, escaping southward to the safety of their allies, the Tlaxcalans, where they plotted a revengeful comeback.

The destruction of Tenochtitlan.

A year after *La Noche Triste* Cortes returned with 450 Spaniards, forty horses, nine field guns, and 10,000 Tlaxcalan allies. He also brought a secret weapon in the form of a dozen brigantines built in Tlaxcala, carried overland to the edge of Texcoco Lake. To capture the city, Cortes planned to advance along three of the causeways on a narrow front with bunched musketeers, cannon, crossbows and cavalry, using the ships to protect his flanks. However, just before the attack, Cortes' Mexican allies, who identified him with Quetzalcoatl, deserted because the planet Venus had gone into its yearly eight-day disappearance as the evening star. When nothing bad happened to Quetzalcoatl-Cortes during the dark of Quetzalcoatl-Venus, and the planet reappeared as the morning star, 100,000 allies flocked to Cortes' aid. On August 13, 1521, after a seventy-five-day siege, and one of the most remarkable naval operations in history, Tenochtitlan fell to the Spaniards, leaving more than 240,000 Aztecs dead from wounds or disease. The people of Tenochtitlan, in the account of Lopez de Gomara, one of the eyewitness conquistadores, were "tormented by hunger, and many starved to death. There was no fresh water to drink, only stagnant water and the brine of the lake. . . . The only food was lizards, corncobs and the salt grasses. . . . The people ate water lilies and seeds of colorin, deerhides, and even pieces of leather. . . . They ate even dirt. Almost all of the nobility perished; there remained alive only a few lords and the little children."

According to C. Harvey Gardiner, author of *Naval Power in the Conquest of Mexico,* Cortes' daring naval maneuvers on Lake Texcoco were unparalleled; no similar victorious naval engagement ever concluded a war and ended a civilization. "One sees in kaleidoscopic panorama," wrote Gardiner, "the sweep of naval history from Ancient Salamis to Korea, ships under sail and oar—ramming, boarding, fleet action, task-force operations, blockade, liaison duty, Marine-like raids by naval landing parties, close support of land operations and psychological warfare. Like Salamis, which was fought for the control of the eastern Mediterranean, the battle of Tenochtitlan also involved the mastery of a world."

2. Indian Sacrifice

After plundering Tenochtitlan, Cortes branded the faces of its inhabitants with hot irons and attempted to force divulgation of the location of the fabled Aztec treasure. Though $15,000,000 worth of gold was found this represented only part of what was known to exist.

For his efforts Cortes was ennobled by the King of Spain and made marquess of the Valley of Oaxaca, captain general, and given a large estate with 23,000 vassals. But Cortes became bitter at not having been appointed viceroy to the country he had conquered. He did grant Montezuma's son a quarter of Mexico City as a fief, and in Spain arranged for the marriage of Montezuma's surviving daughters to members of the Spanish nobility. Having given to one of his subordinates as wife the native mistress of his adventures, La Malinche, without whose intermediary efforts he could hardly have conquered New Spain, Cortes married Doña Juana de Zuniga, niece to the Duke of Bejar.

When Cortes returned with enough Spaniards and native allies to defeat the Mexica, he ordered the great and beautiful city of Tenochtitlan destroyed; palaces, columns, and gods were buried in the mud. To avoid the stench of the dead, the Spaniards set up camp in the nearby village of Coyoacan. Groups of captive Indians razed every last building of the Aztec capital and filled in the canals till not a stone was standing. On the leveled ruins Cortes founded his own great capital, Mexico City, patterned on a feudal model already dying in Europe.

Mexican slaves by the thousands, many of them highly skilled as sculptors, carpenters, masons, and gardeners, hauled stone and timber from the debris of Tenochtitlan. Iron

chisels and iron hammers enabled them to cut the porous red stone of the valley into palatial European houses, over the doors of which the new hidalgos could place their carved escutcheons. Where Indian palaces and pyramids had stood, churches and monasteries sprang up complete with battlements, buttresses, and heavy grilled windows against the Indians who had built them.

The Flemish artist Theodore de Bry depicted Indians hanging themselves or taking poison in acts of mass suicide from shock at the overthrow of their culture. So great was the terror in Mexico about 1530 that Indians desisted from relations with their wives to avoid having children doomed to slavery. When asked to describe Christians, an old chief replied, "They ask for maize, for honey, for cotton, for women, for gold, for silver. Christians will not work, they are liars, gamblers, perverse, and they swear."

Surviving on drinking water and a few tortillas, the Indians, at their own expense, supplied all the work and all the material. Brought up from childhood to a Spartan life, trained to endure pain, they worked long hours without showing fatigue, constantly subjected to unbelievable savagery by the Spaniards.

Individuals were torn from their families to work as slaves in gold and silver mines, branded on their faces each time they changed masters. The prettier women were raped and infected with the pox, smallpox, leprosy, and all manner of plagues. By 1545, in Tlaxcala alone, a quarter of a million Indians had died of the plague: altogether 3 million were to

The Plague.

As a result of the Spanish Conquest, the population of Mexico was reduced to one-tenth. Indians, formerly in very good health, were weakened by hunger and fatigue and became easy prey to disease and the pox, large and small.

Fray Bernardino de Sahagun tells how he personally buried more than 10,000 victims of the plague, often in great trenches 100 at a time.

die as disease spread to Tabasco and Yucatan. Spanish apologists retorted that their presence had saved 600,000 Indian lives from being sacrificed on the altars in the first thirty years of the Conquest. They said of the Indians that "God truly did them a great service by entrusting them to the Spaniards who converted them and treated them so well."

As land was stolen from the natives, great famines ensued, yet heavy taxes were laid on Indians; those who failed to pay were tortured to death. Indians who refused to join the Catholic Church were horsewhipped, had their heads shaved, and were forbidden to hold office or title in their villages. For failing to attend mass, or for practicing any of his old rites, an Indian could receive a hundred lashes.

According to the Spaniards, Indians were supposed to know only the Our Father, Ave Maria, Credo, and Ten Commandments: reading and writing were considered as dangerous as the devil.

In Spain an eminent jurist, Juan Gines de Sepulveda, invoked the authority of Aristotle to stigmatize the Indians of the New World as natural slaves. He maintained that as inferior beings they would benefit from the labor they performed for the superior Spaniards and that war against the Indians to force them to Christianity was not only expedient

Designed for the detection and punishment of heretics, the Inquisition was used as a giant pork barrel for the enrichment of crown, Church, and Inquisitors, while cheerfully eliminating dangerous radicals: those who had been taught medicine, geography, rhetoric, chemistry, physics, mathematics, and astronomy by Moorish philosophers in universities such as Cordova, whose libraries had since been destroyed. The Inquisition was also an excuse to rid the planet of such organized mystics as Illuminati, Pantheists, Manicheans, and Albigensians. As a result no Spaniard could write, speak, or even think without taking into consideration the torture racks and fires of the Holy Office.

All the accused were presumed guilty before trial, a trial which took place in absolute secrecy. The defendant was afforded no counsel. Accuser and judge were the same person. The names of witnesses against the defendant were withheld from him. Women, children, and slaves could not be used as witnesses by the defendant, but could be used by the prosecution, who could order them tortured to obtain further accusations. There was never any case of acquittal pure and simple.

Minor penalties could be commuted for payoff. Major penalties were either the dungeon, with single or double fetters, or the secular arm for death by fire or strangling. The crown did not interfere with the operations of the Holy Office, which could, with impunity, arrest bishops and persons close to the king.

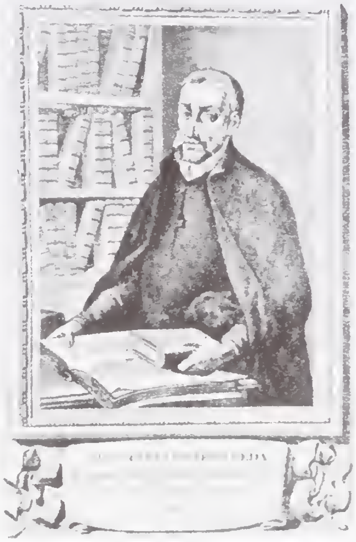
The victim's goods, subject to confiscation, were incorporated into the royal and Church domains. The Inquisitors, who paid no taxes and gave no account of confiscations effected, took their share. As a deterrent to possible opposition in New Spain thirty-four Negroes, including four women, were hanged and decapitated in Mexico City.

but lawful. Sepulveda—who never went to America and never saw an Indian in his natural habitat—considered the Indians "homuncoli, in whom you will scarcely find even vestiges of humanity, who not only possess no science but also lack letters and preserve no monument of their history except certain obscure reminiscences of some things in certain paintings."

By comparison Sepulveda considered Spaniards to be unequaled for their "frugality, sobriety, freedom from gluttony and lasciviousness," adducing as evidence their behavior during the sack of Rome, in 1527, when, as even their own historians admitted, the Spanish indulged in "the worst outburst of savagery in the annals of the period, burning monasteries and churches, violating nuns, and putting pregnant women to the sword."

In putting down the Indians, Sepulveda's ploy was to not "awaken curiosity or excite the cupidity of more scientific and enterprising nations."

Don Martin Cortes, the bastard son of Cortes and La Malinche, who was legitimized by the Pope, was tortured by the Inquisition with water forcibly poured down his throat for his alleged participation in the first major Creole conspiracy to make New Spain independent of Spain, with the Marques of Oaxaca, legitimate heir to Cortes, as first King of Mexico.



The Spanish jurist Juan Gines de Sepulveda said it was right to wage war against the Indians for four reasons:

1. For the gravity of the sins which the Indians had committed, especially their idolatries and sins against nature.
2. On account of the rudeness of their nature, which obliged them to serve persons having a more refined nature, such as the Spaniards.
3. In order to spread the faith, which would be more easily accomplished by the prior subjugation of the natives.
4. To protect the weak among the natives themselves.

Other ecclesiastics, opposing Sepulveda, especially the Dominican friar Bartolomé de Las Casas, who had crossed the ocean many times and spent a lifetime in America, appealed to divine and natural law to obtain better treatment for the Indians, telling succeeding Spanish kings, often to their face, of the sins committed by the conquerors of New Spain. To Charles V, Las Casas argued that the Aristotle quoted by Sepulveda was a gentile, probably burning in hell, whose philosophy should be accepted only when consistent with Christian doctrine. Las Casas believed the Indians should be Christianized without the use of soldiers or force, only by peaceful means, by the persuasion of the Gospel preached by godly men. He said the Indians were in no way inferior to the Greeks or Romans, not a whit less rational than the Egyptians; their temples, he said, were no less worthy of admiration than were the Egyptian pyramids.

Showing a healthy disregard for the orders of his ecclesiastical superiors, which forbade the baptizing of Indians

In New Spain, whereas "women of ill repute" were publicly stripped, whipped, and rubbed with honey to be bitten by insects, Jewish women had to appear naked before their judges and were put to the rack for practicing their religion.

While bands of Spaniards roamed the country destroying palaces and monuments, leveling cities, burning archives, and looting the temples of their gold and jewels, a few friars like Bartolomé de Las Casas labored for the Indian cause and tried to reconstruct the records of the past. In their villages, the Indians tried to save what artworks and manuscripts they could by burying them in their huts or taking them into the woods where they also hid and protected their medicine men.

unless instructed in the Christian religion, Las Casas was willing to baptize uninstructed children about to die disemboweled by Spanish soldiers.

To combat such unwanted opinions as those of Las Casas and to keep from the world the true story of the horrors perpetrated in New Spain, the Council of the Indies forbade possession or reading of the pamphlets published by Las Casas in Seville in 1552: they even went so far as to forbid the reprinting of the works of Cortes, Lopez de Gomara, and other conquistadores, though these were mostly apologias written to obtain favors from the crown.

The same censorship was reserved for the works of a whole series of enterprising monks who arrived early in New Spain and set about accumulating data on the history of Mesoamerica, traveling throughout the country, often at great pains, the most impressive of whom were the Franciscan friars Toribio Motolinia, Diego Duran, and Bernardino de Sahagun.

Franciscan friar Diego de Landa, born of the noble family of Calderones, arrived in Yucatan in 1549 at the age of twenty-five. Before becoming bishop of Yucatan, he was elected guardian of the convent of Izamal, east of the modern city of Merida. There he was told to erect a building for his monks, who had been living in houses of straw. As a site Landa chose a mound which had been used by the Maya as a "residence of the priests of the gods," in order, says Landa, "that the devil might be driven away." Vandalizing one of the greatest and oldest pyramids of Mexico, Landa eventually built for himself a fortress cathedral.

In the public square of Mani, south of Merida, Landa then amassed and burned, in the presence of the Spanish nobility resident in the country, the accumulated codices and inscribed statues of the natives.

The Jesuit Domingo Rodriguez noted that Landa destroyed 5,000 idols, 13 great stones that served as altars, 22 smaller stones, 27 rolls of hieroglyphs on deer skin, and other precious curiosities not described.

Cogolludo, in his *Historia de Yucatan,* described Landa as an "extravagant fanatic, and so hard hearted that he became cruel."

Not that it was easy for these friars to reconstruct what had actually occurred in the Valley of Mexico and surrounding Mesoamerica before the arrival of the Spaniards. The higher clergy that followed Cortes into conquered Mexico adopted his policy of destroying everything they could find of the native culture, burning whatever documents or codices fell into their hands, obliterating carefully chronicled history, myth, and legend, the worst culprits being the bishop of Mexico, Juan de Zumarraga, and the bishop of Yucatan, Diego de Landa. In the words of Landa: "We found great numbers of books written in these characters, but as they contained nothing that did not savor of superstition and lies we burnt them all, at which the natives grieved most keenly and were greatly pained."

To remedy this folly, dedicated Franciscans hit upon the device of teaching the surviving cultivated Mexicans to write in their own tongue with Latin characters, in lieu of their complex glyphs, so as to record what the natives could remember of their cultural heritage, much of which had been incorporated into songs and epic poems, passed down from generation to generation.

From such sources—including three surviving Mexican nobles, the princes Ixtlilxochitl, Tezozomoc, and Chimalpahin—the friars learned that the Mexica were members of an Aztec tribe which had only recently entered the Valley of Mexico in the middle of the thirteenth century and had established themselves on an island in the great Texcoco Lake at the beginning of the fourteenth century.

The Mexica said that around the lake they had found remnants of a high degree of civilization which they believed had existed in the area for more than a thousand years, and to which they gave the name of Toltec, meaning "artist" or "builder" in Aztec.

According to the Aztecs, the Toltecs had created a great capital city at Tollan, where, under the aegis of a divinely inspired leader, Quetzalcoatl, they had developed "superb artisans, devout worshippers, skillful tradesmen, stone masons, carpenters, bricklayers, workers in feathers and ceramics, spinners and weavers, tall, virtuous men who sang and danced, and had priests skilled in astronomy who kept an accurate count of days, years, and the movements of the stars and planets."

According to the Aztec tradition, the Toltec leader Quetzalcoatl had fallen on evil days and been obliged to depart eastward about A.D. 950 of our era. Thereafter the Valley of Mexico was invaded by less civilized Indians from the north, among the last of which were the Aztecs, who burned their own records and rewrote their history to bury their obscure

In Spain, Juan de Zumarraga had been ordered by the Emperor Charles V to exterminate the witches of Navarre, which he did by burning thousands of them at the stake. Appointed Bishop of Mexico, he boasted of having destroyed 500 Indian temples and 20,000 "idols." On Sunday, November 30, 1530, Zumarraga had Don Carlos Ometochtzin, lord of Texcoco, publicly burned at the stake in Mexico City's Plaza Mayor, accused of having worshiped the god of rain.

Familiars of the Holy Office had found two "idol" temples hidden in his palace: during the trial it developed that Indians covertly resorted to their old religious practices of inducing the powers of nature when the rain failed, much as was successfully accomplished by Dr. Wilhelm Reich in the United States in the 1950s, for which the satisfied blueberry growers of Maine paid him with money, whereas the U.S. Food and Drug Administration paid him with the public burning of his books and a prison sentence which cost him his life in the penitentiary.

In the market place of Texcoco, Zumarraga had a pyramid formed of the documents of Aztec history, knowledge, and literature, their paintings, manuscripts, and hieroglyphic writings, all of which he committed to the flames while the natives cried and prayed.

Into the holocaust went the codified laws of Texcoco's King Netzahualcoyotl (forefather of Don Fernando de Alva Ixtlilxochitl), who had reigned in Texcoco a century before the arrival of Cortes and had acquired the reputation of a Solomon distinguished for his courage, wisdom, and virtue, a refined astronomer and lover of plants and animals, who had composed sixty hymns in praise of the creator of heaven.

(Left) The Nahuatl word for Montezuma was written with the composite picture of a mousetrap, *montli*, for the sound *mo*, an eagle head for *quauh*, transfixed by a lance, *zo*, surmounted by a hand, *maitl* for *ma*—which came out *mo-quauh-zo-ma*.

(Above) Aztec picture writing describing the travels of their forefathers from the legendary home in Aztlan.

(Below) Tlaxcalans carrying equipment for Cortes' attack against Tenochtitlan.

origins and pass themselves off as true descendants of the indigenous noble Toltecs.

With this ready-made lineage, the Aztec Mexica—by their own saying—set about cruelly fighting for political dominance of the central plateau, stretching their power further and further afield, proclaiming their mission to be the gathering of all nations together into the service of their own god of war Huitzilopochtli.

By 1519, when the Spaniards arrived in highland Mexico, Montezuma's Aztecs ruled a polyglot colonial empire of several million people, stretching from the Pacific to the Gulf, from central Mexico to what is now Guatemala, most of whom were only waiting for an occasion such as the arrival of Cortes to rebel against their masters, and thus, inadvertently, destroy what remained of Indian civilization and turn over to the Spaniards the control of all of Central America.

Throughout the sixteenth century, by a careful sifting of the evidence obtained from Indian sources, the brighter minds among the historian friars, such as Bernardino de Sahagun, concluded that a truly great civilization had indeed existed in the Valley of Mexico, prior to the Aztecs, which had lasted over two thousand years. Sahagun also concluded that before Tollan this civilization had been centered in the great abandoned city of Teotihuacan, with its mysterious mounds, which he figured to have been destroyed almost a thousand years before the arrival of the Spaniards. It also seemed reasonable to Sahagun that so great a city must have prospered for at least a thousand years before it was abandoned or destroyed, which meant that it had been peopled five hundred years before the birth of Christ, a city as Sahagun described it, "very rich and well ordered, very wise and powerful, which suffered the adverse fortune of a Troy."

More open-minded than most of his ecclesiastical colleagues, Sahagun even managed to capture a feeling for the metaphysics of this lost civilization, establishing from the chronicles that Teotihuacan had been called the "City of the Gods" because

> the Lords therein buried, after their deaths, were canonized as gods, and it was said that they did not die, but wakened out of a dream they had lived; this is the reason why the ancients say that when men died they did not perish but began to live again, waking almost out of a dream, and that they turned into spirits of gods . . . and so they said to the dead: "Lord or Lady, wake, for it begins to dawn, now comes the daylight for the yellow-feathered birds begin to sing, and the many-colored butterflies go flying"; and when anyone died, they used to say of him that he was now *teotl,* meaning to say he had died in order to become spirit or god.

Fray Bernardino de Sahagun.

So handsome a youth was Bernardino de Sahagun that the older monks of the Order of St. Francis secluded him to prevent temptations from the outside world. Born Bernardo Ribeira in the province of Leon in 1499, he was given the name of his home town when he joined the order.

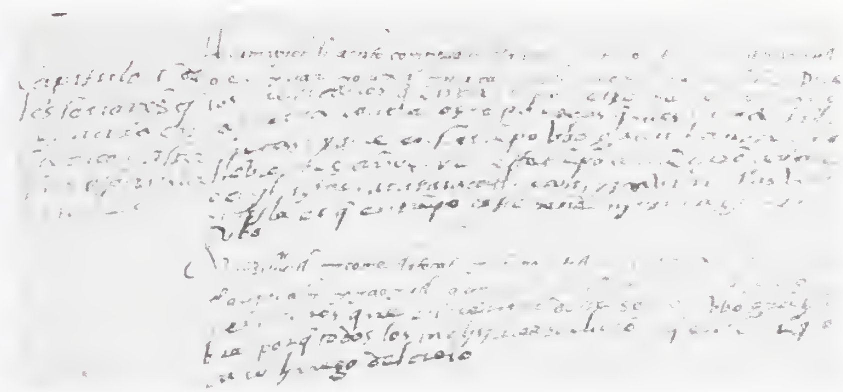
In 1529 on a ship for New Spain with eighteen other Franciscan monks, he learned to speak Nahuatl from repatriating Mexican Indians whom Cortes had dragged to Spain to show off to the Spanish court. Having mastered the language of the Mexica, Sahagun traveled through the country acquiring a vast lore which he turned into a twelve-volume anthropological, mythological, and social history of ancient Mexico, laboriously compiled over a period of fifteen years in the Monastery of Tlalmanalco at the foot of the two volcanoes Iztaccihuatl and Popocatepetl. Realizing that the Spaniards, in their zeal to destroy a religion they considered idolatrous and barbarous, were destroying the Aztecs' whole way of life, Sahagun did much to restore to the Mexicans their rightful reputation. Brother Sahagun sought out the most learned and often the oldest natives, and asked each to paint in his Aztec picture writing as much as he could clearly remember of Aztec history, religion, and legend. He also taught the natives to transcribe their Aztec words in Latin letters. Sahagun's story of the Conquest as told to him by contemporary Indians who had witnessed the events so displeased the Spanish authorities, Sahagun was forced to revise the text to suit the victors, only salvaging his conscience by retaining the original text in Aztec. Even so, his great work never saw the light. The original manuscript was buried and is lost to this day. An incomplete copy surfaced during the French invasion of Spain in 1808, and was published by Carlos M. Bustamente in 1840, to be translated into English a century later.

Unacclaimed by his peers, "America's most remarkable historian of the sixteenth century" died in poverty and oblivion of an epidemic of catarrh at the age of 91, mourned only by a vast crowd of saddened Indians whom he had lovingly befriended and taught.

But the reports of Sahagun and other industrious friars, who conscientiously accumulated long manuscripts giving fine details of the history, customs, and religion of the Indians, might just as well not have been written. They were buried in the archives to keep from the world the shame of what the conquerors, lay and cleric, had done to the inhabitants and culture of Mesoamerica.

In the mother country, where only writings which glorified the Church and its servants were thought worthy of the press, a few works were allowed publication, all derived from highly controlled sources, most of whom had never been to America, and whose material was already superannuated before it got into print. No book couid be printed except under license, nor could it be imported or exported without permit, on pain of death and confiscation of goods. All libraries, public and private, were subject to rigorous inspection, and students could not travel abroad. Access to Mexico was forbidden to foreigners in order to prevent commercial competition, espionage, and the possible contagion of Protestant heresies.

Not till the end of the seventeenth century did an observant Neapolitan traveler manage to visit Mexico and bring out detailed news. A strictly practicing Catholic with a penchant for hobnobbing with the higher clergy, considered a loyal subject of Spain because Charles II was also king of the Two Sicilies, Giovanni Gemelli Careri was able to travel freely about Mexico and bring out what amounted to the first outside report on the country and its antiquities.



Part of Sahagun's original manuscript.

PART III

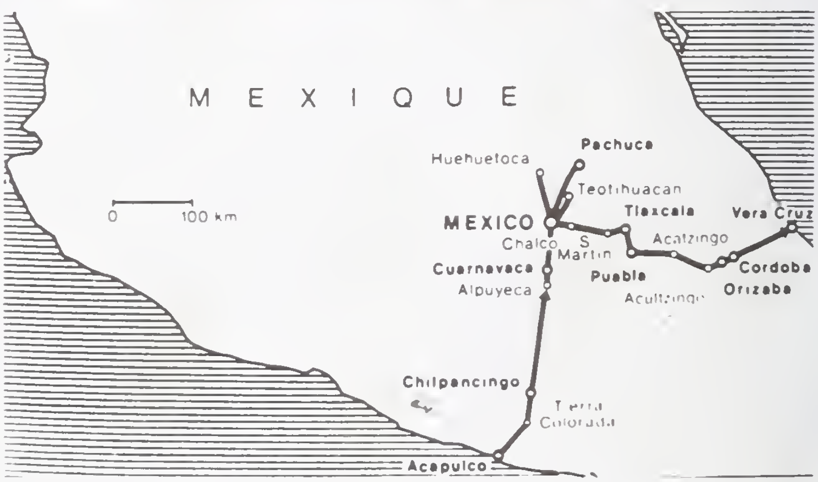
ARLY OBSERVERS

During the century after the Conquest, when Spain was virtually sealed off from the rest of the world, one Englishman, Thomas Gage, did manage to visit Mexico as a Dominican friar. A student of the Jesuits and the Dominicans in both France and Spain, he could pass for a Spaniard, and was therefore able to do missionary work in Central America between 1627 and 1637.

Gage was most struck in Mexico City by the women, the apparel, the houses, and the streets. He noted that almost half the population of the city sported coaches, many of which exceeded in cost the best of the court of Madrid and other parts of Christendom, "for they spare no silver, nor gold, nor the best silks from China to enrich them." Gage admired the broad streets lined with goldsmiths and silversmiths, and was astounded by the freedom enjoyed by the women to gamble: "Day and night is too short for them to end a *primera*."

Gage found men and women excessive in their apparel. "The attire of this baser sort of people of blackamoors and mulattoes is so light, and their carriage so enticing, that many Spaniards even of the better sort (who are too prone to venery) disdain their wives for them." Noting that "their bare, black and tawny breasts are covered with bobs hanging from their chains of pearls," Gage concluded that "most of them have been slaves, though love has set them loose at liberty to enslave souls to sin and Satan."

In 1640 Gage renounced his Catholicism, embraced Protestantism, and, back in England, informed against a number of English Jesuits, contributing to their deaths. In *A Survey of the West Indies* he gave a broadside attack against the corruption of the Roman Catholic Church, encouraging Cromwell's government to plot invasions of the New World in order to seize Spanish territory.



3. Reports from New Spain

On the last leg of a hazardous five-year trip around the world which had taken him to Armenia, Persia, India, and China, Careri, a jurist born in Calabria, arrived in Acapulco in January of 1697 after a gruesome five-month non-stop voyage from Manila in a small ship with two hundred passengers ravaged by scurvy.

Careri found the town of Acapulco, which he had expected to be Mexico's gateway to the East, no more than a fishing village with straw-roofed shacks inhabited, almost exclusively, by Negroes, mulattoes, and very few Indians. Only when a ship was in port would Spaniards appear from nowhere. Merchants aboard a ship from Peru brought ashore 2 million pieces of eight with which to buy silk and porcelain from China, cloth from Bengal, pearls from Persia, turning the town of Acapulco overnight into a thriving mart of free-spending Spaniards. Careri, who dabbled in commerce to help defray his traveling expenses, was quick to see that trading fortunes could easily be made in Acapulco. Even the local curate, whose yearly salary was a mere 120 pieces of eight, managed to increase his fortune to 14,000 a year by soaking the relatives of foreign merchants 2,000 pieces for a Christian burial in the local hallowed ground.

Giovanni Francesco Gemelli Careri, Neapolitan jurist, at the age of 48 when he traveled to Mexico in 1699.

Setting off on muleback for the 14,000-foot climb over the massif to Mexico City, Careri was delighted to find the bare mountains around Acapulco alive with deer, rabbits, parrots, and turtledoves with which to improve the abominable fare at the first wayside inn, a conglomeration of straw huts where he was devoured by horseflies. Of delicate health, suffering constantly from "intestinal flux," Careri traveled in short hops and long stopovers, amazed along the way to find oranges, lemons, apples, peaches, and pomegranates flourishing beside exotic capulins, avocados, mameys, sapodillas, custard apples and bananas. He was even more amazed to find that oranges and lemons lay rotting on the ground because the natives, accustomed to subsisting on tortilla pancakes and kidney beans, would not bother to pick the fruit.

As he climbed, Careri found that the soil, rich in iron, yielded bountiful harvests. The woods abounded with boars, panthers, eagles, royal herons, and wild geese.

Mexico City Careri found to be a metropolis of 100,000 souls which, to his traveled eye, rivaled Italy in the beauty of its buildings and churches and outdid Italy in the beauty of its charming, well-built women, who, according to Careri, preferred men from Europe, no matter how poor, to the Mexican-born Creole Spaniards because of the latter's pronounced taste for mulatto women, a taste, so he explained, acquired as children suckling mulatto breasts.

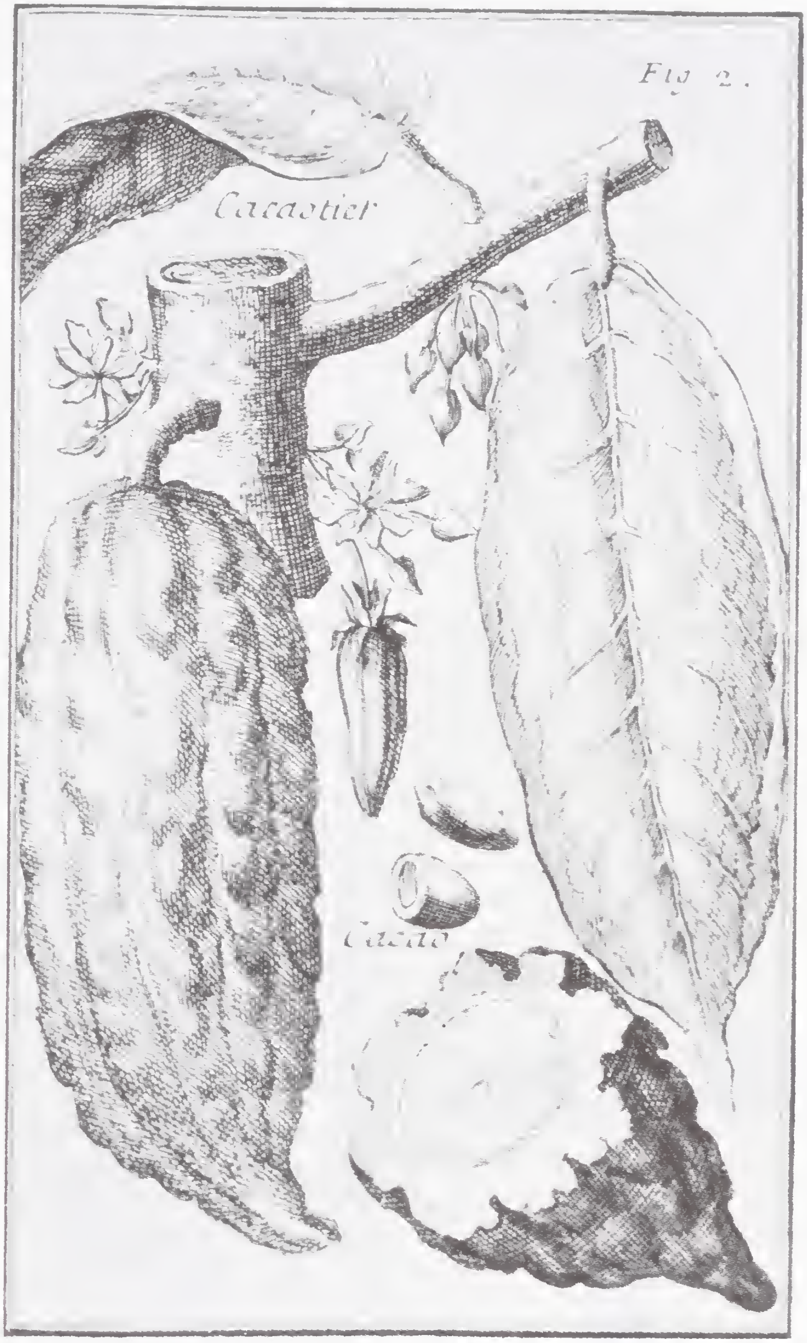
By ten years after the Conquest, Acapulco was already a thriving port, the point of entry and departure for a vast trade, much of it based on the demand for the epicurean specialties of the New World. Spanish seamen made possible a globe-circling trade from Madrid to Havana, to Veracruz, and then overland to Acapulco for continuation across the Pacific to the Philippines and beyond.

Cacao beans, of which the Mexicans got three crops a year, were used as currency in the markets, being worth 60 or 80 to a real. A real was a quarter of a peseta.

Of the cacao bean an anonymous conquistador wrote, "These seeds which they call almonds or cacao are ground and made into powder, and some other small seeds they have are also ground, and the powder put into certain vessels that have a spout. Then they add water and stir with a spoon, and after it is well mixed, they pour it back and forth from one vessel to another until it is foamy. The foam is gathered and put in a cup and when they are ready to drink the beverage, they beat it with some small spoons made of gold or silver or wood. To drink it one must open the mouth wide, for since it has a froth it is necessary to make room for it to dissolve and go in gradually.

"This drink is the most wholesome and substantial of any drink of the world, because whoever drinks a cup of this liquor can go through the day without taking anything else even if he is on a journey, and it is better in warm than cold weather because it is a cold drink."

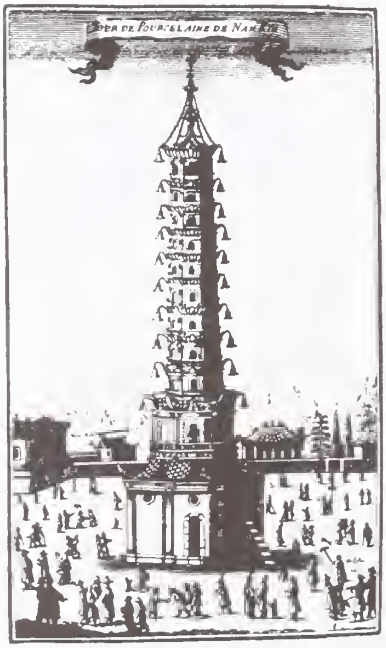
Another chronicler describes the care taken by the Mexicans in raising the delicate cacao tree: "It grows only in a warm climate, and before they plant it, they plant two or three other trees that have large leaves. When these are two estados high, they plant the cacao tree between them so the two can protect this delicate tree from the sun and wind and provide a covering for it. They hold this tree in great esteem because its grains are the principal money circulated in this country, each one being worth half a marchetto. It is the most commonly used coin, but very unhandy after gold or silver."



In the growing city, Careri found Mexicans largely preoccupied with the centuries-old problem of draining and lowering the level of the surrounding lakes to prevent the city from recurrently flooding, a program which involved millions of man-hours of backbreaking slave labor to dig canals and clear subterranean waterways.

The Spanish viceroy, Count of Montezuma, greeted Careri "very civilly"; and an old friend from Naples who had recently been appointed governor general of the province of New Mexico introduced him to a society which was delighted

The progenitors of the Mesoamericans gave to the world not only cacao but maize, pumpkins, squashes, potatoes, sweet potatoes, tomatoes, lima beans, kidney beans, peppers, pineapples, strawberries, persimmons, peanuts, alligator pears, cassava, quinine, cascara, cocaine, copal, balsam, cochineal, anil, alpaca, the llama, the guinea pig, turkeys, and rubber. To have developed such produce and animals would have been the work of thousands of years.



Careri's view of the porcelain tower in Nankin.

to entertain a traveler who could tell them stories of adventures in Peking, with vivid descriptions of such remote wonders as the Pyramid of Cheops and the Great Wall of China, rarely visited by Europeans.

To Careri, Mexico was a colony grossly exploited by a handful of Spanish merchants interested primarily in gold, silver, and pearls, who had managed with the support of the higher clergy to reduce the Indians to serfdom or brigandage; the penalty for which was branding of the testicles with a red-hot poker followed by two hundred lashes on the back.

On his way around the world, Careri visited the Great Pyramid of Cheops on the Gizeh plateau, where he obtained this sketch.

Careri noted that Strabo believed the Great Pyramid had originally been used as an astronomical observatory.

In Careri's day, in Mexico, at the beginning of the eighteenth century, religious institutions owned two-thirds of all the real estate but produced very little with their vast hoarded wealth. Twenty-nine monasteries for men and twenty-two convents for women had grown up in Mexico City, plus so many churches with sub-buildings and large gardens that it was hard to find land for new civilian houses in the lake-surrounded city.

Blacks and mulattoes, who had been forcibly added to the population, were kept strictly segregated and forbidden to wear Spanish dress, with the result, as Careri noted, that they dressed in the most bizarre fashion, "wearing a sort of skirt sideways across their shoulders."

The real owners of Mexico appeared to be the ecclesiastical authorities, who made it tough for Spaniards from Europe to get an economic stake in the country. Of an inquisitive nature that often got him into trouble, Careri discovered that the archbishop's yearly salary was a princely 60,000 pieces of eight, with access to another 200,000 income from his see. In the thirty years since the founding of the city's cathedral, 1,052,000 pieces of eight had been spent on adorning it.

When not going to mass or to the theater, Careri amused himself by searching out people of interest, and it is thanks to his rambles in seventeenth-century Mexico that the world was to get its first real glimpse of what the culture had been like before the arrival of the Spanish.

The most interesting of Careri's contacts was a long-faced lorgnetted priest, Don Carlos de Sigüenza y Gongora, then in his fifties, with a variety of duties, and a passion for probing into the historic past of the Mexicans.

Born in Mexico of noble Spanish parents, Sigüenza had been expelled from the Jesuit order, but had maintained friendly relations with his former comrades. Cultivating friendships with the native Indians, and winking at his duties for the Inquisition, Sigüenza managed to induce the Indians to bring forth manuscripts and paintings which they had carefully hidden for fear of being burned at the stake like the former King of Texcoco.

Don Carlos de Sigüenza y Gongora.

Professor of mathematics at the University of Mexico, General Examiner of Gunners, Corrector of the Inquisition, poet, astronomer, historian, and geographer, Don Carlos was by far the most erudite Mexican in his times, a Renaissance man who had made all of human knowledge his province, peering into dark corners to ferret out the facts.

From Sigüenza's collection of Aztec kings and warriors.

Sigüenza, on the contrary, specifically cultivated the friendship of the direct descendants of the kings of Texcoco, especially Don Juan de Alva, son of Fernando de Alva Cortes Ixtlilxochitl, author of the first history of the Mexican people written in Latin after the Conquest. In return for this friendship, Don Juan taught Sigüenza the language of the Nahua, showed him how to decipher many of the native hieroglyphs, interpreted the Indian myths, and, in the end, turned over to him an invaluable prize: the complete collection of his family papers.

Another great haul of precious original documents had come into Sigüenza's possession during the riots and ensuing fire which had swept the center of Mexico City a few years earlier. Hiring some Indians at his own expense, Sigüenza had placed ladders up to the windows of the flaming archives, smashed his way in with an axe, and thrown out all the manuscripts, codices, and capitulary books not yet consumed by the flames. With the help of his nephew, this priceless secret material was brought to the Hospital del Amor de Dios, a refuge for sufferers from the "French disease" or from bubas, where Sigüenza, as chaplain in residence, had his quarters.

There Careri paid a visit to Sigüenza and was shown remarkable writings and drawings relating to the antiquity of the Indians, including such prized items as a manuscript history of the Mexicans by Fernando de Alvarado Tezozomac, son of the successor to Montezuma; some original writings of Chimalpahin Quauhtlehuanitzin; a book, since lost, by Archbishop Zumarraga; and, most important, the works of Fernando de Alva Ixtlilxochitl.

With the help of these rare documents and a great many calculations based on eclipses of sun and moon and passages of comets as depicted in the paintings, Sigüenza was able to reconstruct an Indian chronology of Kings, tracing them back through the centuries. With his penchant for mathematics, Sigüenza was able to tackle complex calendrical problems that had baffled the earlier friars.

From Ixtlilxochitl, Sigüenza learned of an ancient Mexican calendar, which had vanished at the time of the Conquest, by means of which the Aztec priests had been able to keep an accurate chronology over very long periods of time in 52- and 104-year cycles, noting the solstices and equinoxes, the transits of Venus, and many subtle computations on the movements of heavenly bodies.

A careful study of these data enabled Sigüenza to fix certain dates with precision, such as the year 1325 for the founding of the city of Tenochtitlan and the beginning of the Aztec empire.

Portrait of Montezuma II given by Sigüenza to Careri.

From the evidence, Sigüenza concluded that a race called the Olmecs had preceded the Toltecs, coming from the East, perhaps from legendary Atlantis—as suggested by the Spanish chronicler Gonzalo Fernandez de Oviedo y Valdes —to settle on the gulf coast of Mexico. That a continent or group of islands known as Atlantis had existed, Sigüenza was convinced; he felt that they had served as stepping-stones to and from the Americas. The rest of the tribes of the

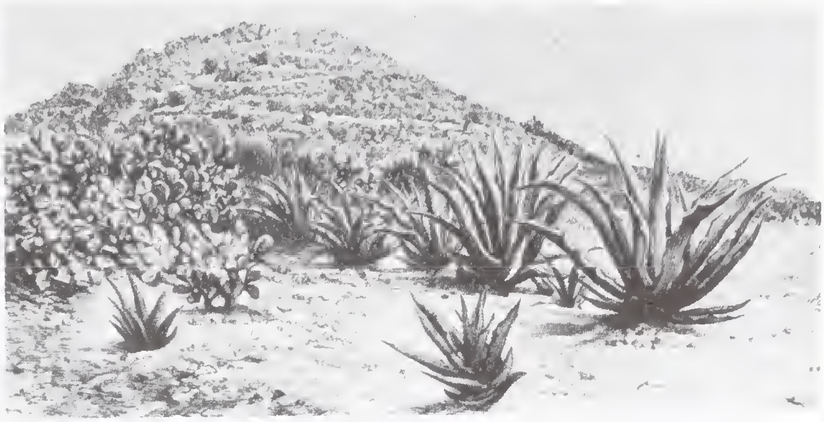
Western Hemisphere, he believed, had come from the north and northwest, possibly from Asia. But to Sigüenza, the similarity between Mexican and Egyptian pyramids, hieroglyphs, and calendars was too strongly indicative of the existence in the Atlantic of an intervening continent or group of islands, for which Plato's account of Atlantis fit the bill.

Pyramids, hieroglyphs, and calendars bound Sigüenza closely to the family of Ixtlilxochitl, who were still titular lords of San Juan Teotihuacan, site of the pyramid complex. This close link enabled Sigüenza to indulge in a more than superficial investigation of the ancient ruins. Whereas others attributed the construction of the great mounds to the Toltecs, Sigüenza believed them to be the work of the earlier Olmecs who had dwelt near the hills of Tlaxcala. As several sixteenth-century writers had reported the Indian tradition that the interior of the pyramids might be hollow, Sigüenza endeavored to dig into the two biggest ones, but with the limited means at his disposal was unable to uncover any passageway or chamber.

So fascinating was Sigüenza's description of these pyramids, that Careri decided he should "not miss some Indian antiquities before leaving Mexico." Rousing himself, he rode out to San Juan for a personal inspection.

On the route around Lake San Cristobal, Careri spent the night at Acolman. Inside this massive sanctuary Careri found a baroque church with a pleasant inner courtyard adorned with carvings by native Indians in the European style of the sixteenth century.

Route from Mexico City past the lake of San Cristobal to San Juan Teotihuacan. In the foreground is the monastery of Acolman. The town was famed under the Aztecs for a breed of fat little castrated dogs especially raised for the tables of the rich, and under the Spanish for its fortresslike Augustinian monastery. In the background are the hills of Sierra del Malpais.



After a night spent like the Jesuits on a pillow made of leather which could be inflated like a balloon and deflated in the morning, Careri set off at sunrise for the village of San Juan Teotihuacan, six leagues away, noting that the local Indians painted their cheeks with crushed herbs to protect them from the cold, and that they put mud in their hair to make it soft and shiny.

With an introduction from Don Carlos de Sigüenza, Careri was able to spend the night at San Juan with Pedro de Alva Ixtlilxochitl, grandson of Juan de Alva, who promised to show him the pyramids on the morrow.

At daybreak they explored first the smaller of the "mounds" called "Of the Moon," which Careri described as being a pile of stones with a slope like an Egyptian pyramid, but differing in that it was not constructed of solid stone. He found the base measured 650 palms north to south and 500 palms east to west: the height, since he had no instruments with which to measure, he estimated to be 200 palms. Taking the Aztec palm, or cemitztl, as 17.5 centimeters, this would have made the Moon Pyramid 105 meters wide at the base by 35 meters high. Its present reconstructed size is 152 meters wide by 42 high. Either Careri's palm was incorrect, or, more likely, the base of the pyramid was so covered in earth and rubble that only a smaller portion of it was visible, as was the case at that time with the Pyramid of Cheops.

Aztec idol known as the God of Rain.

From Sigüenza, Careri had heard that this pyramid had once been crowned with a "huge idol of the Moon clumsily carved from hard stone," which had been destroyed on orders from Bishop Zumarraga. That such an idol, eighteen feet tall, had once stood on the "Hill of the Moon" had been officially reported to Phillip II of Spain in 1580 by a local magistrate, Don Francisco de Castañeda, as part of the earliest-known official description of the pyramids of Teotihuacan. Castañeda also reported the presence of many more idols around the pyramid, the largest of which were "six

All over Mexico, statues of what the Spaniards called "idols" were smashed or destroyed after being stripped of their gold or jewels.

idols called the Brethren of the Moon," three large pieces of which, said Careri, still lay at the foot of the pyramid.

Two hundred paces to the south, Careri and his noble Indian guide explored the pyramid known to the Aztecs as "Tonatiuh," or "House of the Sun." Careri says that two of its sides were 1000 palms long (or 175 meters instead of about 230), whereas the other two were 650. The height he estimated to be a fourth more than the height of the Moon Pyramid. In fact it is one-half.

According to Castañeda's report, there had once stood on the summit of the Sun Pyramid, facing west, an "idol" of very hard, rough stone, all of one piece, eighteen feet high, six feet wide and six feet thick, called "Tonacatechuhtli," or "Sun God," but whether these statues formed part of the original pyramid complex or were added by later generations there was no way to tell.

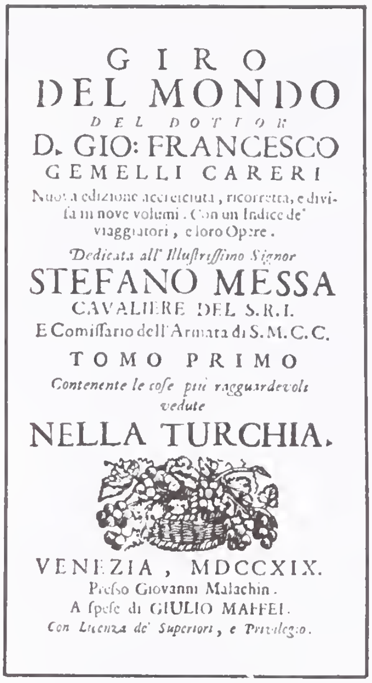
Careri says he found part of this statue halfway down the pyramid; he described it as having a slot in the stomach "where one put the sun," adding that two large pieces which had formed the arms and feet still lay at the base of the pyramid. Careri was told that the statues which had once adorned the summits of the two pyramids had originally been covered in gold, which was removed by the Spaniards at the time of the Conquest.

According to Castañeda, there had also been "a small temple" at ground level at the base of the great pyramid atop which stood a smaller idol called "Mictlantecuhtli," or "God of the Underworld"; but Careri saw no sign of it. He was puzzled as to how the Indians could have cut such "idols" out of hard stone without the use of metal chisels; he also wondered how they had managed to raise such great weights to the top of the pyramids when "they had neither machines nor the wit to invent such machines."

How, asked the Italian, had the Indians been able to transport heavy stones from distant quarries when they had neither mules nor horses before the arrival of the Spaniards—a question which no one in Mexico could satisfactorily answer for him.

From the crumbling walls which he saw spread out in all directions, and the number of smaller mounds which he believed to have been erected to honor other idols, Careri had

Though Sigüenza had corresponded as far afield as with the extraordinary prelate Father Athanasius Kircher, who was determined to discover the secret lore contained or built into pyramids and obelisks, the rest of the world was not yet ready for the subject.


GIRO
DEL MONDO
DEL DOTTOR
D. GIO: FRANCESCO
GEMELLI CARERI
Nuova edizione accresciuta, ricorretta, e divisa in nove volumi. Con un Indice de' viaggiatori, e loro Opere.
Dedicata all' Illuſtriſſimo Signor
STEFANO MESSA
CAVALIERE DEL S.R.I.
E Comiſſario dell' Armata di S.M.C.C.
TOMO PRIMO
Contenente le coſe più ragguardevoli vedute
NELLA TURCHIA.
VENEZIA, MDCCXIX.
Preſſo Giovanni Malachin.
A ſpeſe di GIULIO MAFFEI.
Con Licenza de' Superiori, e Privilegio.

First page of Careri's *Voyage Around the World* published in 1719.

no doubt that a large city of Teotihuacan had once existed around the pyramids. But when it came to giving a date for the possible construction of these pyramids, Careri considered that no historian had discovered anything reliable.

Echoing the thoughts of Sigüenza, Careri attributed the construction to the Olmecs, possibly refugees from Atlantis, or to Europeans who had crossed the Atlantic, pointing out that even Aristotle had known that the Carthaginians had sailed beyond the Strait of Gibraltar to a "new world," but had been forbidden further such voyages by a senate fearful that the richness of the newly discovered lands would make the sailors forget their home. On his way back to Mexico City, it began to rain, and Careri's horse, overtired from the strenuous journey, lay down in the mud and died, a fate which was to overcome Careri's interest in the world of pyramids prospected for him by his friend Don Carlos de Sigüenza y Gongora. After eleven months in Mexico, Careri sailed for Havana and Seville, where he landed in 1698 with a handy supply of cochineal (for scarlet dye), Havana cigars, indigo, cocoa, and vanilla, discreetly hidden to avoid the duty. Because of his round-the-world trip, King Charles II of Spain received Careri but was not overly impressed.

In a six-volume opus, *Giro del Mondo,* or "Around the World in Eighty Months," which was quickly translated and condensed, Careri gave his contemporaries exotic glimpses of the Near, Middle, and Far East, plus the first and best description of Mexico to have reached the outside world. For his efforts he was quickly labeled an imposter who had never left Naples, a fiction to which historians were to cling till very recent times. Oliver Goldsmith and Adam Smith were both convinced that Careri was a fraud, and William Robertson, the eighteenth-century Scottish historian, in his monstrously inaccurate *History of America,* refused to include Careri's reports.

According to Robertson, neither the Mexicans nor the Peruvians "were entitled to rank with those nations which merit the name of civilized." He described the palaces attributed to the Indians by the Spanish conquistadores "as more fit to be the habitations of men just emerging from barbarity than the residence of a polished people. . . . Nor does the fabric of their temples and other public edifices appear to have been such as entitled them to high praise. . . . These structures convey no high idea of progress in art and ingenuity. . . . If buildings corresponding to such descriptions had ever existed in the Mexican cities, it is probable that some remains of them would still be visible. . . . It seems altogether incredible that in a period so short, every vestige of this boasted elegance and grandeur should have disappeared. . . . The Spanish accounts appear highly embellished."

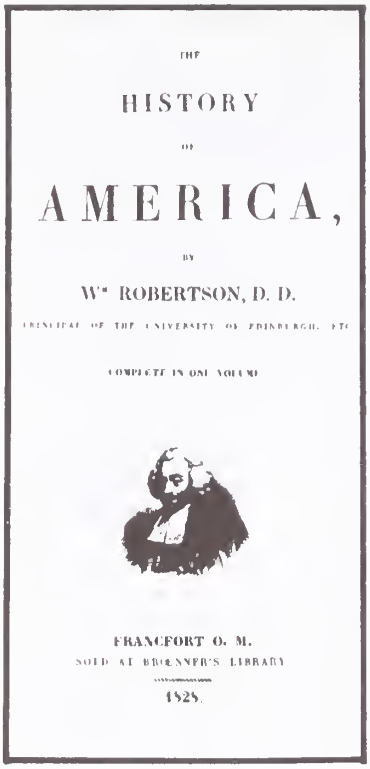
And the Dutch-born historian Cornelius de Pauw, in his *Recherches Philosophiques sur les Américains,* claimed that "the so-called palace occupied by the Mexican kings was a hut."

Calendar wheel obtained by Careri from Sigüenza. Encircled by a snake, the Mesoamerican symbol of time, the outer wheel shows a 52-year cycle divided into thirteen repetitions of the 4-year cycles of rabbit, house, cane, reed. The next circle shows the eighteen months of the Aztec year. In the center are the symbols for the four seasons.

Only a few Europeans of progressive outlook such as Giordano Bruno and Montaigne refused to believe in the inferiority and depravity of the Indians of Mesoamerica.

Sadly, as the first edition of *Giro del Mondo* came off the presses, Don Carlos de Sigüenza y Gongora, responsible for most of what Careri reported of value from Mexico, died, too poor to have had his manuscripts put into print. In line with the policy of the Inquisition to allow a man to accumulate manuscripts during his lifetime, but see to it that after his death they got no further dissemination, twenty-eight of Sigüenza's own manuscripts along with his priceless collection of books, manuscripts, and codices were quickly scattered, stolen, or destroyed. Luckily, the Jesuits salvaged the lion's share of their former novice's own manuscripts; but when their order was thrown out of Mexico in 1767 these manuscripts were also buried in some archives or lost.

Ironically, what was known of some of Sigüenza's writings was to reach the world through Careri's flimsy reports, such


THE

HISTORY

OF

AMERICA,

BY

W^m ROBERTSON, D. D.

PRINCIPAL OF THE UNIVERSITY OF EDINBURGH, ETC

COMPLETE IN ONE VOLUME

FRANCFORT O. M.

SOLD AT BROENNER'S LIBRARY

1828.

as his interpretation of the Mexican calendar taken from Sigüenza's lost work *Ciclografia Mexicana*, which Sigüenza had been kind enough to lend Careri when he was in Mexico City, but which the Neapolitan jurist, weak on mathematics, had poorly understood and miserably transmitted.

With venom, De Pauw attacked the reliability of the Mexican calendar found by Sigüenza and interpreted by Careri, writing that "with breathtaking impudence and ignorance Careri has followed the explanation of a certain creole professor named Congora [sic] who had not dared to publish a work he had written on the subject because his friends and relatives assured him it abounded in absurdities." De Pauw could not countenance the possibility that Mexicans had recorded the passage of centuries with the use of "calendar wheels." Such reckoning, he said, supposed a long series of astronomical observations "incompatible with the prodigious ignorance of those people." How, asked De Pauw, could they have perfected their chronology "if they did not have words enough to count to ten?"

After Careri's departure, almost a century was to pass before the veil of obscurantism was once more to be pierced by the arrival in Acapulco of another famous traveler—Baron Friedrich Heinrich Alexander von Humboldt.

4. Humboldt's Mission

When Humboldt arrived in Acapulco on March 23, 1803, aboard a frigate aptly named *Atlante,* he was in his thirty-fourth year, and one of the most popular individuals in Europe. A friend of Goethe, Schiller, Metternich, and Chateaubriand, he was almost as well known as Napoleon Bonaparte, with whom he had failed to go to Egypt during the 1799 expedition only because the ship on which Humboldt was to have sailed from Marseilles was sunk in a sudden storm, obliging him to seek adventure in the Americas.

From Guayaquil in Ecuador, Humboldt brought with him to Mexico his good friends Aimé Bonpland, the botanist, and Carlos de Montafur, a fighter for freedom in Latin America. The trio brought an enormous pile of luggage containing telescopes, surveying instruments, minerals, plants, mastodon bones, skins of jungle creatures, and specimens of birds.

In contrast to the port of Acapulco which Humboldt and his companions considered one of the prettiest in the world, they were struck by the lugubrious atmosphere and burned landscape surrounding the town, which they described as a miserable and unhealthy spot, hot and tropical, a haven for escaped convicts and rum-filled slaves.

Humboldt's original plan in coming to Acapulco had been to reverse Careri's route toward the Philippines, but because his instruments were beginning to rust he decided instead to return immediately to Europe. This plan was scotched by an outbreak of yellow fever in the gulf port of Veracruz, which determined Humboldt to stay in Mexico at least till the

Humboldt standing talking to Aimé Bonpland, surrounded by the equipment with which they had explored and made scientific observations across South America from the mouth of the Orinoco to the Andean highlands.

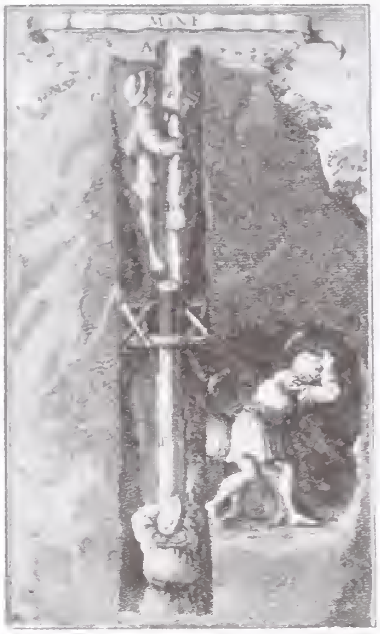
fall of the year (when the disease was less catching), or better still, the following spring so as to avoid a winter crossing of the Atlantic.

In Acapulco, Humboldt and his companions made astronomical observations to correct the misplaced coordinates of the town, and they spent some time observing the nature of earthquakes, which were frequent in the area. Finally, in a 104-degree heat wave, they set off in Careri's footsteps up the dusty mule trail toward the capital, climbing slowly because of the number of pack animals carrying their biological and mineral specimens, stopping here and there to study rocks and plants and to make astronomical and barometric observations.

During the starlit nights Humboldt obtained accurate readings of his location so that by day he could produce graphs of the geological structures he encountered, invaluable to later surveyors. He even mapped an easy way to convert the mule path into a proper roadway to the capital once traffic might warrant the endeavor.

Aimé Bonpland, aged 40.

Portrait of Alexander von Humboldt at the age of 25.



The sight of the Mexican mines led the almost radically liberal Humboldt to observe that "there can be no durable prosperity for the two Americas until this unfortunate race, humiliated but not degraded by long oppression, shall participate in all the advantages resulting from the progress of civilization and the improvement of social order."

In his own mining career in Germany, when still in his twenties, Humboldt had learned to double production of a mine by improving its working conditions and safety measures, and by providing night school for the miners, often at his own expense.

Between Chilpancingo, in the Sierra Madre del Sur, and Taxco, clinging to its hillside, Humboldt came across the great silver mines of Mexico. Indian laborers, panting by day under heavy loads of ore, blasting by night in an inferno of powder smoke and dust, were still being treated like mongrel dogs.

Leaving Taxco, the travelers wound their way through limestone mountains to Cuernavaca, where Cortes had built his first palace and planted Mexico's first sugar plantation. A day's ride took them to the crest of the continental divide, 11,000 feet above the sea, from where they could look eastward down onto the City of Mexico with its cluster of churches, palaces, and gardens, which, from their vantage point, appeared to be floating on the surrounding lake.

As a botanist, Humboldt was struck by the beauty of the cypresses at intervening Xochimilco, lovely great trees which had rooted beneath the lake to form a world of "floating gardens called *chinampas*." These gardens provided an abundance of vegetables which could be floated by the Indians along narrow waterways right to houses and convents near the viceroy's palace in the great Plaza Mayor, where the main temple of Tenochtitlan had stood.

As Humboldt and his companions approached the city, a messenger brought word of welcome from Viceroy Don José Iturrigaray, granting Humboldt passports to travel wherever he pleased in New Spain, a special treatment arranged for Humboldt in Madrid by the minister of Saxony, who had convinced the Spanish crown that such a distinguished scientist and "conservative" young nobleman would not rock the boat of state with his reports from Mesoamerica. Actually the arrangement had every earmark of being a Masonic ploy to facilitate an intelligent reconnaissance of Mexico, possibly on behalf of long-term mining interests in Europe.

Within the city, with its wide clean avenues, flanked by iron candelabra, resplendent at night with lighted palaces and churches, Humboldt was welcomed as an erudite and learned visitor. It was his charm, however, and his apparent sincerity and ease, along with his sociability and brilliance of conversation, which really opened doors to him. Wherever he went, cultivated persons gave him their confidence; in Mexico he got help from peasant and governor, missionary and bishop, savant and noble, being welcomed indiscriminately into palace or snack, workshop or hacienda. Almost everyone had heard of Baron Humboldt as either astronomer, physiologist, botanist, economist, archeologist or philologist; but seldom had any of them had occasion to frequent so distinguished a personage.

The chinampas or so-called floating gardens of the Valley of Mexico, of which Xochimilco is the most famous, date back more than 2000 years, and were the main source of food-stuff for the inhabitants of the entire valley, producing as many as seven different crops in a year, two of which were maize.

Properly maintained, they could remain fertile for centuries without having to lie fallow.

Xochimilco consisted of a network of canals of various widths laid out generally at right angles to form a grid. Rafts and water vegetation were cut from the surface of the canals and towed to strips where they were built up in layers and covered with rich mud scooped up from the canal bottom.

Many such chinampa towns surrounded by lovely canals and cultivated strips developed on the western and southern shores of the Lake of the Moon.

An added asset in the canals was an abundance of fish and axolotls, large salamanders prized for their tender meat and scarcity of hard bones.

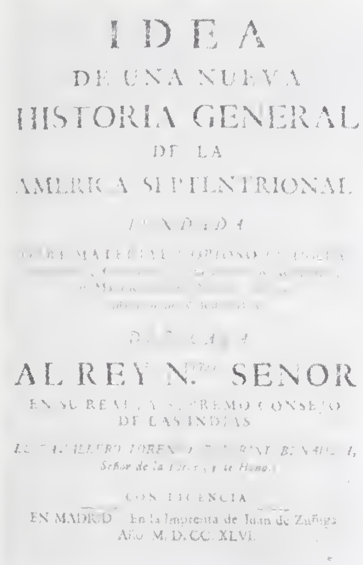
Most amazing, the viceroy immediately opened up for Humboldt the country's classified archives. To help him with his research, Humboldt found, in circumstances that seemed more than fortuitous, a former classmate from Freiberg University, Don Andres Manuel del Rio, who had providentially become director of Mexico's school of mines. A young savant, Dr. M. Oteyza, was selected to tutor Humboldt on the history of Mexico and to show him where he could obtain rare Indian picture writings which had escaped the *autos da fe* of the Conquest, picture writings so scarce in New Spain, according to Humboldt, that the majority of educated persons had never seen one.

With access to the official files and a bent for statistics, Humboldt estimated the population of Mexico City to be 137,000 inhabitants, or twice that of contemporary New York, with the difference that in Mexico City there were only 2,500 Europeans, the rest of the population was composed of 65,000 Creoles, 33,000 Indians, 26,500 mestizos, and 10,000 mulattoes.* Like Careri, Humboldt found both town and county pullulating with priests, monks, and nuns—one priest for every sixty inhabitants, or 100,000 priests in a country of 6 million souls. To Protestant Humboldt, the higher clergy of Mexico appeared to be living in clover, some receiving incomes greater than that of the then president of the United States, Thomas Jefferson.

* Creoles were Spaniards born in Mexico; mestizos were part Spanish, part Indian; mulattoes were part Negro.

When Humboldt arrived in Mexico City, it was the largest city on the continent of America; he found it "undoubtedly one of the finest ever built by Europeans in either hemisphere."

After several months of studying the statistics and geography of the country, and of analyzing Mexico City as the political, commercial, industrial, and ecclesiastical capital of New Spain, Humboldt turned to the city's antiquities to observe it as an ancient center of civilization. He was shocked to discover the extent of the destruction of Tenochtitlan, as well as of ancient statues and painted codices. He also learned that since Sigüenza's death another great collection of books, manuscripts, and codices had been pillaged and dispersed, that of the eighteenth-century Milanese traveler Lorenzo Boturini Benaducci, which had been burned, stolen, or taken abroad, where part of it was seized by British pirates who destroyed it without understanding its value.


IDEA
DE UNA NUEVA
HISTORIA GENERAL
DE LA
AMERICA SEPTENTRIONAL
[illegible]
AL REY N.TRO SEÑOR
EN SU REAL [illegible] CONSEJO
DE LAS INDIAS
[illegible]
CON LICENCIA
EN MADRID: En la Imprenta de Juan de Zuñiga
Año M. D. CC. XLVI.

Perhaps the greatest collection of ancient Mesoamerican documents was accumulated by another Italian, Lorenzo Boturini Benaducci, born in the see of Como in 1702, who liked to trace his family back to the ninth century A.D. After studying in Milan and Vienna, Boturini was driven to Madrid by the war between Spain and Austria. There he found Doña Manuela de Oca Sylva y Montezuma, who convinced him to go to New Spain to collect a pension of a thousand pesos owed her as a direct descendant of Montezuma II. Armed with a papal Bull authorizing him to make a collection to provide a crown for the Virgin of Guadalupe, Boturini scoured Mexico for documentary evidence in proof of the miraculous apparition of the Virgin at Guadalupe, and in so doing came across scores of priceless ancient historical documents. Arrested as a foreigner soliciting funds for the Virgin, Boturini was jailed and his documents seized.

Deported back to Spain, he was captured by British pirates on the high seas and put ashore at Gibraltar minus clothes and belongings. Vindicated by the Spanish authorities, Boturini was given a pension and the job of writing a history of New Spain, but by that time his collection of documents in Mexico had been pilfered and wantonly destroyed. Of two hundred manuscripts only thirty-eight remained, partly destroyed by soldiers from a nearby barracks who were entertained by the exotic drawings. Of Boturini's work, all that survived of value was a booklet entitled *Idea for a New General History of North America* with a tantalizing catalogue of his unique but scattered manuscripts.

Francisco Javier Clavigero, who entered the Jesuit Order in Mexico in 1748, found in the Jesuit College Library the remaining works of Sigüenza y Gongora and what was left of Boturini's collection, which he studied and used to become what a later Jesuit historian Charles E. Ronon called "the eighteenth century's *Voice of America*."

When the Jesuits were expelled from Mexico in 1767 by Charles III, Clavigero took refuge in Bologna where he witnessed the suppression of his order in 1773. Left with little to do, he produced his *Storia Antica* (written in Italian because few in Italy could understand Spanish) largely to preserve for posterity a record of the achievements of the native civilization of Mexico and refute to the world the misinformation of such historians as De Pauw and Robertson, who had wounded his Creole feelings.

The Inquisition took objection to Clavigero's comparison of the Spanish rule in New Spain with the Turkish oppression of the Greeks, and held up publication of his work in Spanish, insisting on compiex amendations. In the end they lost the manuscript. When Clavigero died in Bologna in 1778, fellow Jesuits retrieved his original manuscript, but also managed to lose it. Early in the twentieth century a dusty manuscript was identified as Clavigero's by Manuel Diaz Ramon, S.J., but it too disappeared only to reappear in the hands of a U.S. dealer. The Mexican scholar Mariano Cuevas had it published, but omitted Clavigero's dissertation on the origin of syphilis, which he attributed to Spanish conquerors rather than to native Mexicans. Modern historians, with access to wider sources, accuse Clavigero of having plagiarized material directly from Torquemada's unpublished *Monarquia Indiana.*

Codex from the collection accumulated in Mexico at the beginning of the eighteenth century by researcher J.M.A. Aubin.

Because of the revolutions and counterrevolutions in Mexico, and twenty-six changes of government between 1830 and 1848, Aubin was able to buy cheaply many manuscripts and paintings, including some rare items from the son of Leon y Gama, which, as an astronomer, were of great interest to him. From Mexico, Aubin managed to smuggle his collection to France by taking the manuscripts and books out of their bindings and jumbling them up to confuse the customs officials at Veracruz. He published some in Paris in 1855, but mostly kept them secret from everyone except Brasseur de Bourbourg.

In 1870, because of losses in an investment in Panama Canal shares, Aubin was obliged to sell his collection, including many of Boturini's documents, to Eugene Goupil, a Frenchman interested in Mexican documents because of his Mexican mother—and so they have survived.

Calendar Stone.

Leon y Gama recognized the great Aztec stone as a sophisticated calendar. He believed its central cloverleaf design represented the legendary Aztec epochs of four suns. In the third circle he recognized the twenty Aztec symbols for the days of the month and the hieroglyph for 4-ocelot, the day when the sun stood at the zenith over Mexico City. As for the two enormous snakes around the outer edge, Leon y Gama believed they represented the Milky Way.

From the perfection and uniformity of the circles on the great stone and the exact division of it into parts, Leon y Gama said it was clear the Indians had a fine understanding of geometry. He also pointed out the ability of artisans capable of so perfectly engraving inscriptions on the stone though they were not supposed to have had tempered chisels but only harder stones. The volume and weight of the stone, said Leon y Gama, showed the Indians' knowledge of mechanics, without which they could never have cut a stone weighing over 24 tons and brought it from its place of origin, a quarry assumed to be in the mountains near Xochimilco, thirty miles away, from which it had been dragged on greased rollers by large groups of natives to the main square of Tenochtitlan. Leon y Gama, who considered the stone an Aztec clock by which priests could tally the movements of the heavenly bodies, believed that holes found in the perimeter of the stone might have been drilled to insert gnomons, or small obelisks, to throw shadows to indicate the days of the solstice, equinox, and zenith. At the beginning of the nineteenth century Sir Norman Lockyer, the English astronomer who first recognized the astronomical function of Stonehenge and the Egyptian temples, was amazed at the brilliance of the Mesoamerican

Among the few important relics which had survived from the Aztec empire, one of paramount interest surfaced only a dozen years before the arrival of Humboldt. In 1790, when the viceroy had ordered repairs to the paving of the great Plaza Mayor to improve the drainage in front of the cathedral, workmen had struck a large stone two feet below the surface, almost in front of the viceroy's palace. The stone, a solid piece of gray-black basalt, measured twelve feet across and was almost three feet thick.

Its presence was explained by the fact that when Cortes razed the city of Tenochtitlan he had ordered all large statues and stonework too solid to be broken up to be buried so that no remnant of the great Indian capital be left to remind Indians of their former glory, or as the parvenu clergy who considered the stone a "sacrificial altar" put it, "to bury with the stone the memory of the abominable acts perpetrated on it."

With great pains the enormous relic was righted, and the underside, which had been face down in the mud for over two centuries, was seen to be covered with the most intricate and delicate carving, as incomprehensible to its discoverers as it had been to Cortes and his early followers.

But there lived in Mexico City in 1790 a historian who had spent a lifetime studying ancient Mexican documents and who, like Sigüenza, had mastered the Nahuatl language and learned to interpret some of its hieroglyphs. Antonio de stone calendar which he found recorded not only the annual rotation of circumpolar star groups but also the annual apparent course of the sun. He called it "an achievement which has never been surpassed in primitive astronomy."

At the turn of the century, archeologist Zelia Nuttall, who considered the calendar "the most precious and remarkable monument ever unearthed on the American Continent," and "one of the most admirable and perfect achievements of the human intellect," saw in the Sun Calendar not only the embodiment of longstanding primitive observations, but a calendar designed to control the actions of all the human beings of the state, bringing their communal life into accord with the periodic movements of the heavenly bodies.

As the four-branched Ollin sign divided the 52-year cycle into four 13-year periods, it also divided the day into four equal parts, consonant with the four quarters of the Aztec world named for their four elementals—fire, air, water and earth. Nuttall says there were four human lords under the Aztec king, and these governed four divisions of the population, classified by the four elements.

The earth people, says Nuttall, specialized in agriculture and pottery; the water people in providing irrigation, drinking water, fishing, etc.; the fire people worked on combustibles, lighting, cooking and metalworking; the air people were the builders, masons and artificers. As a person was given the name of the day on which he was born, this determined his position in the commonwealth, his class, his future occupation.

Seen by Nuttall, the great stone was the work of a master mind "who destined it to be the image of a plan based on the idea of a central and yet all-embracing, dual, yet quadruple force or power."

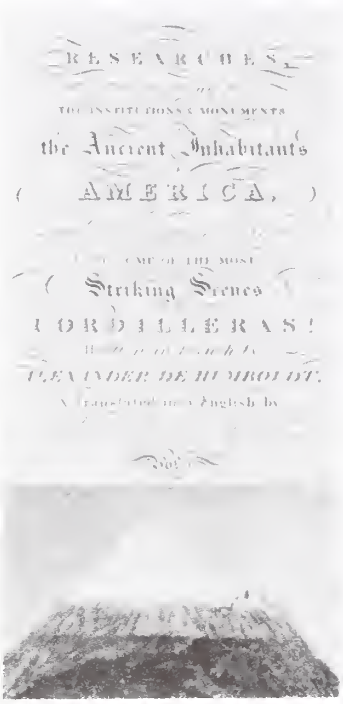
Leon y Gama, then in his fifties, recognized the stone as the famous Aztec calendar, of which Sigüenza had written, taking his information from the descendants of Ixtlilxochitl.

To Leon y Gama the discovery of the calendar proved beyond doubt the assertion of Sigüenza, cautiously reported by Careri, that the pre-Conquest Indians had possessed an advanced and remarkable knowledge of mathematics and astronomy which they had used to make accurate observations of the movement of sun, planets, and stars to produce a calendar with cycles of 52 years of 365 days, each divided in 18 months of 20 days, whereto they added 5 on regular years and 6 on leap years.

In a monograph explaining the calendar stone, Leon y Gama tried to show how falsely the ancient Mexicans had been described as "irrational and simpleminded beings." But his explanation was too embarrassing to the Spanish clergy. Without elementary notions of astronomy, they continued to insist that the "calendar stone" was a sacrificial altar, arguing that the very fact that the intertwined recurrent cycles were put together in such a complex and aesthetic manner obviously meant they were ornamental, adducing as evidence the fact that the same symbols appeared on earrings, necklaces and other purely decorative objects.

When Humboldt saw the great stone, it was propped up against the west wall of the cathedral, already wantonly disfigured by a populace exhorted by its priests to execrate anything connected with their former religion. As an astronomer, Humboldt was quick to validate Leon y Gama's interpretation of the stone, supporting him with a long essay on the significance of the Aztec calendar. Humboldt accepted Leon y Gama's interpretation that eight triangles radiating from the central sun alluded to eight divisions of the day, pointing out that the Aztecs had evidently reckoned the civil day in the same manner as the Persians, the Egyptians, the Babylonians, along with the greater part of the nations of Asia with the exception of China, dividing the day from sunrise to sunrise into eight intervals of three hours.

It was equally clear to Humboldt that the Indians had started and divided the year by the solstices, equinoxes, and days of the zenith. Humboldt pointed out that most of the names by which the Mexicans denoted the twenty days of their month were the same as those given to the signs of the zodiac in use from remotest antiquity among the nations of Eastern Asia—tiger, hare, ape, dog, serpent, and bird, heavenly asterisms that bore the same names in the Tartar and Tibetan zodiacs. From all of this Humboldt concluded that the people of the two continents might have derived their astrological ideas from a common source.



In his *Atlas Pittoresco,* Humboldt devoted more than a hundred pages to a discussion of the Mexican calendar stone and the relationship between the mathematical and astronomical systems of Aztecs, Toltecs, Peruvians, Nootkas, and other native American peoples, with those of the Chinese, Hindus, Oigones, and other Oriental peoples.

He found a vast amount of evidence for a common origin of the cultures of the two continents, including the systems of both the solar and lunar zodiacs, with many similar animals allotted, and even similar sounds of some of the astrological terms.

Humboldt's conclusion that the people of Mexico at the time of the Spanish Conquest had enjoyed a greater degree of civilization handed down from antiquity than they had been credited with, and that the American Indian in antiquity had a sophisticated understanding of astronomy, was derided by reviewers, who conceded that the Indians might have had a calendar chronology but would not admit "that a nation so barbarous as the Mexicans had any knowledge of the causes of eclipses."

Humboldt turned to other subjects. Though he traveled extensively in the country on sociological and geographical quests, he appears to have relied more on the reports of Mexican friends than on firsthand observation to fill in his knowledge of other Mexican antiquities. The Xochicalco pyramid near Cuernavaca he passed without even knowing it was there, relying on others to describe it; he did likewise for the ruins of Mitla. Though he did travel to Tula and express the opinion that it might have been the site of the Toltec capital, Tollan, he did not bother to look for archeological evidence.

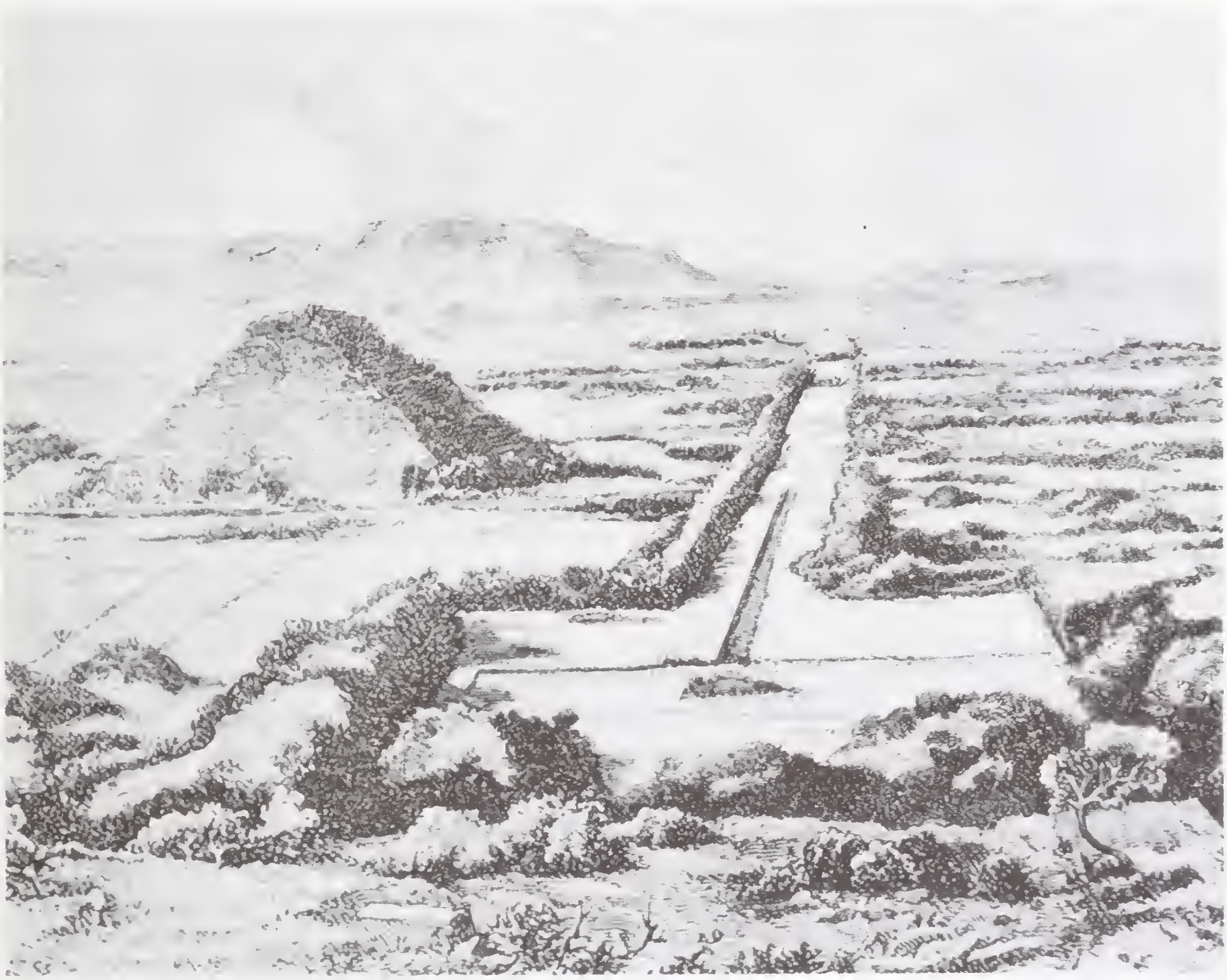
Humboldt claimed that "the only ancient monuments in the Valley of Mexico imposing enough in size and grandeur for European eyes" were the ruins of the pyramids of San Juan Teotihuacan. Historians have recounted that he traveled to these pyramids by horse and coach with Bonpland and Montafur and was "immediately struck by the extraordinary geometric symmetry of the great ruined complex, marveling at what the buildings and temples must have looked like a thousand years earlier, with platforms adorned with the gilded images of gods." However it is more likely that Humboldt again relied for his description of the site on the work of Careri; and for the measurements of the Sun and Moon pyramids on the figures given him by his young friend Oteyza.

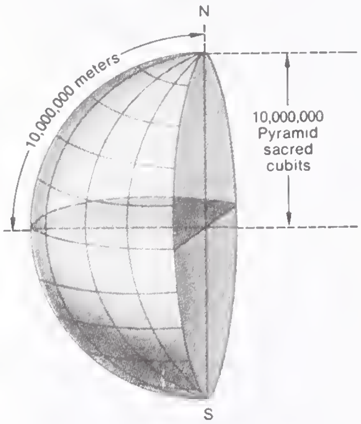
Humboldt had carefully read Careri before embarking on his exploration of Mexico; but until he arrived in Acapulco he had no way of knowing whether Careri had been telling the truth or, as his critics maintained, inventing fables. Humboldt soon discovered that Careri had indeed preceded him, and he was categorical in his defense of the authenticity of Careri's descriptions of Mexico: "Having covered a great deal of the territory so minutely described by the Italian traveler, I can affirm that there is no doubt that Careri was in Mexico. . . . Careri's descriptions have that touch of local color only found in those who have had the advantage of seeing with their own eyes."

Ironically, Humboldt's description of the Teotihuacan complex appears to have been seen through Careri's eyes.

Pyramid of Cheops as model of earth's Northern Hemisphere.

Humboldt could hardly have surveyed the Sun and Moon pyramids at Teotihuacan as being oriented "within 52 mintes exactly placed from north to south and east to west," as he describes them, when they were, and are, in fact, oriented more than 15 full degrees (or almost 1000 minutes) east of true north. A surveyor as preoccupied as was Humboldt with accurate calculations of latitude and longitude (who observed an error of mere seconds of arc in the location of Acapulco, and who calculated the latitude of the eastern tower of the cathedral of Mexico to within 600 feet of the modern calculation) is unlikely to have been capable of so gross an error. Humboldt also described the slope of the Sun Pyramid as being 52 degrees, very similar to that of the Great Pyramid of Cheops, when in fact the Teotihuacan slope is a much gentler 43 degrees, 35 minutes—an error of more than 10 degrees. Humboldt also erroneously described "a system of smaller pyramids about 10 meters high, several hundred of them along wide avenues which follow precisely the line of parallels and meridians leading up to the faces of the pyramids."





Herschel suggested that the most practical system of measures should be based on the length of the polar axis of the earth which he believed had been calculated in antiquity as 20 million Pyramid Sacred Cubits. This gave an ancient inch within one part in a thousand of an English inch. The notion first propounded by Isaac Newton was used by astronomer Charles Piazzi Smyth as the basis for his often incorrect but brilliantly intuitive conceits about the Great Pyramid and ancient units of measure.

Equally amazing is the fact that Humboldt, who was such a dedicated astronomer and geographer, should have missed the geodetic and astronomic functions of pyramids, whereas his contemporary colleague, Edmé François Jomard, with whom he was to have traveled to Egypt on Napoleon's expedition, and with whom he later corresponded, had brilliantly confirmed the scattered reports of classical Greek authors to the effect that the Pyramid of Cheops was a geodetic scale model of the Northern Hemisphere whose apex represented the North Pole and perimeter an exact fraction of the equatorial circumference of the earth—or 1/2 a minute of degree.

The only reasonable deduction is that Humboldt never visited the Teotihuacan complex, or if he did, did so in a manner so cursory that he might as well have never seen it. A careful reading of Humboldt on Teotihuacan shows him to be most circumscribed in his description, never using the first person.

For the dimensions of the pyramids he had the work of Oteyza, who had recently measured the Sun Pyramid's base at 208 meters or 665 English feet; again, because of the rubble at its base, about 8 meters or 24 feet short. To convey to Europeans an idea of what this meant, Humboldt pointed out that the northerly facade of the Hotel des Invalides in Paris, where Napoleon was eventually to be buried, was exactly 600 feet long—in French feet or *pieds du roi,* the sixth of a toise, or one French fathom. In English feet this would have been 636. Confusing, but indicative that somewhere there might be a relation between the pyramids of Egypt and those of Teotihuacan, in that 600 Egyptian feet had been found by Jomard to be one Egyptian stadium, or 1/10 of a mile, equal to 6 seconds of arc, or 1/600 of a degree of longitude.

To convey an idea of the cubic capacity of the Sun Pyramid, Humboldt relied on Oteyza's estimate of 33,743,201 cubic French feet, though actually Oteyza had measured in neither French feet nor English feet, nor even in meters, but in the Mexican *vara,* one of which consisted of 31 inches of the old *pied du roi*; all of which made it hard for anyone but a mensurational aficionado to be moved by the fact that Humboldt and Oteyza considered the height of the Sun Pyramid to be 171 French feet or 180 English—equal to 2160 English inches.

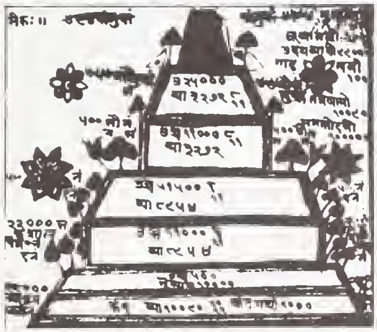
Curious as to whether the pyramids of Teotihuacan had been built entirely by man or whether the builders had taken advantage of natural hillocks to cover with stone and cement, Humboldt tended to the conclusion that they were entirely man-made, saying "their position in a plain with no other hills makes it unlikely they were built on outcroppings." He also concluded that the Indian tradition that the structures were hollow was too vague to credit and that until the pyramids were pierced horizontally there would be no way of knowing.

Humboldt was amazed that whoever built these pyramidal structures should have done so in a manner so similar to the Ziggurat of Belus in Babylon, the remains of which he had observed. It led him to wonder whether the constructors had been allied to a Mongolian race from the East, as had first seemed plausible, or whether they were somehow linked to the Middle East, as indicated by the botanical and geological data. Again Humboldt was apparently unaware that the ziggurats of Mesopotamia had also been constructed as geodetic scale models of the Northern Hemisphere, like a stack of diminishing blocks, each facade of which gave a rectangular Mercator-like projection of the seven classic zones between the equator and the pole.

Humboldt disputed the attribution of construction of the pyramids to the Toltecs, which would have placed them in the eighth or ninth century A.D., and was inclined to favor Sigüenza, some of whose manuscript notes he had read, who attributed the pyramids to the Olmecs, the first people mentioned in the Indian chronology of New Spain, who were supposed to have come from the East, or even from Europe.

Humboldt referred to the Toltec leader Quetzalcoatl as a "Mexican Buddha," and he was amused to quote Spaniards who described him as white, bearded, and accompanied by strangers wearing black soutanes, saying they believed him to be either a Carthaginian or an Irishman, either possibility of which Humboldt was not ready to envisage.

Though Humboldt's description of the Teotihuacan complex appears to be secondhand, he devoted firsthand attention to the Great Pyramid of Cholula. After eleven months in Mexico, Humboldt decided to leave via Veracruz, stopping at



Humboldt found the Cholula Pyramid to be the largest in America, a truncated structure with four terraces, 367 feet from east to west, by 348 feet from north to south. It appeared to have been in constant use up till A.D. 1200. The interior he found to be made of mud and small stones covered by a thick wall of amygdaloid porense. On the outer layer were stones bound together by traces of mortar called *tetzontli* by the natives.

The mound could be entered through a small opening on the eastern side. Inside was a bewildering maze of passages, with here and there a frescoed wall adorned with butterflies and insects in yellow or black, and the evidence of seven superimposed constructions.

Humboldt says the pyramid had been surmounted by a jade image of Quetzalcoatl, "Lord of the Breath of Life." The Cholula Pyramid is the largest known structure in the world in terms of cubic content. Two hundred and ten feet high, it covers forty-five acres. The pre-Conquest Mexican legend about Cholula is very similar to the Biblical account of the Tower of Babel. According to the legend, after the deluge which destroyed the primeval world, seven giants survived, one of whom built the great pyramid of Cholula in order to reach heaven, but the Gods destroyed the pyramid with fire and confounded the language of the builders.

On September 16, 1810, Miguel Hidalgo y Costilla, a parish priest in the dusty little town of Dolores in the province of Michoacan, raised the cry which came to be known as the "Grito de Dolores," calling for an end to Spanish rule in Mexico. Hidalgo, who was born in Dolores, a few miles from San Miguel Allende (named for his co-insurrectionist, Captain Ignacio Allende) was a tall gaunt second-generation *criollo,* trained by the Jesuits, impressive in his black cassock and white-fringed hair.

His revolutionary ardor came from having watched government constables chop down the olive trees, vineyards, and mulberries he had taught his parishioners to grow, in contravention to the Peninsular law against the production in the colonies of olive oil, wine, or silk.

Naming himself "Captain General of America," he seized the icon of the Virgin of Guadalupe, the Morenita, most holy of all symbols to the native Indian, as banner for his army. Spaniards and officials fled before him. But at the gates of Mexico City, which the more intrepid Allende wished to attack, Hidalgo vacillated. When his forces turned to indiscriminate pillage and massacre, the *criollos,* who also longed for liberation from Spain, became afraid for their lives, especially after the example of Haiti, where native blacks had slaughtered all the native whites. The *criollos* supported the Spanish Viceroy, who ordered the summary execution of all rebels taken in arms. In recaptured towns, one man in ten chosen by lot was hanged or shot. Hidalgo's forces retaliated by garroting Spaniards. The Spanish retaliated by burying their enemies in quicklime.

Defeated and captured, Hidalgo was shorn of his vestments. Shot by a firing squad, on July 30, 1811, his skull was hung in an iron cage as a deterrent to further revolution.

Puebla to inspect the enormous pyramid, which he described as "a mountain of unbaked bricks" once dedicated to Quetzalcoatl, whom he regarded as "the most mysterious being in the whole Mexican mythology," a hero whom he now believed to have reigned much earlier, in a Golden Age of the Anuacs, "when all animals and all men lived in peace, and the earth brought forth without culture the most fruitful harvests, the air being filled with birds of marvelous song and plumage."

On his way from Puebla to Veracruz Humboldt noticed ice carriers from the snowfields of Mount Orizaba bringing ice to the sherbet makers of Veracruz, much as the Ottoman refiners of sherbet had brought it in carts to the Sublime Porte from the peaks of Mount Olympus.

Determined to visit Thomas Jefferson, a fellow naturalist, democrat, creator of an effective democracy, and brother

After Hidalgo's execution, the banner of revolt was taken up by another priest, José Maria Morelos y Pavon, who was of mixed Spanish, Amerindian, and Negro origin. Born in Michoacan, he had worked as a laborer and muleteer until he was 25. Starving himself to gain an education, he entered holy orders, where he studied under Hidalgo.

A short, squat man, Morelos was a taciturn and humble genius, ravaged by malaria and constant headaches, against which he wore a tight bandana over his balding head. Too radical for the *criollos,* who longed for Mexican independence, Morelos drove them into the royalist ranks. They feared the insurgent warfare would destroy the economy: already, commerce and agriculture were at a standstill.

Morelos was betrayed by an auburn-haired mestizo, Augustin de Iturbide, who managed to pass himself off as a *criollo* and tell all he heard about the revolutionaries to the royalists, for which service he quickly rose from lieutenant to colonel in the royalist army. When he learned that Morelos had ordered his insurgents to blacken their faces so that they could recognize each other in close combat, Iturbide, against orders, had a troop of his cavalry darken their own faces. After dark on Christmas Eve of 1813, Iturbide led a reckless mounted charge into the heart of the Morelos camp, bursting in upon the surprised insurgents. Morelos' regiments fired on each other, and the insurgent army dissolved in the face of inferior royal forces. A royalist officer, one of Morelos' old lieutenants who had changed sides, caught Morelos as he tried to remove his spurs for flight. Asked what he would do if the situation were reversed, Morelos replied he would confess the officer and shoot him. Convicted of treason and branded as a Protestant, Morelos was unfrocked and shot to death three days before Christmas 1815.

Mason, Humboldt sailed from Veracruz to New York in March of 1804, loaded with minerals, plants, sculpture, and the few ancient manuscripts he had managed to collect, all of which were to help him produce several volumes on his travels in the Americas, which, when published in expensive folio editions, opened the eyes of Europe to the astounding possibility that a civilization had existed in the Americas far more cultivated and knowledgeable than anyone had theretofore believed, scotching the general opinion that the Indians conquered by Cortes were nothing but barbarous feathered sodomites devoted to the worship of monstrous serpentine idols to whom they ghoulishly sacrificed thousands of victims.

Humboldt's stay in Mexico caused him to be suspected of having helped foment the Mexican revolution against Spain which broke out a few years after his departure. But although he had been sought out by sensitive souls because of his philosophical and metaphysical bent, and by liberals and political actionists because of his penchant for liberal and egalitarian doctrines and his open pronouncements against the economic and social system of exploitation in New Spain, Humboldt must have considered himself too indebted to the crown of Spain, for receiving him so well and granting him such freedom, to risk writing what might have been considered subversive to his royal benefactor. But with or without his help, the revolution broke out a few years after his departure.

For a long time Humboldt dreamed of going back to Mexico.

Iturbide.

Having risen to the rank of general in the royalist army fighting against the insurgents, Augustin de Iturbide grew so rich on graft he overstepped himself by taking too much from a convoy of silver he was supposed to protect. Disgraced, he entered a lay retreat in the convent of La Profesa, where he plotted a revolt against the viceregal regime to detach Mexico from Spain. To subvert the army, he seized an entire pack train carrying half a million silver pesos to Acapulco. Making lavish offers of promotion, Iturbide managed to lead his army into Mexico City in September of 1821, riding on a black horse and wearing a plumed hat, surrounded by a gang of new generals decked in gold braid. As president of the council of regents, Iturbide fomented a barracks revolt to have himself proclaimed Emperor Augustin I. Of the first year's national income, 80 percent went to the army, 11 percent to Iturbide, and the rest to administer a country whose economy had been ruined by ten years of civil war. When congress complained, Emperor Augustin I disbanded it and ruled by decree in imitation of Napoleon I. But others could play the same game. One of Iturbide's lieutenants, Antonio Lopez de Santa Anna, who had risen to the rank of general, called for a republic (though he admitted candidly he did not know the meaning of the word), and Iturbide was sentenced to perpetual exile.

Once the revolution, which started in 1810 and dragged on for ten years, had rid Mexico of Spanish rule, he would have liked to return to organize "a great scientific establishment for all of Free America." In October of 1822 he wrote to his brother Wilhelm from Verona that "the Emperor of Mexico, Iturbide, whom I know, is about to fall and make way for a Republican government. . . . I have the notion of ending my days in a pleasanter way and more useful for science in a part of the world where I am extraordinarily well liked, and where everything indicates I would be happy. It is a way not to die without some glory, to unite around me many educated people, and enjoy that independence from opinions and feelings which is necessary to my well being."

Humboldt wished to make a base in Mexico City from which to explore all the places he had only heard of or written about secondhand. But his expensive publications cost too much of his fortune, and though there was mention that in France 4 or 5 million francs were being collected to reorganize the mines in Mexico, nothing came of the venture, and Humboldt, growing old and depressed, was obliged to live out his life in the constricted atmosphere of the court at Potsdam without ever seeing Mexico again.

His large illustrated works, however, were to spark an unquenchable interest in a whole new breed of adventurers who set out to explore the antiquities of Mexico.

5. British Enterprise

Antonio Lopez de Santa Anna.

William Bullock, a Liverpool jeweler, amateur naturalist, and antiquarian, was so impressed by Humboldt's massive volumes on Mexican antiquities that he decided to travel to Mexico and bring back specimens of his own to exhibit in London to a public whose taste for the exotic had been stimulated by the recent discoveries of Napoleon's savants in Egypt, just published in the monumental twenty-volume *Description de L'Egypte.* As a merchant, Bullock was in the *avant garde* of a whole company of English entrepreneurs who wished to profit by trading with an independent Mexico open to foreigners.

In December of 1822 Bullock sailed for Veracruz in the company of his twenty-year-old son aboard an English merchantman armed with twelve cannon for protection against ubiquitous pirates. Though he had been told to expect "the most stable government" in Mexico, Bullock found the port of Veracruz in the hands of republican insurgents under General Antonio Santa Anna, while the self-appointed Emperor Iturbide had retreated to Puebla with his royalist army.

Heading for the highlands, the Bullocks were disappointed by their first wayside inn, where they were kept awake by mosquitoes, barking dogs, and braying asses; in the morning they were obliged to "clean our persons from the deposits of the poultry that had roosted over our heads."

In Puebla, the first impressive city reached by the Bullocks, they learned that the emperor had resigned the government into the hands of the republicans and fled the country, which had installed General Santa Anna as president of the Mexican republic; so the Bullocks followed Humboldt's footsteps to Cholula, where they examined the ruins

Veracruz.

Villa Rica de Vera Cruz, or the Rich Town of the True Cross, had been a mere campsite of huts until Cortes declared it a town as a device to bypass the authority of his boss Velasquez in Cuba so as to seize Mexico for the crown in his own name. By having himself elected chief magistrate of the municipality of Veracruz, Cortes became directly subordinate to Charles V and so cut Velasquez out of a fifth of the booty. Thereafter Vera Cruz became the port of entry to Mexico from Europe.

To Bullock, Veracruz had an Oriental look, with low cupolas, something like mosques without the elegance of minarets. To the south were the cemetery and the slaughterhouse, to the north the flat yellow-fever marshlands inhabited by iguanas, snakes, herons, and wild duck.

Whereas Careri had complained of being devoured by field lice, Bullock found the city hot, dusty, and with filthy streets cleaned of offal by carrion vultures. Humboldt, more scientifically, had noted that all the buildings were built of stone dredged up from the sea, called *madreporicas,* there being no other stone available.

of the pyramid, which they found covered with prickly pear, tuna, copal, and other vegetation, on top of which the Spaniards had built an imposing church.

"It was here," noted Bullock, with his penchant for establishmental history, "that Cortes, on his first advance, was welcomed as a liberator and brother, but having accidentally discovered that it only arose from a deep-laid plan to assassinate him and all his followers, he, with his accustomed presence of mind and decision of character, secured the chief persons of the place; and, to strike terror in others, made a terrible example, by putting to death 70,000 of the inhabitants."

In the spring of 1824, Iturbide, like Napoleon returning from Elba, tried to recapture his empire, landing by boat at a port in Tamaulipas with a packet of paper money and printed proclamations, unaware that the congress had voted a bill of attainder if he ever set foot again on Mexican soil. The local authorities seized and shot him.

A good bourgeois, Bullock was as impressed by the broad streets of Puebla that were paved with large stones in checkered or diamond patterns as he was by the splendid equipages and retinues of the wealthy Pueblans, whose handsome carriages were drawn by richly caparisoned mules attended by servants in showy liveries, parading through the streets and parks.

To show the flag, and *épater* the natives, Bullock sported a walking-stick gun, a portable chair and table, a camera lucida,* "and other little specimens of English ingenuity."

Approaching Mexico City, the Bullocks came upon suburbs they considered "mean and dirty, the people covered with rags," but they were well pleased by the center of the city with its wide streets and grand houses.

* The camera lucida is an optical instrument for drawing in perspective, invented at the beginning of the nineteenth century by an Englishman, Dr. William Hyde Wollaston. By looking with one eye vertically through a strip of plain glass tilted at an angle of 45 degrees, an image is reflected onto the surface of a sheet of paper so that the outline can be accurately traced with a pencil. A helpful device for transferring architectural structures onto paper, it had the advantage of being cheap, small, and portable.

Whereas in Puebla Bullock was astonished to find that the wives of mining magnates kept houses in a princely state, and would go to church escorted by hundreds of servants and twenty ladies in waiting, in Mexico City Bullock was most impressed by the streets, which were two miles long, perfectly level and straight, ending in a gorgeous view of the surrounding valley with snowcapped volcanic mountains in the distance.

As snobbish as any merchant, Bullock was happy to secure the services of Count Luchese, uncle to the Duke of Monteleone, a descendant and heir of Hernan Cortes, to guide him through the city. Luchese graciously escorted his English visitors around the 700-foot-long palace of the viceroy with its 1,100 windows overlooking the Plaza Mayor, which Bullock deemed to be "the finest in the world." In the palace grounds they saw not only the mint and the prison, but a botanic garden with fountains and fragrant plants unknown to Europeans before Humboldt, aflutter with pretty, tame birds.

In the Hospital of Jesus, Bullock was even shown an iron chest in which were kept the bones of Cortes. Thirty years earlier these grisly remains of the conquistador had been removed to the hospital from the Church of St. Francis to be venerated in a crystal coffin secured by bars and plates of silver, and were only just saved by royalist "friends of the family" from a mob of republicans who wished to scatter to the winds the bones and ashes of this "detestable old Spaniard." Pensively Bullock examined the skull, which he found to be small, with some missing teeth. Later scrutinizers found evidence in the bones of degenerative symptoms corresponding to dwarfism and a condition of congenital syphilis in the osseous system.

In the city, the English merchant was most impressed by the comfort of the three-storied houses, painted in dis-

Bullock found that the sumptuous house of Emperor Iturbide had been turned into a stagecoach hotel.

temper, highly decorated, with rows of wrought-iron balconies and porticoed courtyards scented by flowers and trees. He thought the climate ideal, a perennial spring, and was enraptured by the clear atmosphere, not yet contaminated by smog, a bourgeois's dream, in which even the execution of a felon appeared to be done in a "solemn and decent manner," so different from the executions he had witnessed in France after the revolution, where "the rabble behaved with the most disgusting ribaldry and obscenity." Here the victims, two Indians accused of robbery and sacrilege, were led to the public scaffold on the backs of asses, dressed in white gowns and caps with red crosses, there to be discreetly garroted "without the public witnessing the horrible contortions often seen in our executions."

Officers of the Inquisition leading "heretics" to the stake.

As Humboldt had declared that apart from the nearby pyramids of Teotihuacan the only objects in Mexico City worthy of the notice of an antiquarian were the great calendar stone and another "sacrificial" stone found near it, Bullock decided to make large plaster casts of both to be shipped to London. With the influence of the Mexican prime minister he was able to obtain permission from the clergy to erect a scaffold by the Aztec calendar and take several separate impressions. Bullock believed the stone to have once formed part of the roof of the great temple of Tenochtitlan, much like the Zodiac of Dendera, the original of which had only just been dismantled and carried to the Louvre. Like Humboldt, he considered the Aztec stone "proof of the perfection the nation to which it belonged had attained in some of the sciences." Few persons, he maintained, even in the most enlightened cities of Europe, would have been capable in his day of executing such a work.

A hundred yards from the calendar stone the so-called sacrificial stone lay buried in the cathedral square with only

On the upper surface of this monolith there are 6 × 6 = 36 single glyphs, which yield 9 groups of 4. If these 9 × 4 are added to the 4 × 4 glyphs on which the chieftains are respectively seated, 13 groups of 4 are obtained, equivalent to the 52 years in the Mexican cycle. Each group is accompanied by the name of a tribe and its capital. Again it took a hundred years before some meaning was found for these mysterious glyphs.

its upper surface exposed, "to impress on the populace," says Bullock, "an abhorrence of the horrible and sanguinary rites that had once been performed on this very altar."

From the clergy Bullock again obtained permission to expose the sides of the stone and to make casts of the twenty-five-foot circumference on which were carved fifteen groups of figures representing the conquests by Mexican warriors of different cities. The casting performance greatly aroused the curiosity of bystanders, who, says Bullock, wondered if the English still worshiped the same gods as had the Mexicans before their enforced conversion to Christianity.

But the antique relic which most appealed to Bullock and on which he most counted to shock or titillate a London audience was reported by Humboldt to have been dug up and reburied in a gallery of the University of Mexico by Dominican priests who considered it too scandalous to be viewed by Christian students.

Bullock had great difficulty persuading the authorities to let him dig it up, but with the help of Humboldt's friend Don Manuel del Rio, who had graduated to professor of mineralogy at the university, he finally obtained permission. The burial spot was ascertained with not too much difficulty, and a few hours' digging disgorged from mother earth the Mexican goddess of earth and mother of the entire Nahuatl pantheon.

"I had the pleasure," says Bullock, "of seeing the resurrection of this horrible deity, before whom tens of thousands of human victims had been sacrificed in the religious and sanguinary fervor of its infatuated worshippers."

To Bullock it was scarcely possible that an artist "combining the ingenuity and imagination of a Brueghel and a Fuseli"

In Bullock's time, the university was a mere survival of medievalism in government and curriculum, the men of learning of the viceroyalty being dedicated to the perpetuation of a doctrinal theology that was already becoming obsolete.

could have conceived so awesome a sight. Bullock described the "colossal and horrible monster" as being hewn out of one solid block of basalt, nine feet high, its outlines giving the idea of a deformed human figure "uniting all that is horrible in the tiger and the rattle-snake." Instead of arms the figure was supplied with large serpents, its drapery was wreathed snakes, interwoven and terminating in the wings of vultures. The "idol's" feet, between which lay the head of another rattlesnake descending from its body, were those of a tiger or jaguar, claws extended in the act of

Coatlicue.

This squat, massive twelve-ton basalt statue, embodying pyramidal, cruciform, and human forms, dug at Bullock's request, and which he considered monstrous, was quickly reburied by an outraged priesthood. Only later was the statue understood to incorporate the essence of Nahuatl cosmological thought. "Nowhere in the history of art," says Professor Leo Gatz, "has a single monument achieved such a complete synthesis of human and abstract universal relations."

In the opinion of Mexico's art critic Justino Fernandez the statue represents "the embodiment of the cosmic-dynamic power which bestows life and which thrives on death in the struggle of opposites."

To Frank Waters, Coatlicue emerges as the concrete embodiment in stone of the ideas of a cosmic being who generates and sustains the universe. "It adumbrates the cruciform orientation of the quadrants of the universe, as well as the dynamic quality of time, which creates and destroys through struggle."

Author Lewis Spence points to the strong similarities between Coatlicue of Mexico and the goddess Cleito, wife of Poseidon, founder of Atlantis: each, says Spence, presided over a Sacred Hill, and each bore seven sets of twins, two of whom—Atlas and Quetzalcoatl—were mountain-born supporters of the world.

seizing a prey. A necklace, above huge deformed breasts, was composed of human hearts, skulls, and chopped-off hands fastened together by entrails. It took Bullock a week to make a cast of Coatlicue, as the goddess was called, whereupon the university authorities ordered the statue reburied "so as to hide it from the profane gaze of the vulgar."

His casting completed, Bullock was free to visit the pyramids of Teotihuacan. On Whitsunday of 1823, accompanied by his son and a co-national, Mr. Gilton, Bullock set off toward Texcoco with an Indian guide and letters of introduction furnished by the viceroy's wife, the Countess of Regla, to the principal inhabitants of this onetime capital.

Leaving the great square of Mexico City, the Bullocks passed a thousand horses and mules loaded with silver being prepared to leave for Veracruz to be shipped to Europe.

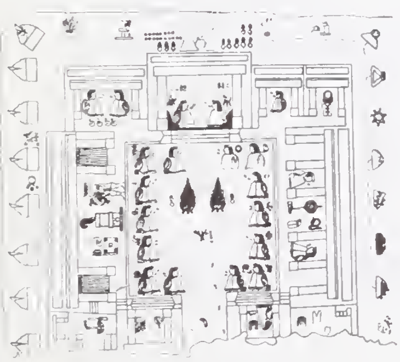
Thereafter for several miles they proceeded along the original causeway across the old lake of Texcoco, which seven weeks earlier at their arrival in the city had been covered with water and myriads of shoveler ducks but was now dry for lack of rain.

Gardens of Texcoco.

Approaching Texcoco—the Athens of America, as Bullock termed it, "residence of historians, orators, poets, artists, and the great men of every department of the sciences who existed in those days"—they crossed the "Bridge of Brigantines" from which Cortes had launched his flotilla to recapture and destroy Tenochtitlan.

In the market place of Texcoco they viewed the spot where Bishop Zumarraga had burned the Aztec heritage of manuscripts and hieroglyphic writings.

Bullock was much moved by the palace of the ancient caciques, or tributary kings of Texcoco, which extended three hundred feet, forming part of a large square built up on sloping terraces, the original walls of which were composed of huge blocks of basaltic stone, four and five feet long, two to three feet thick, cut and polished with great exactness, many of which had gone to build the nearby Catholic church.



Sixteenth-century drawing of an older map of the palace court of Texcoco.

As the sky darkened with thunder clouds, Bullock inquired about the "celebrated pyramids of the Sun and Moon, or for San Juan of Teotihuacan." But his inquiries were fruitless, so he headed for Otumba in the expectation of finding them near that place.

For a couple of hours they rode over fine country on which the number of handsome Spanish churches and haciendas exceeded those of any part of Mexico through which Bullock had yet traveled.

At one point he passed a stand of olive trees, the finest he had ever seen. "Those of Tuscany are not half the size; they

must many of them be thirty feet in diameter." At the foot of some low mountains Bullock described the landscape as being soft iron-colored stone without vegetable soil or vegtation, in which the continual passing of horses had worn deep tracks up to the knees of animals.

By evening, thunder turned to torrents of rain, which filled the dry beds of the rivers, pouring muddy waters toward the great flat lakes.

On the far side of the mountain, Bullock at last caught sight of the two great pyramids on the plain before them, five or six miles away; an hour's ride brought them to Otumba just before dark, "the first place," noted Bullock, "reached by Cortes after his defeat of *La Noche Triste*." An old lady gave them refuge in a carpenter's shop where they could dry their clothes and sleep. In the morning, after bread and hot chocolate, they queried the local padre for information about the pyramids, but he could give them none, though they were in full view of the windows of his house, about a league and a half away.

As Bullock and his party approached the shrub-covered mounds, they could see the "square and perfect form of the largest," and distinguish its terraces. Attacking the smaller pyramid first, they found it much dilapidated, but ascended to its top over masses of falling stones and ruins of masonry with less difficulty than they had expected. On the summit Bullock found the remains of "an ancient building, forty-seven feet long and fourteen wide with walls three feet thick and eight feet high, mostly of unhewn stone with three win-

Bullock's illustration of the Sun Pyramid on the summit of which he says he found the remains of an ancient temple.

dows on each side." The northern end of the building appeared to them to have been divided at about a third of its length.

Bullock says that he and his companions sat atop the Pyramid of the Moon, with the great Pyramid before them, "contemplating this scene of ancient wonders." His eye took in not only the greater part of the Valley of Mexico, with its surrounding mountains, but also Mexico City, some thirty miles away, a feat quite impossible now because of the smog.

Cortes winning the battle of Otumba by killing the "snake woman" leader of the Aztec forces.

Bullock was of the opinion that when Cortes came through the valley the large pyramids were in the same condition in which he found them—covered with dirt and shrubbery—and that it was on ascending one of them that Cortes was able to see the approach of the great Indian army which Francisco de Aguilar (who was with Cortes at the time) estimated at the incredible number of "five to six hundred thousand selected men." Bullock says there was no other eminence nearby which could have answered the purpose, concluding that "It was at this place that Cortes fought and defeated the innumerable army of Indians; after the horrible night of desolation he expressly says that he arrived on the plains near Otumba; he ascended an eminence, and discovered the whole district covered with armies; despair filled every breast, except the intrepid leader's." Paraphrasing Bernal Diaz' account of how a mere four hundred wounded and weary Spaniards with two score

Pulque is a liquor made from the fermented juice of the maguey plant, whose flower grows as high as 20 feet, with 10-foot leaves. Some yield as much as 600 liters of liquid, drawn from a hollow in the center, from which first honey then pulque is derived.

For the Aztecs, pulque was not only a nutritive drink but a medicine and a ritual intoxicant related to their complex pantheon. It was also given to conquered warriors about to be immolated.

Excessive drinking of pulque was controlled among the Aztecs, if not eliminated, by a taboo on the "fifth cup." This was reserved for priests, in whom it induced an ecstatic reaction, often causing them to dance. Even a fourth cup was frowned upon, since it might result in drunkenness, a punishable offense in Tenochtitlan except in privileged cases (the sick, the aged, or celebrants at certain festivities).

The early Spanish churchmen considered pulque detestable, the cause among Indians of "idolatry, thieving, murders, sacrilege, sodomy, incest and other abominations.' But the viceregal government soon used it as a source of revenue, the tax bringing in a yearly 100,000 pieces of eight.

When the green leaves of the maguey are crushed and the fibers separated on a stone with water, hemp is produced from which cloth can be woven which takes the place of linen. Ropes are also entwined. The spines are used for needles; and the leaves, when intact, can be used to roof houses. The shoots nearest the earth, which are white and tender, can be cooked and eaten. Dry, the leaves provide fuel for a gentle smokeless fire, whose ashes are medicinal. When the root is drawn from the center of a dead plant it can be used as a rafter.

horses got out of this iron trap, Bullock pontificated romantically: "The unnumbered host of Indians arrived, and closed round the small band of Spaniards, when the dauntless Cortes, with a few horsemen, charged furiously that part of the enemy where the royal banner was carried, the bearer was killed, the banner taken, and the whole of the immense multitude fled in consternation from the field, offering no further interruption to the retreat of Cortes."

Bullock's romancing led to the conjecture that the Indians, like the Trojans in a Homeric epic, were overcome by what they considered supernatural forces, as if the Spaniards were demigods descending on them from Teotihuacan, the "home of the Gods."

At the base of the Moon Pyramid Bullock had a drink of pulque and tried to make friends with some native children, but they "seemed much terrified at our white faces and odd dress." To Bullock the smell of fresh pulque was acceptable, but very disagreeable when matured to the point it was appreciated by the Mexicans.

When Bullock asked an old woman if she could tell him who had built the pyramids, she replied, *"Si, señor. San Francisco."*

According to an old legend told to Sahagun, a woman, Mayahuel, later regarded as a goddess, and the mother of Centzon Totochtin, the patron of Tepozteco, invented pulque and knew how the maguey should be pierced in order to extract the honey. In the Borgia Codex, which originated in Puebla or possibly Tlaxcala, Mayahuel is a prominent figure dressed in white, the color of pulque. The Borgia Codex also shows another pulque god, Patecatl, who discovered how to supplement the honey from the maguey to aid in the fermentation process. His name, like that of his associate deities, was taken from the locality in which he was worshiped. Several place names survive to identify the first makers of pulque with a mountainous place called Chichinahuia. Because this drink was topped with foam, the snowcapped peak was also called Popocatepetl, meaning "Foamy Mountain."

The Codex Magliabecchiano, probably painted between 1562 and 1601, has several representations of pulque deities, including Mayahuel and Atlacoaya. Eduard Seler noted that the face of a pulque god was usually painted in two colors, one half in red and the other in black or dark brown with yellow spots. This decorative scheme also characterized representations of Tlaloc and Quetzalcoatl. Pulque deities were further distinguished by a crescent-shaped ornament worn directly under the nose.

Not far from the great pyramid, near a gate, they found an enormous stone with sculptured ornaments, which appeared to Bullock to be of great antiquity. A boy who had followed them beckoned Bullock's son toward a plantation where they found another great stone covered with sculpture with a hole in the top, which Bullock supposed to be a "stone of sacrifice."

The ascent of the large pyramid was less difficult than they expected. All the way up they found lime and cement mixed with fallen stone. Bullock described the terraces as clearly visible, particularly the second, which he estimated to be about thirty-eight feet wide, covered with a coat of red cement eight or ten inches thick, composed of small pebblestones and lime. But in many places, the copal trees had destroyed the regularity of the steps, though "nowhere injured the general figure of the square," which, Bullock says, "was as perfect in this respect as the great pyramid of Egypt."

Wherever they climbed, the party found broken pieces of obsidian knives, arrowheads, and spear heads. On reaching the summit, they came upon "a flat surface of considerable size, but which had been much broken and disturbed." Here they rested and again Bullock rhapsodized on the view which included the city of Mexico some thirty miles distant.

On top of the pyramid Bullock found fragments of small statues, earthenware, and, surprisingly, oyster shells, the first he had seen in Mexico. On the way down they picked up several ornamental pieces of earthenware, the relief pattern on one of which resembled those of China.

Bullock says that on the northeast side of the Sun Pyramid, about halfway down, an opening had been attempted at some remote period. He maintained that any passage should have been from south to north, on a level with the ground, or only a few feet above it, as "all the remains of similar buildings have been found to have their entrances in that direction."

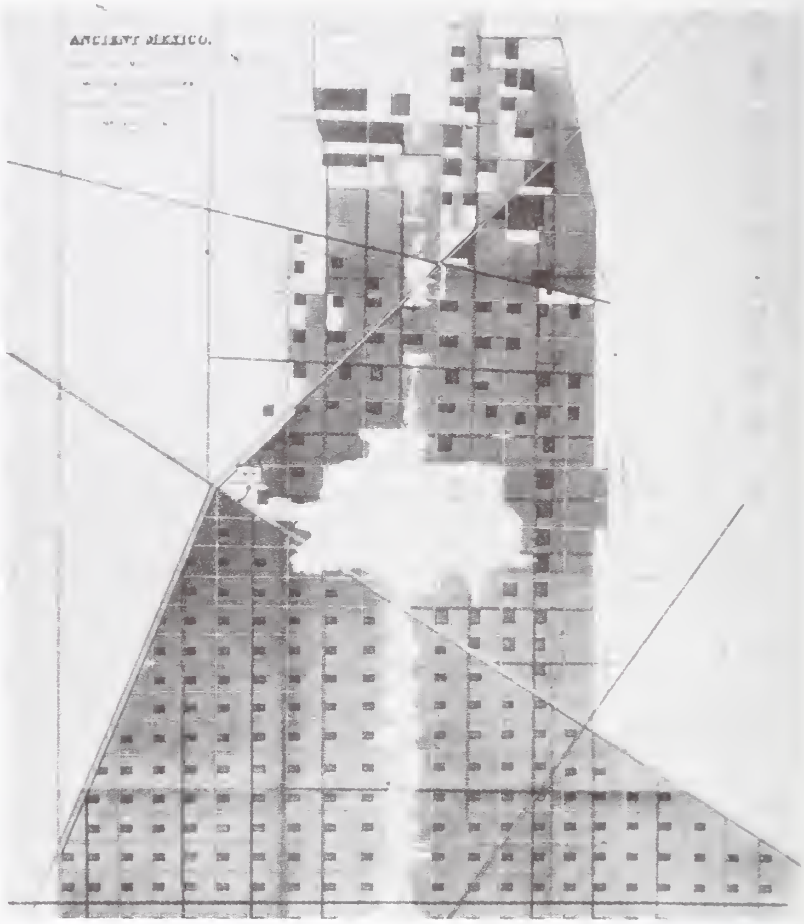
In the village of San Juan Teotihuacan, Bullock and his party procured refreshment and provender for their horses. By evening they reached the town of San Cristobal, once again soaked with rain, having come by way of the long causeway built to prevent the flowing of the waters of the Lake of San Cristobal into that of Texcoco; thence they returned to Mexico City by way of Guadalupe.

Much impressed by the monumental ruins of Teotihuacan, Bullock was amazed that no one in Mexico City seemed to care the least about them or could give him any information regarding them. His three-day excursion had convinced him of the veracity of accounts of ancient Mexican splendor such as were given by Francisco Clavigero; what he had seen enabled Bullock to discount the theories of such denigrators as De Pauw and Robertson. "Had Monsieur Pauw," says Bullock, "or our better informed countryman Robertson, passed one hour in Texcoco, Tezcotzingo, or Huexotla, they would never have supposed for a moment that the palace of Montezuma in Mexico was a clay cottage or that the account of the immense population was a fiction."

Further to convince his compatriots of the splendor of ancient Mexico, Bullock had models made of the Teotihuacan pyramids to be shipped to England. He then set off on the return journey via Puebla and Veracruz, this time carried on a litter strung between two mules, taking with him a menagerie of several armadillos, deer, parrots, curassow birds, quans, and tiger cats, most of them running around loose, to the dismay of his Puebla hostess. He also took with him a variety of flowers and ornamental plants as yet unknown to European botanists. His extensive collection of preserved animals and birds astounded the natives, who could only imagine they were being taken to his homeland for medicinal purposes.

Typically, what appealed most to Bullock from his stay in Mexico were the parts of the countryside which reminded him most of Devon; fields covered with verdure, woods with

Collection of calendar stones and "idols," reproductions of which Bullock took back to England for exhibit.



Map of Tenochtitlan.

Among the mementos of manuscripts and hieroglyphic pictures brought back to England by Bullock was an original map of the ancient city of Tenochtitlan made by orders of Montezuma for Cortes to be transmitted to the King of Spain. The map shows how the city was divided into squares with chinampa gardens linked by canals and pathways.

Tenochtitlan was a chinampa city with six to eight plots to each house, each chinampa about 300 feet long and 15 to 30 feet wide. The map shows the profile of each householder and his name.

flowers and blossoms and fruits, hills smaller and more diversified than in England, "clothed with trees, shrubs and flowers in such endless variety that no part of Europe can vie with it."

What he liked least were the bullfights, with their tearing, mangling, and killing of bulls, horses trailing their entrails, and the wounded and dying matadors who gave "as exquisite delight in Mexico as Madrid."

Back in London, Bullock the impresario redecorated his "Egyptian Hall" for an exhibition of Mexican curios. Avid Piccadilly strollers could now view the "monstrous" Coatlicue and the Aztec calendar stone—which came to be known as "Montezuma's Watch." Except for a few rare Aztec manuscripts and the drawings in Humboldt's expensive folios, these were the first Mexican antiquities to reach Europe, the "first exotic peep at pre-Columbian America."

On the profits of the exhibition, Bullock acquired a silver mine in Mexico and would have dropped into oblivion except for the publication by John Murray of a booklet, *Six Months Residence and Travels in Mexico,* in which Bullock summed up his Mexican adventures.

6. Spanish Reappraisal

In their concentration on the pyramids of Teotihuacan and and the Aztec calendar stone, Humboldt and Bullock managed to miss a whole world of ancient and amazing ruins in the lower-lying jungles of Chiapas, Yucatan, and Guatemala. During the next two decades these ruins were to intrigue Europeans and North Americans as greatly as had the discoveries of Napoleon in Egypt.

The first to be discovered included a pyramid which many years later was to reveal a secret walled-up burial chamber as impressive and difficult of access as had been the so-called King's Chamber in the Great Pyramid of Cheops in the time of Caliph al Mamun.

In 1773 Friar Ramon de Ordoñez y Aguilar, canon of the cathedral town of Ciudad Real in Chiapas, then a Guatemalan province sandwiched between Yucatan and Tabasco, heard from an Indian a tale so amazing it was hard to believe. Not far from the village of Santo Domingo del Palenque, within a few miles of where Cortes was known to have passed with an escort of Indians but made no mention of the fact, there appeared to be a whole abandoned city beautifully built of stone and carved statuary, quite different from anything on the Mexican plateau, entirely smothered by the jungle. Titillated by the prospect of being the official discoverer of such an amazing relic, Brother Ordoñez had his parishioners fashion for him a palanquin to transport him sixty miles to the wattle and daub village of Santo Domingo del Palenque.

From there Ordoñez' parishioners carried him another eight miles into the jungle, where they came upon a stone complex completely overgrown with vegetation. The site was so stunning that Ordoñez was prompted to dash off an im-

Santo Domingo del Palenque.

Founded in 1564 on the grassy savannah of Tumbala by a Dominican missionary, and described as a "small Eden" shaded by huge ceiba trees, Santo Domingo received the additive Palenque, or "palisade," when the Spaniards ordered high walls built to protect themselves from the unfriendly natives resistant to conversion.

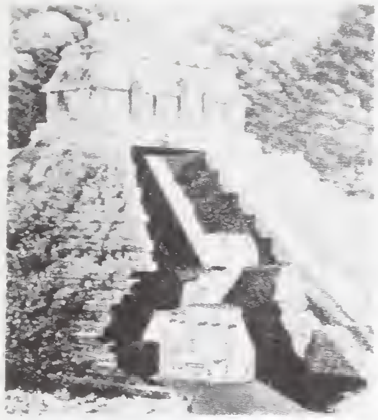
mediate *memoria* to his political superior in Guatemala City, Don José de Estacheria, which he followed with a weightier monograph entitled *A History of the Creation of Heaven and Earth,* in which he attempted to explain that the ruins—which he named the "Great City of Serpents"—must have been built in remote antiquity by a people who had appeared from the Atlantic guided by a leader called Votan, whose basic symbol was a serpent.

Ordoñez claimed to have gotten the material for his story from a book written by Votan himself in the Quiché language, asserting that the original book had been burned by Nuñez de la Vega, Bishop of Chiapas, in 1691, who before destroying it had copied parts of it which he showed to Ordoñez.

Votan was said to have set out from the land of Chivim (not specifically identified but believed to be transatlantic), and to have come to Yucatan via the "Dwelling of the Thirteen" (identified as the Canaries), with a stopover on a large Caribbean island presumed to be either Hispaniola or Cuba, but more likely the former. From there Votan is said to have crossed to the east coast of Mexico, where he made his way up the Usumacinta River to found the city now known as Palenque.

Votan is described as having arrived with a retinue dressed in long robes, of having exchanged ideas and customs with the natives, who submitted to his rule and who gave to the strangers their daughters in marriage.

Bishop Nuñez de la Vega also quoted Votan's book in a publication of his own entitled *Constituciones Diocesianos de Chiapas*. According to Nuñez de la Vega, when Votan came to America he listed the names of all the provinces and cities in the area in which he tarried. One was known as Huehueta, where Votan is claimed to have placed a treasure in a damp, dark subterranean house, appointing a woman as



Secret burial chamber in Palenque pyramid.

According to Ordoñez, Nuñez, and the native Mexican sources, the Chivim were Hivites, descendants of Heth, son of Chaanan, grandson of Noah, expelled from Geth by the Philistines a few years before the Hebrews went out of Egypt. One of their tribe, Cadmus, was believed to be the son of Ogyges who was on Mount Hermon beyond the Jordan, east of Chaanan, and was, according to Ordoñez, killed by Moses during the Exodus, which he dates as 1447 B.C. The tribe, expelled by the Hebrews, is said to have conquered Sidon and founded Tyre, from which Votan sailed for America.

chieftain of the treasure, with keepers to guard her. Nuñez de la Vega says that as bishop he carefully inspected the whole province to identify the locality where the treasure had been buried, and when he found it ordered its guardians to surrender what turned out to be nothing more than several lidded clay jars, green stones, and manuscripts. These the bishop publicly burned in the market place along with Votan's manuscripts.

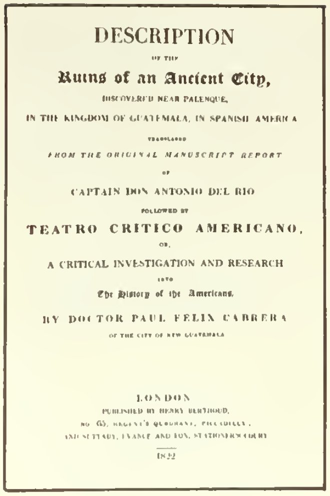
Four times Votan is said to have returned to his former home across the Atlantic known as Valum Chivim, which Ordoñez eventually identified as the city of Tripoli in Phoenicia. After one of these return voyages, Votan is described as having come to a great city where a magnificent temple was under construction which was intended to reach to heaven, but was doomed by a confusion of languages. In his *Constituciones,* Nuñez de la Vega was even more specific, saying that what Votan saw was "the great wall, the Tower of Babel."

In a manuscript written in Quiché in 1554 by several Maya Indians, its Spanish translator, Padre Dionisio-José Chonay, had this to say: "It is supposed in the manuscript that the three great Quiché nations mentioned in particular are descendants of the Ten Tribes of the Kingdom of Israel, whom Shalmaneser reduced to perpetual captivity, and who, finding themselves in the confines of Assyria, decided to emigrate." The actual text ran: "These, then, were the three nations of Quichés, and they came from where the sun rises, descendants of Israel, of the same language and the same customs."

In attestation of what they had written, the Indians signed the document on September 28, 1554, saying: "We have written that which by tradition our ancestors told us, who came from the other part of the sea, from Givan-Tulan, bordering on Babylonia."

In another manuscript, Votan's arrival is dated at 1000 B.C., which led modern scholars to suggest that Votan and his "men in Petticoats" could have been Phoenicians. Constance Irwin, in her book *Fair Gods and Stone Faces,* agrees that Votan and his followers could well have been Phoenicians, but places the date somewhat later. She says the great city which Votan could have visited for trade might have been Babylon, the greatest city in the Middle East, a favorite market for Phoenician merchants, where stood the magnificent Tower of Babel rebuilt by Nobopolassar and his successor Nebuchadnezzar in the seventh and sixth centuries B.C.

After his death, Vctan was associated with jade and snakes. Constance Irwin points out that two intertwined


DESCRIPTION

OF THE

Ruins of an Ancient City,

DISCOVERED NEAR PALENQUE,

IN THE KINGDOM OF GUATEMALA, IN SPANISH AMERICA

TRANSLATED

FROM THE ORIGINAL MANUSCRIPT REPORT

OF

CAPTAIN DON ANTONIO DEL RIO

FOLLOWED BY

TEATRO CRITICO AMERICANO,

OR,

A CRITICAL INVESTIGATION AND RESEARCH

INTO

The History of the Americans.

BY DOCTOR PAUL FELIX CABRERA

OF THE CITY OF NEW GUATEMALA

LONDON

PUBLISHED BY HENRY BERTHOUD,

NO 65, REGENT'S QUADRANT, PICCADILLY,

AND SUTTABY, EVANCE AND FOX, STATIONERS COURT

1822

Goya's portrait of his patron, King Charles III of Spain (1759–1788), who is described as one of the enlightened despots of the eighteenth century. After a long apprenticeship in Naples he came to Spain at the age of 43. During the American Revolutionary War he sided with the American colonists against the British. It was under Charles III that the Jesuits were expelled from Spain and from Spanish possessions. He also put some restraints on the hated Inquisition.

snakes formed the emblem of healing, wisdom, and fertility in Babylon, whence it spread east and west, the caduceus becoming a common object on Phoenician and Carthaginian stelae.

Ordoñez' story of Votan did not cause much of a stir in Guatemala City, but his description of the ruins of Palenque sparked his boss, Estacheria, who was president of Guatemala's Royal Audiencia, into ordering the mayor of Santo Domingo, José Antonio Calderon, to make an official survey of the ruins with the help of an Italian-born architect resident of Guatemala City, Antonio Bernasconi. Their report, forwarded to Madrid, was placed in the hands of Charles III of Spain, who, being also King of the Two Sicilies, had developed a penchant for Greek and Roman ruins. The prospect of finding similar antiquities in New Spain induced King Charles to order a systematic exploration of the architectural ruins near Palenque.

To implement the royal edict Estacheria selected a captain of artillery stationed in Guatemala City, Don Antonio del Rio. Decked in a three-cornered hat and powdered wig, "wafting" according to one account "through the jungles of Palenque an aroma of the latest fashionable scent," Del Rio set off on horseback to ascertain the age of the ruins, the extent of the population which had built the ruins, the cause of their abandonment.

Arriving on the scene, *el capitan* found the jungle so thick he couldn't distinguish a neighbor at arm's length. To clear the ruins he hired two hundred natives with axes and machetes, who soon uncovered more extraordinary buildings, palaces, temples, and pyramids, adorned with stucco sculpture and embellished with hermetic hieroglyphs in elaborate carved tableaux, all of which appeared to extend for miles into the jungle, where they had lain undisturbed for centuries. Within the buildings the captain found a maze of rooms, corridors, and subterranean passages, of which he took careful measurements.

With him, Del Rio had brought an artist, Ricardo Armendariz, who made rough sketches of the buildings and figures carved in stone or cast in stucco relief, with which to prepare a pictorial report of twenty-five plates. In his final report, Del Rio suggested the ancient Romans may have visited America, and that there had been a connection between Mexico and ancient Egypt. He quoted Father Jacinto Garriod, who visited Principe in 1638, to the effect that the northern parts of America had been visited by Greeks, English, and others. This final report, illustrated by Armendariz, was forwarded to Madrid, where Charles III had been replaced by his weak son, Charles IV. Because of systematic

Castañeda's renditions of Mayan reliefs are strikingly similar to motifs in Buddhist countries. In Buddhist tradition the Buddha's third week of meditation was spent under a Muchalinda tree, and it was during this time that Muchalinda the serpent king was said to have come forth and spread his hood as a canopy over the Buddha to protect him from the heat of the sun. It was then that the serpent became sacred. The sun, the tree, and the serpent are three of the most sacred symbols of the Buddhist; they appear in practically all decorative art, stylized or natural, throughout Mesoamerica. As with the Mesoamerican, Buddhist doctrine teaches a life after death, that the earth will be destroyed five times, that four destructions have already taken place, and the last will be by flood. Both the Buddhist and the Aztec maintained monasteries for retirement to a life of meditation and both had carvings that they worshiped, placed in niches in the walls of their sacred buildings.

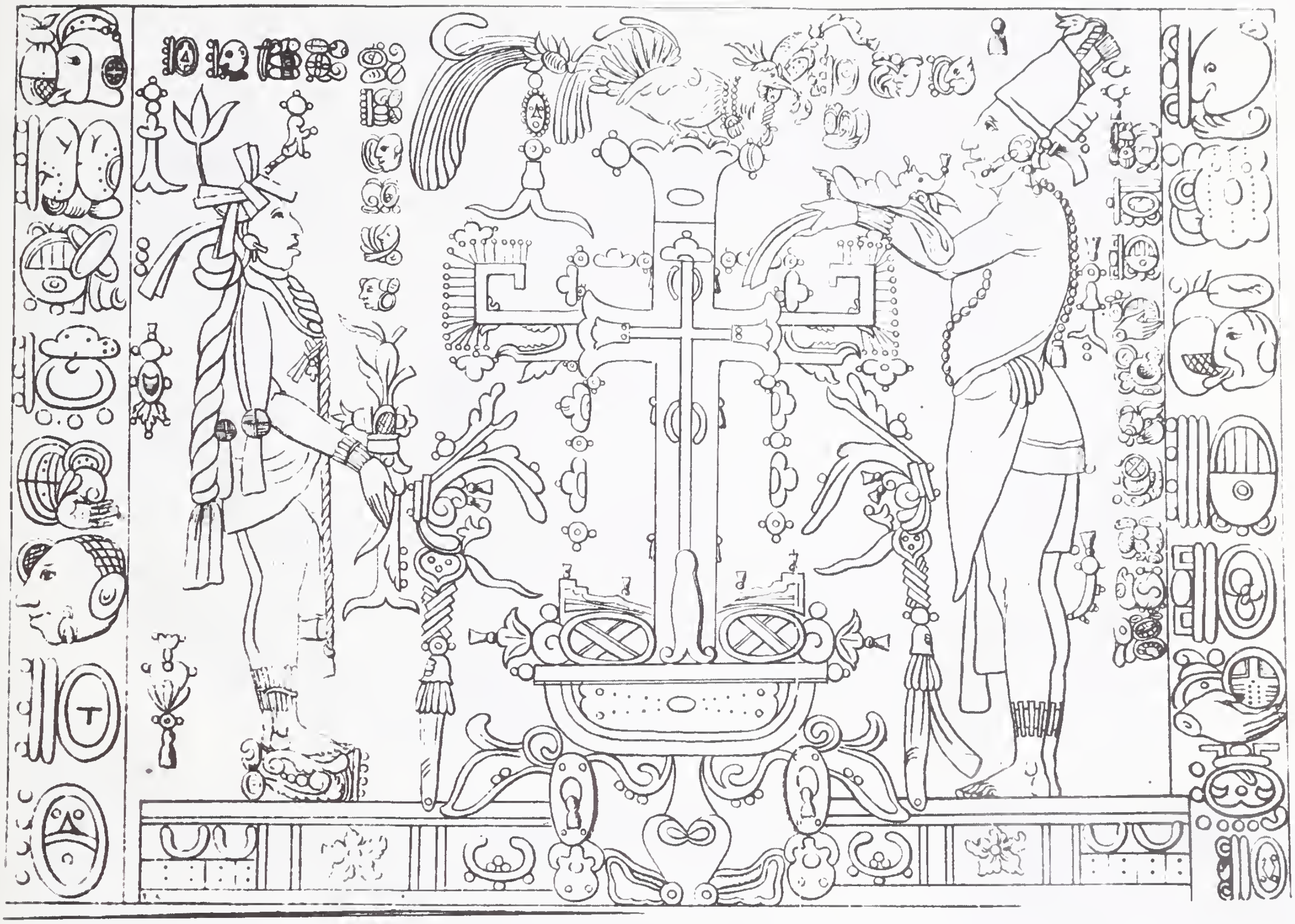
opposition by the clergy, the report was buried in the archives.

Fortunately a manuscript copy made in Guatemala City was edited by an Italian, Dr. Paul Felix Cabrera, described as "a gentleman of fatuous erudition" who not only cleaned up Del Rio's "barracks language" but attached to the report a preface wherein he also ascribed to the ruins of Palenque a Near Eastern origin. In this report, Cabrera also developed the tradition of Sigüenza and Boturini, who believed the Olmecs had arrived on the east coast of Mexico from somewhere across the Atlantic with a stop on the island of Antilia or Hispaniola. Cabrera suggested that the strangers were Carthaginians, and that the first colony had been sent out from Carthage to America before the First Punic War. In the New World, said Cabrera, these Carthaginians had interbred with native women to produce the Olmecs. Cabrera's report was also buried.

Charles IV of Spain was a handsome, amiable near-imbecile and cuckold whose queen took a 25-year-old lover, Manuel de Godoy, to rule the kingdom first as the Duke of Alcudia, then as a prince. Godoy managed not only to disgrace and destroy the crown but to turn Spain into a pawn of revolutionary France so that the Spanish fleet was destroyed by the British. In New Spain, Godoy imposed a series of such grossly corrupt and looting viceroys that he paved the way for revolution.

Cabrera says one of Castañeda's drawings represents Votan or a Hivite from Tripoli in Phoenicia. He says Votan was called a *culebra,* or snake, and later was "placed among the Gods." Cabrera adds that Amaguemecan was in the province of Chiapas, where the Indians carefully preserved the remembrance of their origin, and of "their ancestors' early progress from the voluntary or enforced abandonment of Palestine on the ingress of the Hebrews."

Votan is said to have declared himself "a snake," descendant of Imos of the line of Chan, and said that he came to America from a distant place by the command of God. According to Manly P. Hall, Votan founded Palenque, built a temple with many subterranean chambers called the "House of Dark-ness," and there deposited the records of his nation.



Throughout Mesoamerica a cult of the serpent existed from the most ancient times, spreading as far north as the mound builders of Ohio; it is still perpetuated today in the rituals of the Zunis in New Mexico and the Hopis in Arizona. Frank Waters points out that the plumed serpent was a primary symbol throughout Alabama, Georgia, and Oklahoma, and that the famous Hopi snake dance in which priests dance with snakes in their mouths is the most dramatic ritual still emphasizing the serpents. As for the jaguar, or Mexican *tigre,* it has been the symbol for the earth and earthbound matter since the earliest glyphs. It was so used by Teotihuacanos, Olmecs, Maya, Toltecs, Zapotecs, and Aztecs.

By this time, Humboldt was giving such wide publicity in Europe to the possibility of an impressive pre-Hispanic culture in America that Charles IV, feeling himself obliged to involve Spain in the proceedings, ordered a thorough exploration of all of Mexico for any pre-Conquest antiquities that might be located.

The job was given to Guillermo Dupaix, a retired army captain of Mexican Dragoons, evidently for no greater reason than that he had spent thirty years in the army. As a draftsman to make a record of whatever ruins they might discover, Dupaix selected a young Mexican aficionado of antiquities, José Luciano Castañeda, who had been sought out by Humboldt because of his not undistinguished collection of antiquities. Together Dupaix and Castañeda set out in 1805 to scour Mexico for remnants of pre-Columbian culture.

For three years they traveled about the country, crossing rough mountains, breaking their way through heavy jungle, delayed by sickness, bad weather, bandits, and machete-wielding natives. Their horses slipped cut from under them

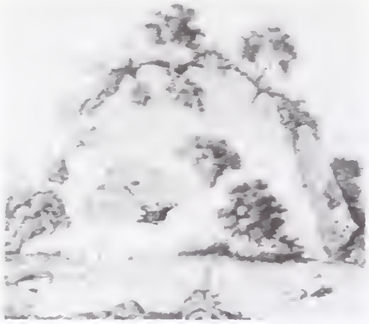
Archeologist Henriette Mertz points out that the fish seen eating lotus flowers in these Palenque panels, as well as the placement of the fish, resemble *makaras,* or fishlike monsters, in the lotus panel at Amaravati. In her opinion, such highly symbolic and stylized forms are unlikely to arise in two totally unrelated places, separated by thousands of miles, without some reason.

Gordon F. Eckholm, outstanding authority on Ancient Mexico, has pointed out that some of the most significant parallels between Hindu-Buddhist and late classic and post-classic Mayan art are those classifiable under the heading of lotus panels. He points out that a principal factor of the lotus panels in Buddhist art is that the rhizome of the lotus plant forms a sinuous pattern along the length of the design area, curving back and forth across the width of the panel and leaving spaces which are filled with leaves, buds, and flowers. The same pattern is followed in these temple reliefs at Palenque. The undulating path of the rhizome of the plant is apparently not a natural feature of either the Asiatic lotus or the American variety.

over steep cliffs or were swept away by turbulent currents. In the end, when Dupaix's legs became so swollen by insect bites he could no longer travel by horse, he suffered (because of his heavy French accent) the added indignity of being detained by the Mexicans as a spy for the French, Napoleon's brother Joseph having temporarily replaced his patron, Charles IV, on the throne of Spain. With all this trouble, Dupaix and Castañeda still managed on their peregrinations to visit and make sketches of the ruins of Xochicalco, Cholula, Mitla, Oaxaca, and many other areas, ending up at Palenque.

Wherever they traveled they became more and more impressed by the extraordinary achievements of the pre-Hispanic Indians. At Mitla, Dupaix found stone structures which he thought displayed "a lavish magnificence worthy of ancient Rome." He was much impressed by the symmetry and accurate measurements of the buildings. The carved stones and the arrangement of the structures gave evidence of the builders' knowledge of mathematics and geometry; artifacts indicated they had a well-formed knowledge of astronomy.

The workmanship of sculptors appeared of "singular beauty of proportion," the pottery of unusual brilliance. From finely cut and splendidly finished masonry, Dupaix was convinced that some metal had been used, though he could find no trace of any, nor of the method used to transport and



hoist into position stones weighing as much as thirty tons. From the well-built aqueducts they encountered, Dupaix concluded the ancient builders had a knowledge of hydraulics; from the construction of their roads and causeways, he felt that their architects rivaled those of Rome.

In the ruins of Palenque, Dupaix was surprised to find glyphs which were like neither those of Egypt nor those of the Valley of Mexico. The work seemed quite original. Unable to compare them with anything he knew in antiquity, either Gothic, Arabic, Chinese, or Phoenician, he concluded he was dealing with a race unknown to historians, who were not necessarily the forefathers of the local Indians. In the end he favored the conclusion that the builders of Mexico's extraordinary pre-Hispanic ruins had come from legendary Atlantis.

As Dupaix was neither archeologist, historian, naturalist, nor entrepreneur, his report, with 145 of Castañeda's sketches, was duly filed in the Cabinet of Natural History in Mexico City, whence, because of the republican efforts at independence from Spain, no one would forward it to Madrid.

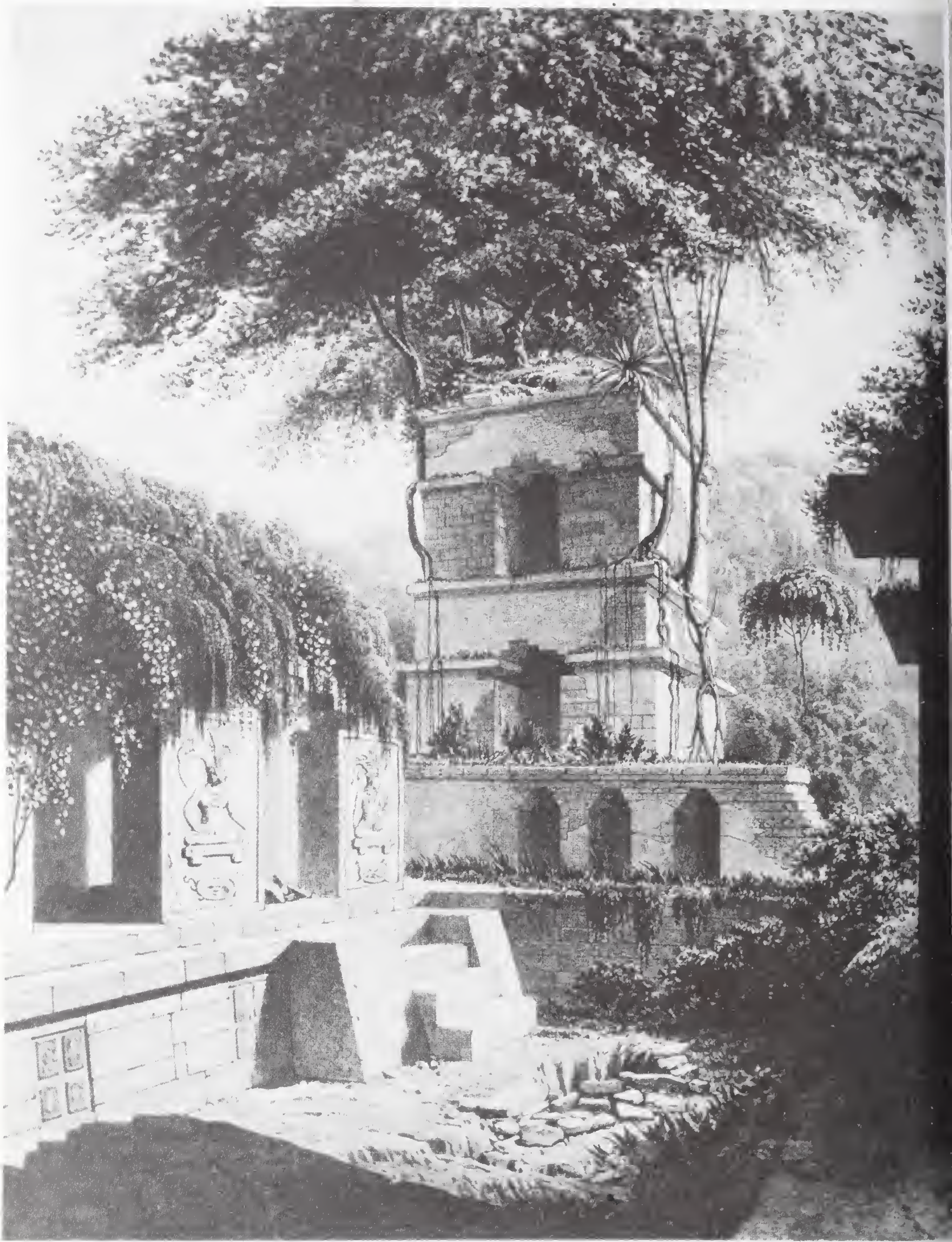
Having done his best, Dupaix disappeared, while Castañeda survived as professor of drawing and architecture at the University of Mexico. There Bullock found him early in 1823 and was so impressed by the originality of his drawings that he had twenty-five of them copied to exhibit in England, only to find on his return to London that he had been scooped by a local bookseller, Henry Berthoud, who had acquired from a British resident in Guatemala City, Dr. Thomas McQuy, a copy of Del Rio's manuscript with Cabrera's unwieldy preface, which he had translated and published as *Description of the Ancient City Discovered Near Palenque,* thus getting into print the first report on the ruins of Palenque.

Dupaix's report and Castañeda's sketches, partly consumed by fungi and cockroaches, were rescued from the Spanish archives by the French Abbé H. Baradère, and ended up in a very expensive folio edition in Paris in 1836 under the auspices of those rival but eminent ministers of state Louis Adolphe Thiers and François Guizot.

Entitled *Antiquités Mexicaines,* the edition was so limited that few could buy it. Yet those into whose hands it fell were so amazed by what they saw they could hardly be restrained from traveling to Mexico. The work was to motivate a series of French adventurers and explorers, prodded and subsidized by the state, who came to open the way for commercial, cultural, and military followers.

PART III

OMANTIC EXPLORERS



7. Discovery of Mayaland

View of the tower at Palenque, seen from the northern gallery, painted as it was at the time, with vegetation growing out of the third floor. To gain sustenance the trees sent their roots some thirty feet to the ground. Waldeck recounts that these roots were stretched so tight that the wind blowing through them at night produced sounds like a harp, only deeper, which caused the Indians to travel several miles at dusk to get away from an area they believed to be haunted. The pillars on the right belong to the western galleries of the palace. The pillars on the left are decorated with stucco figures.

To illustrate Del Rio's report, the publisher Berthoud employed a romantic skirt-chasing French adventurer and former pupil of the painter Jacques Louis David, Jean-Frédéric Maximilien Waldeck, who was so smitten with the scenes he engraved from the sketches of Ricardo Armendariz that he determined, despite his fifty-six years, to explore the site himself, signing himself on as a hydraulic engineer for an English silver-mining company in Mexico in order to obtain his passage.

Boasting of his friendship with Humboldt, Lord Byron, Beau Brummell, and Marie Antoinette (whom he claimed to have visited in prison), and of having accompanied Napoleon on his expedition to Egypt, where he had become intimate with Edmé François Jomard, Waldeck soon quit the mining company and took up residence in Mexico City, no longer as Citizen Waldeck, the revolutionary vogue being momentarily over, but as the Count of Waldeck. There he supported himself painting portraits of the local gentry, soliciting right and left for a grant to explore and record the ruins of Palenque. His days he spent collecting rare books and artifacts, investigating the history of the Nahua, about whom he was to write an unpublished history. His evenings were passed at the opera, the ballet, or the theater, complaining all the time that whereas he had expected to find a lively cultivation of the arts and letters in Mexico City, he found only "an elite notorious for its neglect of cultural life."

Eventually, obtaining sufficient subsidy to take him to Palenque, Waldeck was able to spend a whole year in the village of Santo Domingo plus four months in a hut he built on the site of the ruins, shacked up with a dark-skinned,

Waldeck says that the two reliefs had been removed from the ruins of Palenque and were mortised into the walls of the living room in the house in the village belonging to a deputy called "Bravo," who said he would sell them only on the condition that the buyer marry one of his daughters.

This lion throne originally drawn by Armendariz was thus embellished by Waldeck. At Palenque Waldeck found wooden beams, stone pillars, and entrance posts, all carved in low relief. Everywhere were symbols and human figures, some in masks and bearded, all clothed in ornate regalia, with strange weapons and the flowing plumes of the quetzal covering their surfaces.

firm-breasted mestiza, braving the densest rainfall in the Western Hemisphere to produce ninety quite extraordinary drawings, till his legs broke out in boils and he believed he had contracted a venereal disease.

When revolution and cholera swept Tabasco, Waldeck took off for Yucatan to make more drawings. There he heard that the Mexican government, suspecting him of being a British spy, was about to seize his drawings. Carefully copying the lot, Waldeck says he allowed the Mexicans to seize the copies while he successfully smuggled the originals to England with the help of the British consul.

Making no effort to suppress his feelings about the Mexicans in general and the governor of Yucatan in particular, whom he enviously accused of keeping a harem, Waldeck took ship and followed his drawings to London. There he used them to publish a handsome folio volume of twenty-one plates accompanied by a hundred pages of text in which he concluded that the Chaldeans and the Hindus had been responsible for the construction of Palenque, a city whose collapse he dated as having occurred about A.D. 600.

The so-called Temple of the Cross drawn by Waldeck from the doorway of the palace. At the foot of the pyramid is the shack Waldeck built for his stay at Palenque with his mestizo mistress. Waldeck said the palace was 273 feet wide at its east base and rested on a pyramid 60 feet high.

John Lloyd Stephens aged 36.

At 3,200 francs, or several hundred dollars a copy, Waldeck's book was more of a collector's item than a popular best seller. When a copy reached John Russell Bartlett's bookstore in New York, Bartlett immediately showed it to one of his best customers, the thirty-two-year-old author of *Incidents of Travel in Egypt and Arabia Petraea,* John Lloyd Stephens, who was as amazed as he was impressed by Waldeck's drawings and the possibility of a civilization in the Western Hemisphere as advanced as that of the Egyptians. But Waldeck's reputation as a faker had accompanied his book; puzzling were his drawings of pyramids in the Egyptian style decorated with Romanesque statues in the full round. So Stephens determined to mount an expedition of his own to Central America to establish if the ruins existed in fact, or were, as suggested by many, the hoax of a romantic draftsman—a perfect possibility in that age of P. T. Barnum.

Stephens' English friend Frederick Catherwood, who had traveled widely in the Near and Middle East to make sketches of rare antiquities, was equally dubious about Waldeck, but enthusiastic about Stephens' offer to accompany him to Central America to illustrate whatever ruins they might actually encounter. In London, Catherwood had read Del Rio's book; in Paris Dupaix's; now he was anxious to check them out. But how, he wondered, were two foreigners to crash their way into an uncharted jungle through territory being fought over by revolutionaries and counterrevolutionaries?

Luckily Stephens had helped elect the Democratic President Martin Van Buren, and so was able to get himself appointed U.S. Diplomatic Agent to the government of the Republic of Central America, a flimsy appointment, in that no one at the State Department knew whether such a government existed, where its capital might be, or who might be its president or minister of foreign affairs, neither of whom had been recognized by either Spain or the Pope.

On October 3, 1839, Stephens and Catherwood sailed from New York's North River aboard the British brig *Mary Ann*

Belize, in Honduras, was part of the so-called Republic of Central America, which embodied the Spanish provinces of Guatemala, El Salvador, Honduras, Nicaragua, and Costa Rica. They had been temporarily united under Iturbide's short-lived Mexican Empire, but had since federated under their own constitution, with a coat of arms of five volcanoes crowned by the liberty cap of the sans-culotte and overcast by a hopeful rainbow. When Stephens and Catherwood arrived in Belize, the only news from the country had been of revolution and counterrevolution.

Catherwood's view of a section of the Great Hieroglyphic Stairway, overgrown by the jungle, with its two thousand glyphs mostly collapsed into rubble. In the foreground lies a Mayan head in the mouth of a great serpent which had formed part of the main staircase. At a glance, Catherwood and Stephens realized that whoever had built these ruins had indeed been part of a great culture. Huge monoliths weighing thirty tons had been carved, polished, and decorated with extraordinary art. Though Catherwood rendered the architecture and sculpture with extraordinary care, Victor von Hagen, the most readable authority on Catherwood and Stephens, says the monkeys in the view are apocryphal rhesus monkeys from Africa, whereas only Capuchins and spider monkeys are supposed to be indigenous.

bound for Belize in Honduras. Their immediate object was to locate a mysterious city in the depths of the jungle which appeared on no map of the area: Copan.

They had chosen to search for this lost site because of an Irishman whose real name they did not know, but whose *nom de guerre* was Colonel Juan Galindo. A naturalized citizen of the Central American Confederation, Galindo had risen to be governor of Peten and had been led to Copan by an unpublished Spanish account of an extraordinary lost city. When he reached the ruins, he was so impressed that he claimed the pre-Columbian inhabitants of Central America had achieved a civilization superior to all other native cultures in the Americas.

Arriving in Belize, Stephens was supposed to accomplish his duty as a diplomat and seek out the seat of government to present his credentials, but both he and Catherwood were more anxious to get to their exploring. On the basis of Galindo's report, Stephens and Catherwood set off into the gloom of the Guatemalan jungle, "where shafts of sunlight seeped through as in a cathedral," little realizing that they would be "dragged through mudholes, squeezed in gulleys, knocked against trees, and tumbled over roots." Crossing the Mica mountain range and coping with every conceivable hurdle placed in their way by the local bigwigs, the unwary travelers finally broke through the jungle into the remains of what they realized was a whole new world, the ruins of a civilization so obscure it didn't even have a name, a great city complex whose inhabitants had vanished without a trace several centuries earlier.

Colonel Juan Galindo.

Here were structures unlike anything either of them had ever seen before, pyramids studded with sculptured figures, Copan, Honduras.

The broken stele lying by a large lava-stone tortoise was described by Catherwood as "one of the most beautiful of Maya carvings in the round." Catherwood and Stephens found the glyphs unlike anything they had ever seen in their wide travels and study of exotic architecture, quite outside the Indo-European tradition. So intricate and complicated were the designs, so entirely novel and unintelligible, that Catherwood had great difficulty accurately copying them, but a later historian was to remark of Catherwood's drawings: "When it is taken into consideration that the Maya hieroglyphic writing was a sealed book at the time he visited Copan, and that he knew nothing about the subject matter of the glyphs he drew, such accuracy is remarkable."

Half a century after Stephens stumbled on this "altar" half buried in the jungle near Copan, his prophecy about it was corroborated by archeologists who concluded that the altar commemorated a congress of priest-astronomers who had met in Copan in A.D. 765 to make some important change in their Mayan calendar.

great plazas surrounded by stepped temples, stones carved with mysterious and quite unfamiliar hieroglyphs. Most of the buildings were so overgrown with vegetation and trees that Catherwood, standing up to his ankles in mud, his hands gloved against swarms of mosquitoes, had a hard time drawing them.

In the underbrush Stephens stumbled upon a rectangular stone altar carved with sixteen cross-legged figures, which he prophetically noted must "beyond doubt, record some event in the history of the mysterious people who once inhabited the city." A broader survey of the jungle ruins revealed a huge acropolis with five large plazas, two main courtyards, and three tall but crumbling pyramids, the whole complex laid out on a plateau a hundred feet above the river.

To facilitate his operations at Copan, Stephens had the happy thought of acquiring the whole site from its rightful native owner, which he was able to do for the sum of fifty U.S. dollars.

After weeks of exploring and drawing, Stephens and Catherwood realized they had barely scratched the surface of what lay hidden around Copan. Anxious to get to Palenque, three hundred miles to the north, they set off on muleback along ribbon trails that wound through the high pine-studded mountains of Guatemala, crisscrossed by deep barrancas and torrents—a road described by one traveler as "made only for birds."

Only the monkeys disturbed the quiet as they swung through the trees, forty or fifty at a time, with little ones in their arms, appearing to Stephens like "wandering spirits of the departed race guarding the ruins of their former habitations."

A couple of Guatemala City Englishmen, John Herbert Caddy and Patrick Walker, privy to the plan that Stephens was first going to Copan, deliberately set out to beat him to Palenque. Though they did so, by a matter of weeks, Stephens was able to beat them into print by a hundred years.

As Stephens approached the ruins of Palenque, he chose to ignore the blanket order issued by the Mexican dictator Santa Anna forbidding all access to foreigners. Stephens' first sight of the ruins convinced him that Waldeck, Del Rio, and Dupaix had not been exaggerating. Nothing in the world, Stephens noted, "ever impressed me as forcibly as the spectacle of this once great and lovely city, overturned, desolate, and lost . . . overgrown with trees for miles around, and without even a name to distinguish it."

On the walls of the building known as the "Palacio" Stephens found Waldeck's name carved beside the faded drawing of a woman and the scribbled date of 1832. He also found the names of Captain John Herbert Caddy and Patrick Walker.

With measuring rod Stephens laid out the floor plan of the Palacio as a mathematical basis for Catherwood's rendition, finding it to be 228 feet by 180, a measurement that was to stand through the years.

Noting the similarity between the hieroglyphs of Palenque and those of Copan, Stephens concluded that the whole intervening area of some 60,000 square miles might have once been inhabited by a civilization that spoke the same language or at least used the same glyphs.

For weeks Stephens worked at uncovering the ruins while Catherwood struggled to capture their incredible lineaments. Soon they were groggy with malaria, their feet swollen with nits that buried eggs beneath their toenails, their faces swollen from the blood-sucking bites of Diptera. When Catherwood finally collapsed, they staggered out of the jungle and sailed for New York with the makings of what was to become one of the great best sellers of the century. Nicely bound and reasonably priced by Harper Brothers, beautifully illustrated by Catherwood, *Incidents of Travel in Central America, Chiapas, and Yucatan* brought to a wide and fascinated public news of the mysterious and unknown Maya, a word that up till then had not appeared in any dictionary. In three months the book went through ten printings.

General view of Uxmal seen from the upper terrace of the governor's palace, showing the Pyramid of the Dwarf, or House of the Magician, on the far right. In the center is the great "nunnery" quadrangle, so called by the Spaniards because of its ninety cell-like rooms. Catherwood and Stephens found that the ruins of the city covered an area of two square miles. The local Indians believed the buildings at Uxmal to be haunted and that all the ornaments were "animated" and would walk around at night. They believed the ornaments harmless during the day but, on the advice of their priests, constantly disfigured them with their machetes so as to quiet their potentially wandering spirits. Within less than twelve months from their first visit to Uxmal, Catherwood and Stephens found the place so overgrown with shrubs and small trees that nothing but the top of the highest pyramid and the base outlines of the other monuments could be discerned.

Labna.

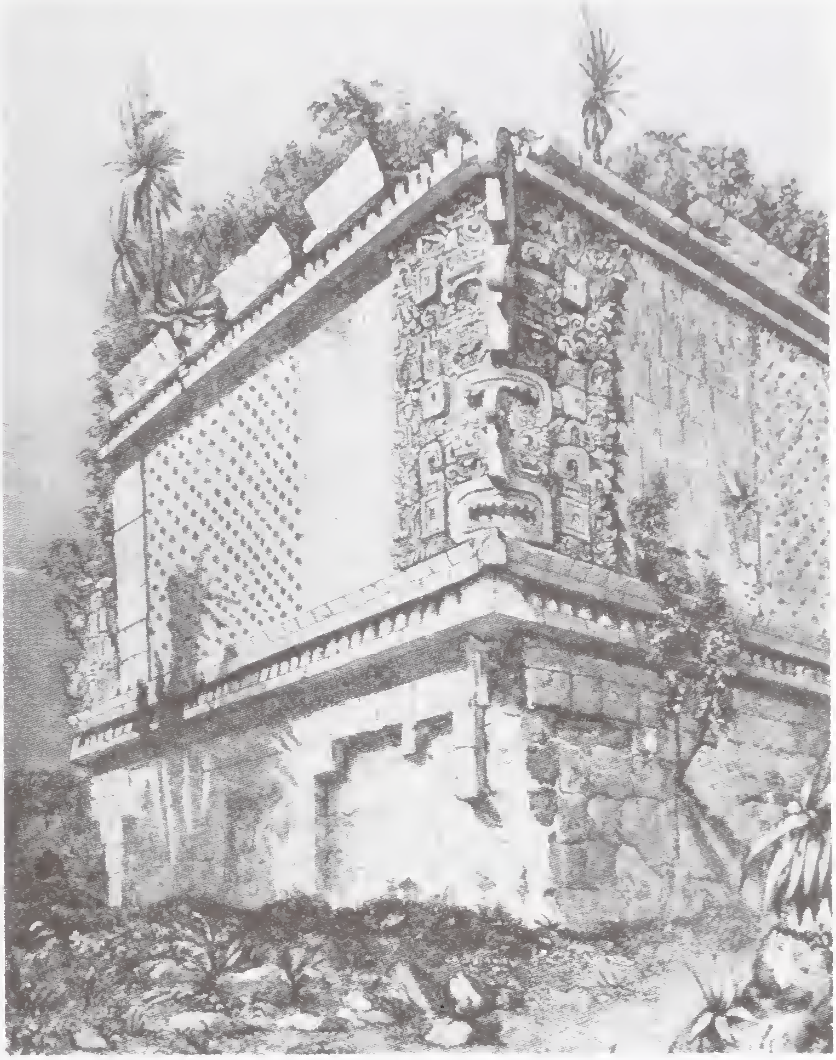
Gateway to Labna, a city in the Mayapan League, between Uxmal and Chichen Itza. Stephens, in frock coat, is standing by the gate. Labna's palace with motifs of masks and columnettes is one of the largest in Yucatan, 400 feet long by 250 feet wide. Catherwood noted that the mortar with which it was built was similar to the pozzuolana found in the ancient buildings in Rome.

Uxmal.

Catherwood and Stephens found that the quadrangular courtyard of the building called "Monjas," or "nunnery," had walls ornamented from end to end with what Stephens called the "richest and most intricate carving, presenting a scene of strange magnificence, surpassing any that is now to be seen among its ruins." The facade, which still showed signs of having been painted, displayed several masked faces with tongues hanging out, and "two colossal entwined feathered serpents running through and encompassing nearly all the ornaments throughout its whole length." Stephens was told that as recently as 1835 one of the facades had still stood intact, whereas he and Catherwood found them all badly dilapidated and overgrown with bushes alive with quail. The dilapidation enabled Stephens to note that some of the buildings had been erected over, and completely enclosed, older ones.

Uxmal.

One of two archways 20 feet high and 25 feet deep which pierce the facade 60 feet from either end of the governor's palace. The design shows repetitive patterns of the elongated snout of what was known as the "rain god."
The main body of the palace was a huge trapezoidal building 320 feet long by 40 feet wide, set on three stepped terraces. The entire length of its second story was covered by a facade of exquisitely cut stone of intricate design, a mosaic of some 20,000 sculptured stones, described by Stephens as a "mass of rich, complicated and elaborately sculptured ornaments forming a sort of arabesque," whose meaning or function entirely escaped him. Catherwood climbed a makeshift ladder to make accurate drawings of the "incomprehensible subjects sculptured on the facade." Later they discovered them to be hieroglyphs, "which from their conspicuous position," Stephens presumed to have some important meaning; but such was the limit of even his open-mindedness, he assumed they could only have dealt with some such prosaic banality as construction details of the building.



This series of pyramidal walls (which looked to Stephens like the fronts of Dutch houses), which was called the "Casa de Palomas" or "Pigeon House," had once been covered with figures and ornaments in stucco, only portions of which remained. In the center, an archway led to a courtyard overgrown with shrubbery. To Stephens, there was something mournful about this particular set of ruins. "Entering under the great archway, crossing two noble courtyards, with ruined buildings on each side, and ascending the great staircase to the building on the top, gave a stronger impression of departed greatness than anything else in this desolate city. It commanded a view of every other building, and stood apart in lonely grandeur, seldom disturbed by human footsteps. On going up to it once Mr. Catherwood startled a deer, and at another time a wild hog."

Half a century was to pass before archeologists recognized in the frets of the "Pigeon House" a highly sophisticated astronomical observatory.

Once Catherwood had regained his health, he and Stephens returned to Yucatan to describe and draw the abandoned Mayan centers of Uxmal, Kabah, Zahil, Labna, Izamal, Chichen Itza, and Tulum, which produced an even better seller: *Incidents of Travel in Yucatan,* considered by Edgar Allan Poe "perhaps the most interesting book of travel ever published." As entertaining as its predecessor, largely because of Stephens' anecdotes and descriptions of odd personalities, it was in substance less illuminating about the mysterious Maya.

Stephens did manage to acquire in the ancient capital of Mani, where Diego de Landa had burned the Mayan codices and documents, a weathered Spanish transcription of the books of Chilam Balam, which included a chronology of ancient Yucatan as told by the natives to sixteenth-century Spanish friars, from which Stephens was able to learn something of the history and customs of the natives. From a lover of ancient lore, Don Pio Perez, who produced a work entitled *A True Exposition of the Method Used by the Indians for Computing Time,* Stephens was able to learn the dot and bar numeration system of the Maya. This gave him an understanding of their solar calendar of eighteen months of twenty days plus an extra five or six, very similar to that of the Aztecs, a system of chronology based on names and numbers for days and months which enabled the ancient Mayan to designate a particular day which could not be mistaken for any other through thousands of years.

The ruins of Kabah, south of Uxmal, another Mayan city abandoned to the jungle. When Stephens first saw this building at Kabah, called by the natives the "House of Justice," it was "so beautifully shrouded by trees that it was painful to be obliged to disturb them." To get this picture with his camera lucida, Catherwood had to stand under an umbrella held by a tranquil Indian while a tropical downpour created what appears to be a lake in the foreground.

The magnificent ruins of the ancient city of Chichen Itza, with its Castillo dedicated to Kukulcan, the Maya Quetzalcoatl, "casting a prodigious shadow" over the flat Yucatecan plain, had as great an emotional effect on Stephens as had Palenque. But he merely gilded Catherwood's lily by noting that "at the foot of the staircase, forming a bold, striking and well-conceived commencement to this lofty range, are two colossal serpents' heads, ten feet in length, with mouths wide open and tongues protruding." Unable to give a rational explanation for these extraordinary pieces of sculpture, Stephens employed the subterfuge of his age by adding, "No doubt they were emblematic of some religious belief, and in the minds of an imaginative people, passing between them to ascend the steps must have excited feelings of solemn awe."

Caracol.

Stephens was seized with the picturesque qualities of what he described as a circular building "unlike any other we had seen, except one at Mayapan, much ruined," with terraces and a winding inner staircase. Noting the novel plan of the building, he remarked that "instead of unfolding secrets, it drew closer the curtain that already shrouded with almost impenetrable folds the mysterious structures." He found the walls of both inner corridors plastered and ornamented with paintings, and noted again, without being able to explain it, a balustrade of gigantic serpents. It was not until the end of the century that archeologists realized the astronomical functions of the building.

Noting the similarities between the Aztec and the Mayan calendars, Stephens facilely concluded that both civilizations had been endemic to America, that the pyramidal structures of Yucatan had been built by neither Egyptians, Carthaginians, Greeks, Romans, nor Israelis, but by native Americans, possibly the forefathers of the natives then living in Yucatan, possibly no more than a thousand years earlier.

Stephens planned one more great work on American antiquities to contain over a hundred folio engravings by Catherwood designed to bring together in one book the works of Humboldt, Prescott, Gallatin, and Wilkinson. Stephens even traveled to Potsdam to pay his respects to an aged Humboldt. But Harper's could not raise sufficient subscriptions to produce so expensive an endeavor. In the end the idea was dropped. Though Stephens' conclusions about the origin of the Mayan civilization remained open to question, his books established him as a gifted writer, and his rediscovery of the Maya opened the way for serious archeology in the Americas.

Another monjas which Stephens found in a good state of preservation and elaborately decorated was believed by him to be the oldest building in the Chichen Itza complex. Over the doorway were twenty small cartouches of hieroglyphs in four rows, five to a row, and a circular niche with seated figure. Stephens noted the similarity between this curved projecting ornament like an elephant's trunk and those of Uxmal. These masks were said to be of Itzamna, the protean god of rain, writing, and learning. Stephens also concluded that the hieroglyphs were similar to those at Copan and Palenque.

Gymnasium.

Stephens described the ball court at Chichen Itza as a gymnasium or tennis court, pointing out that the two massive stone rings, four feet in diameter, carved with two entwined serpents mortised into the opposing walls twenty feet above the ground, probably served for the celebration of some public games. He then quoted Herrera on the diversion of Montezuma.

"The king took much delight in Seeing Sport at Ball, which the Spaniards have since prohibited, because of the mischief that often hapned at it; and was by them call'd *Tlachtli,* being like our Tennis. The Ball was made of the Gum of a Tree that grows in hot Countries, which, having Holes made in it, and moulded together, turns as black as Pitch. The balls made thereof, tho' hard and heavy to the Hand, did bound and fly as well as our Footballs, there being no need to blow them; nor did they use Chaces, but vy'd to drive the adverse Party that is to hit the Wall, the others were to make good, or strike it over."

Tulum Castillo.

Stephens and Catherwood arrived at Tulum on the east coast of Yucatan (now known as Quintana Roo) from Cozumel Island by boat and large canoe. They found the Castillo to be the main temple of the complex, which had been first spotted from the sea by the Spaniards several years before the arrival of Cortes. The site was overgrown with trees which, with their deep green foliage and mysterious buildings, presented to Stephens "an image of a grove sacred to Druidical worship." He described the surrounding scenery as the wildest he had yet found in Yucatan. Clearing a platform in front of the Castillo, whose base they measured as 100 feet long, they could look down over an immense forest on one side, and on the other could see deep in the clear water at the foot the the cliff, "gliding quietly by a great fish eight or ten feet long." No drawing, said Stephens, could convey a true idea of the solemnity of the living shroud that covered the Castillo, "or of the impression made upon us when the ring of the ax first broke the stillness that had so long prevailed around." The back or sea wall of the Castillo rises on the brink of a high, broken precipitous cliff. It commands, said Stephens, "a magnificent ocean view, and a picturesque line of coast, being visible from a great distance at sea." At night the howling of the winds, the cracking of branches in the forest, and the dashing of angry waves against the cliffs added a romantic tone to their sojourn; but Stephens lamented that "we were rather too hackneyed travellers to enjoy it, and were much annoyed by moschetoes."

With Catherwood, Stephens found some low buildings which, because of the lowness of all their doorways, were attributed by the natives to *covenbados*, or "hunchbacks."

Tulum.

The Temple of the Frescoes at Tulum was accidentally discovered when Stephens' companion Dr. Cabot went hunting for a pair of flushed oceloted turkeys. Dr. Cabot is seen off to the left. Stephens (in short coat) and Catherwood (in frock coat) are seen in front of the temple, which they reported to be 45 feet long and 26 feet deep, resting on a 6-foot terrace. The walls of the corridors of the building were found to be covered with paintings "green and mildewed from the rankness of vegetation."

(Above) Izamal.

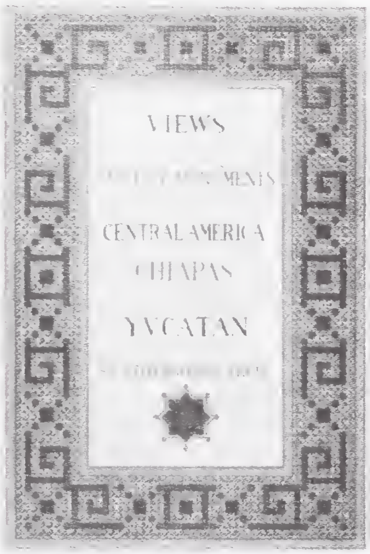
This head, now destroyed, was seven feet wide and almost eight feet high when drawn by Catherwood. It was near what Stephens called the most stupendous mound he had seen in the country: six or seven hundred feet long and sixty feet high, built with cyclopean rocks, and containing mysterious inner chambers. In this romanticized picture, Dr. Samuel Cabot, Jr., is hunting a jaguar at the base of one of several large pyramids.

(Left) Well at Bolonchen.

Stephens and Catherwood seized torches and descended 210 feet into a dark, damp cavern, where they were taken down another 80 feet by means of a large, rudely constructed, and very slippery ladder, 12 feet wide, lashed together by withes. Beyond this another ladder descended a further 75 feet. Crawling along a low stifling passage for about 300 feet, they came upon a rocky basin full of water. By this time the two gringos were so dirty and exhausted, they not only drank of it but took off their clothes and bathed in it. The cave was called "Xtacumbi Xunan," or "hidden lady," because of some pretty girl who had been stolen from her mother and hidden in its depths by her lover. Every year when the wells went dry in the village, a festival was celebrated for the opening of the cave, and the villagers would begin their daily stint of descending 1400 feet to fetch their water. As there are no rivers in Yucatan, the only available water flows beneath the limestone shelf appearing here and there in deep cenotes. The original of this drawing by Catherwood is in the collection of Henry Schnackenberg of Newton, Connecticut.

The only known likeness of Frederick Catherwood, a self-portrait from *Views of Ancient Monuments* as he stands by the ruins of Tulum in Quintana Roo, helping Stephens measure the front of the Temple of Frescoes. Round-faced, sandy-haired, and with blue eyes, Catherwood was six years older than Stephens, taller and more solidly built. Of Scottish ancestry and a well-to-do English background, he received a classical education from Oxford. As artist, archeologist, and explorer, he had visited and drawn almost every important archeological site in the Near East, going into forbidden areas dressed as a Moslem. In Rome he was so entranced by the architectural drawings of Piranesi that he developed a brilliant technique of his own for reproducing ancient sites.

Aldous Huxley in an introduction to a monograph by Victor von Hagen wrote of Catherwood, "From dawn till dusk, day after day and for weeks at a stretch, this martyr to archaeology had exposed himself to all the winged and crawling malice of tropical nature. Ticks, ants, wasps, flies, mosquitoes; they had bitten him, stung him, drunk his blood, infected him with malaria. But the man had grimly gone on drawing. Itching, swollen, burning or shuddering with fever, he had filled whole portfolios with the measured plans and elevations of temples, with studies of Mayan sculptures so scientifically accurate that modern experts in pre-Columbian history can spell out the date of a stele from Catherwood's representations of its, to him, incomprehensible hieroglyphs."



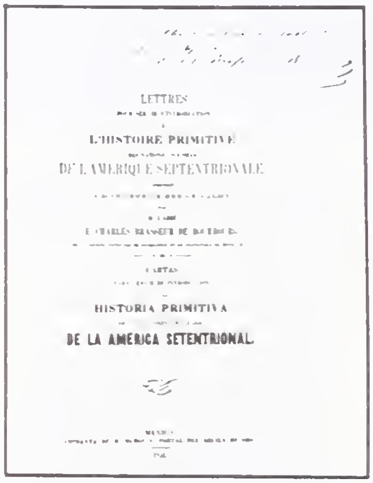
Having failed to receive credit for his work for Stephens, even on the title page of Stephens' books, and having lost the greater part of his originals in the fire that destroyed his rotunda exhibition in New York, Catherwood sailed for England to produce in London a folio volume with twenty-five of his favorite views of Central America. For a really first-class opus, Catherwood gathered six of England's outstanding lithographers, and he had the printing executed by an intimate friend, Owen Jones, in his own studios. The resulting *Views of Ancient Monuments of Central America, Chiapas, and Yucatan* appeared on April 25, 1844. The ordinary edition sold for five guineas, and a smaller number of hand-colored sets "delicately done by an expert hand" were issued at twelve guineas.

Prince Albert, consort to Queen Victoria, bought a copy as a present to send to Humboldt in Potsdam in reciprocation for a copy of his *Kronos* which the Queen had recently received.

The edition of three hundred copies was soon exhausted; and in order to make a living, Catherwood substituted for his cherished title of architect that of civil engineer and sailed for tropical British Guiana in November of 1845 to organize the building of a railroad between Georgetown and Mahaica. When the native director was run over by the engine after the line had stretched a mere 5 1/2 miles for the exorbitant cost of £127,000, Catherwood moved to California by way of Panama.

Successful, at last, in the railway business of that booming state, Catherwood decided on a holiday in England. For the return trip to the States he boarded the S.S. *Arctic*, which sailed from Liverpool on September 20, 1854, with 385 passengers and crew. In mid-Atlantic the *Arctic* was rammed head-on by a French screw-propelled vessel, the *Vesta*. The *Arctic's* crew seized the lifeboats and pulled away from the ship, leaving the passengers—male, female, and children—to shift as best they could. By dusk the *Arctic* sank with its complement of passengers excepting the Duc de Gramont, who, determined to return to his diplomatic post in Washington, successfully jumped into the first officer's boat. Among those who sank beneath the ocean waves was Frederick Catherwood, Archt.

8. Another Champollion


LETTRES

L'HISTOIRE PRIMITIVE

DE L'AMERIQUE SEPTENTRIONALE

CARTAS

HISTORIA PRIMITIVA

DE LA AMERICA SETENTRIONAL

Facsimile of Brasseur de Bourbourg's letters to the Duc de Valmy designed to serve as an introduction to his *Early History of the Civilized Nations of North America.* Published in Mexico City in 1851, it is personally dedicated by the author to the Smithsonian Institute in Washington, D.C. The letters contain erudite essays on the value and veracity of Cabrera's and Nuñez de la Vega's theories about the Hittite, Carthaginian, and Phoenician origins of the people of Palenque.

While pathfinder Stephens had done a reporter's job of bringing to the world knowledge of some forty ruined cities with detailed examinations of Copan, Quiché, Palenque, and Uxmal, what was needed was a detective intellect to unravel the deeper mysteries of these ancient sites. Just looking at the buildings and illustrating them, no matter how beautifully or accurately, had not done the trick; some Champollion was needed with a Rosetta stone.

The man to make the next significant breakthrough toward explaining the origin and history of the mysterious Maya was a Fleming from near Dunkirk, who admitted that his teenage reading of Del Rio's book had "decided my archeological vocation for the future."

Encouraged by the success of Stephens' book, and anxious to resolve more riddles, Charles Etienne Brasseur de Bourbourg set off for America in 1845 at the age of thirty-one, freshly ordained to the priesthood. Tall, courtly, and strikingly handsome, he had mastered the art of journalism as a young man in Paris writing for *Le Monde* and *Le Temps;* and the art of novel writing by doing such potboilers as *Selim or the Pacha of Salonika* under the pseudonym of de Ravensburg, which developed for him as easy a literary style as Stephens'. What he needed next was academic standing. This he obtained by studying for the priesthood in Rome, sensing it would be easier to obtain access to people of substance and to the restricted archives of this planet by approaching them neither as a journalist nor as a novelist but as the Abbé Brasseur de Bourbourg, an ecclesiastical title which, along with his ecclesiastical duties, was to rest lightly on his shoulders. Not so his detective quest.

In this he became a ferreter out of rare books and valuable manuscripts, so indefatigable that he was to throw a whole new light on the origin of the natives of America.

Already in New York, on his way to Mexico, Brasseur had been able to obtain manuscript copies of the histories of New Spain by Las Casas and Duran, which had not yet appeared in print. In Mexico City, through the intercession of a friendly cabinet minister, the viceregal archives were opened to him, and Brasseur was able to read in manuscript the original history of the Aztecs written by Ixtlilxochitl. Other friends got him into other restricted libraries where he kept himself busy for a couple of years, adding to his twelve spoken languages and twenty reading ones by learning Nahuatl from a descendant of a brother of Montezuma.

To explore the country, Brasseur traveled on mule and horseback in Dupaix's footsteps, going to Tula, Queretaro, Guanajuato and the Pacific Ocean, all the time searching for rare manuscripts and artifacts. In Central America he went as far as Nicaragua, San Salvador, and Guatemala, where he found two extraordinary prizes: the *Annals of the*

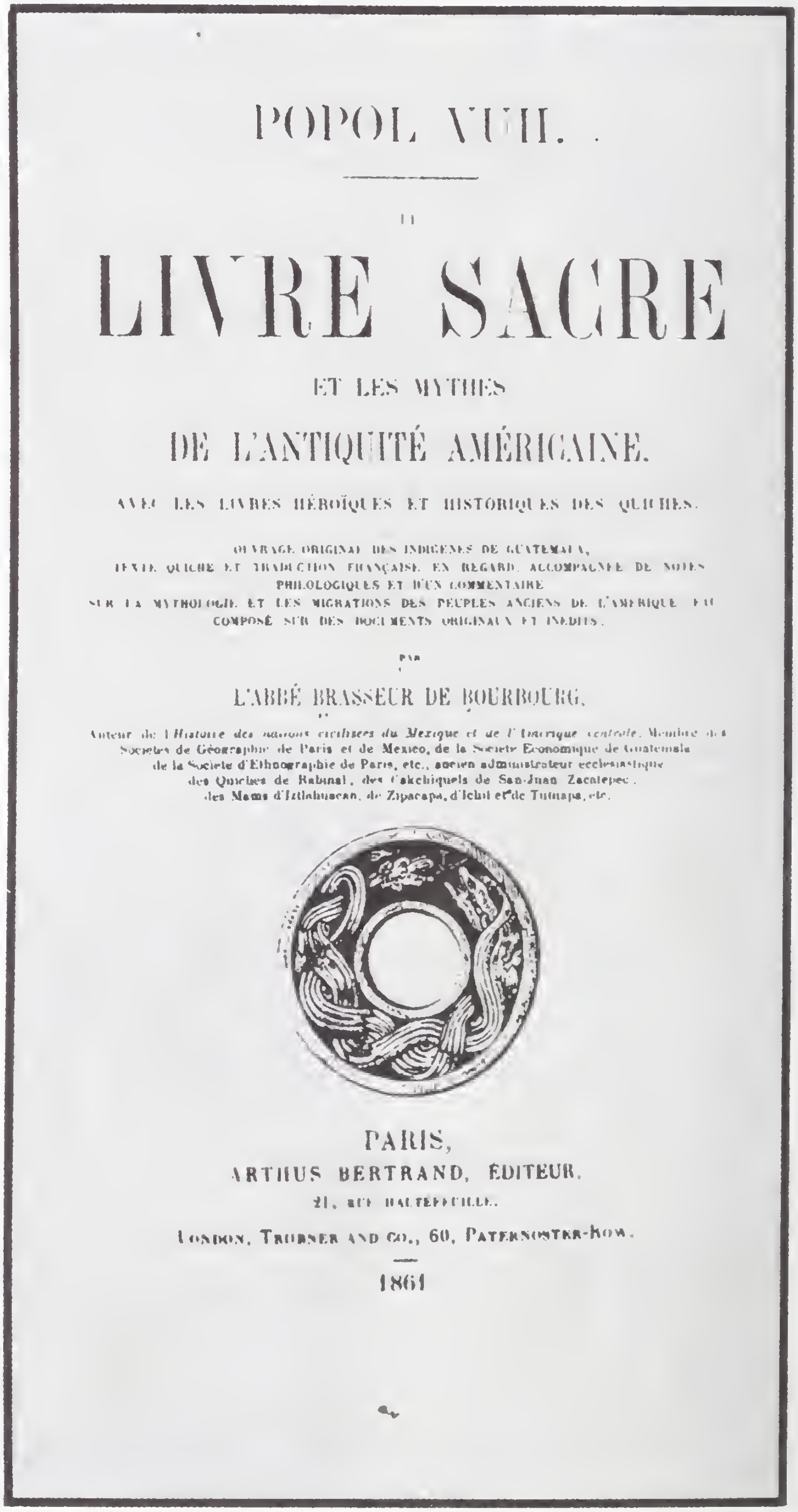
Brasseur de Bourbourg.

On shipboard en route to America, Brasseur de Bourbourg met the French Minister to Mexico, Levasseur, who made him chaplain to the French Legation, a position which gave Brasseur official access to many libraries in Mexico City where he found the works of Bernardo de Lizana, one of the earliest Spanish historians of New Spain, who believed Hispaniola had been colonized by Carthaginians who spread to Cuba and Yucatan. The notion was supported by Ixtilxochitl who believed the Olmecs had come to Eastern Mexico from the Antilles via Florida.

Poking about in secret archives, Brasseur found that thirteen separate chiefs appeared to have landed in the Gulf of Mexico at different times before Cortes.

From Ordoñez' manuscript on Palenque, which he also found in Mexico City, Brasseur learned that Cabrera had plagiarized and misunderstood Ordoñez. According to Ordoñez, though Votan's forefathers had come to the Antilles from Africa via the Canaries, Votan, the sixth chief of that name, was born in Cuba, whence he sailed up the Uzamacinta to found Palenque.

Cakchiquel and the *Popol Vuh,* both important historical documents which he translated by mastering the local dialects of Cakchiquel and Quiché. The *Popol Vuh* proved to be one of the great primitive epics, a collection of myths, history, and customs of the Indians.



POPOL VUH.

LE

LIVRE SACRÉ

ET LES MYTHES

DE L'ANTIQUITÉ AMÉRICAINE.

AVEC LES LIVRES HÉROÏQUES ET HISTORIQUES DES QUICHÉS.

OUVRAGE ORIGINAL DES INDIGÈNES DE GUATÉMALA,
TEXTE QUICHÉ ET TRADUCTION FRANÇAISE EN REGARD, ACCOMPAGNÉE DE NOTES PHILOLOGIQUES ET D'UN COMMENTAIRE
SUR LA MYTHOLOGIE ET LES MIGRATIONS DES PEUPLES ANCIENS DE L'AMÉRIQUE, ETC.
COMPOSÉ SUR DES DOCUMENTS ORIGINAUX ET INÉDITS,

PAR

L'ABBÉ BRASSEUR DE BOURBOURG,

Auteur de l'*Histoire des nations civilisées du Mexique et de l'Amérique centrale*, Membre des Sociétés de Géographie de Paris et de Mexico, de la Société Économique de Guatemala de la Société d'Ethnographie de Paris, etc., ancien administrateur ecclésiastique des Quichés de Rabinal, des Cakchiquels de San-Juan Zacatepec, des Mams d'Iztlahuacan, de Zipacapa, d'Ichil et de Tutuapa, etc.

PARIS,
ARTHUS BERTRAND, ÉDITEUR,
21, RUE HAUTEFEUILLE.

LONDON, TRÜBNER AND CO., 60, PATERNOSTER-ROW.

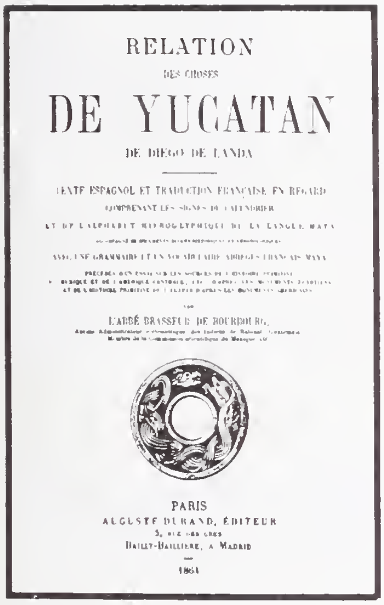
1861

The *Popul Vuh* or "common book of the people" containing national legends of the Quiche Maya was written at an unknown date in Latin script in the Quiche dialect by some native familiar with the ancient records. It was first translated into Spanish in the eighteenth century by the Spanish priest Francisco Jimenez and published in Vienna in 1857, attracting little attention. Brasseur's original text with his French translation in 175 pages of octavo was published in 1861.

Back in Paris, where he published the *Popol Vuh* in a French translation, Brasseur was given access to a private collection of unique Mexican documents and manuscripts collected over the years by J. M. A. Aubin, who had previously not allowed any scholar to view them. Aubin had gone to Mexico in 1830 attached to a scientific expedition, but the loss of all his instruments and thus of his means of working had obliged him to take a job as tutor to a rich Mexican family. The job allowed him enough leisure to search for rare and ancient documents, such as a priceless ritual calendar of the Aztecs, part of Boturini's scattered collection, which he obtained from the nuns of the Convent of Tonalama for a mere eight pesos.

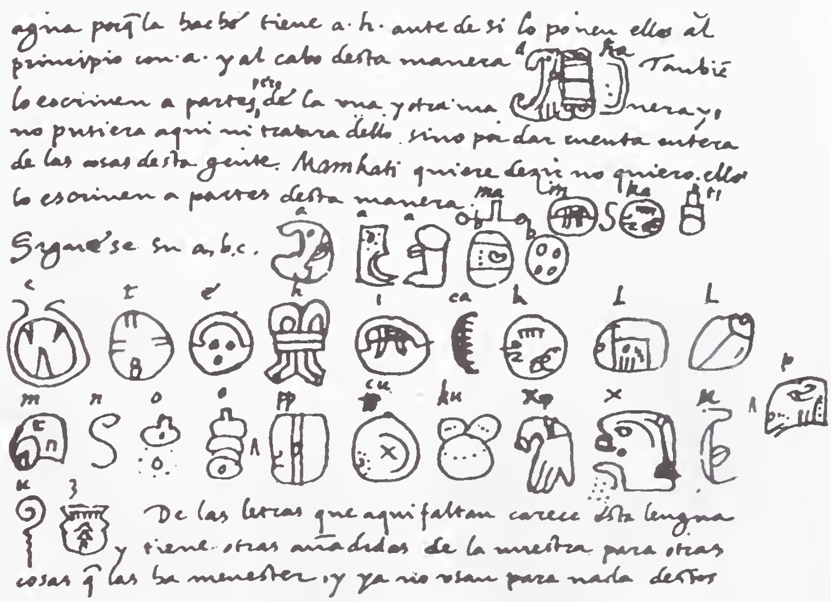
With access to Aubin's collection and from his own research among the Indians, Brasseur was able to produce and publish a much more impressive four-volume *Histoire des Nations Civilisées du Mexique et de l'Amérique Centrale,* which was greeted by the critics as the most comprehensive treatment of Mesoamerican history to have appeared in print. So impressed were the Spanish academicians, they immediately agreed to open their archives to Brasseur, so that in Madrid he was able to make even more significant discoveries. Buried in the archives of the Academy of History, where it had been lost for several centuries, Brasseur found Bishop Diego de Landa's manuscript *Relacion de las Cosas de Yucatan,* still today the single greatest source of information about the ancient Maya culture of Yucatan, which Brasseur immediately translated into French and published side by side with the original Spanish.

Landa's manuscript raised Brasseur's hopes of deciphering the Maya glyphs. In this he was only partially successful,


RELATION
DES CHOSES
DE YUCATAN
DE DIEGO DE LANDA
TEXTE ESPAGNOL ET TRADUCTION FRANÇAISE EN REGARD
COMPRENANT LES SIGNES DU CALENDRIER
ET DE L'ALPHABET HIÉROGLYPHIQUE DE LA LANGUE MAYA
PAR
L'ABBÉ BRASSEUR DE BOURBOURG
PARIS
AUGUSTE DURAND, ÉDITEUR
BAILLY-BAILLIERE, A MADRID
1864

Landa's book, written in about 1566, gave a history of Yucatan from native sources, with descriptions of the Mayan calendar and ceremonies. It also included drawings of glyphs for the 20 days, 18 months, and claimed to be a key to hieroglyphic writing.

Brasseur published the book in French in 1864, just a year after its discovery. In his introduction, Brasseur described his Atlantean position.


agua porq la hache tiene a. h. ante de si lo ponen ellos al principio con a. y al cabo desta manera
Tambie lo escriven a partes de la una y otra manera
no pusiera aqui ni tratara dello sino por dar cuenta entera de las cosas desta gente. Mamhati quiere dezir no quiero. ellos lo escriven a partes desta manera
Siguese su a, b, c.
De las letras que aqui faltan carece esta lengua y tiene otras añadidas de la nuestra para otras cosas q las ha menester, y ya no usan para nada destos

Mayan glyphs for the days.

The first column on the right is from Landa's *Relaciones*, the second is from the Troano Codex. The remaining four are from the Book of Chilam Balam of Káua.

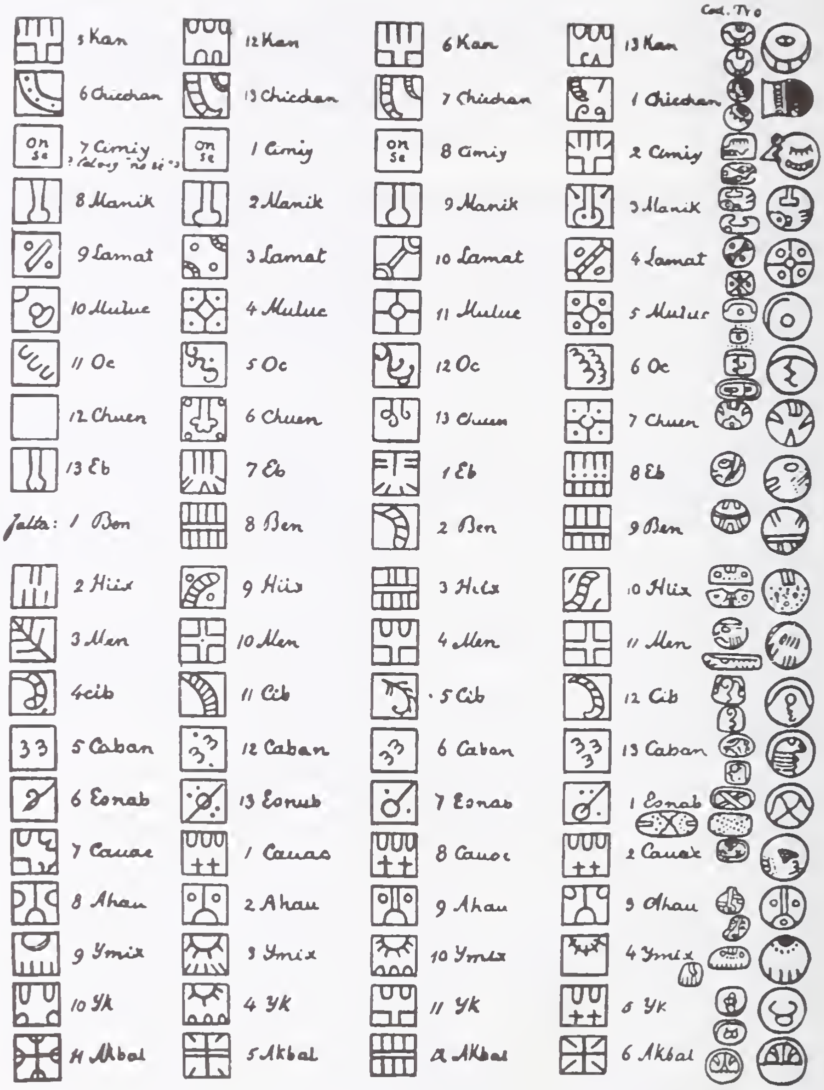
Operating on the premise that the Maya concocted composite glyphs with various meanings both symbolic and phonetic, Brasseur became overly sophisticated in the etymological nuances of meaning he attached to this or that position of a glyph. He thus got carried away by the momentum of his own notions about ancient Maya history.

Conversely, his history of Atlantis was built on a mixture of his interpretation of the Maya myths and of their hieroglyphs. Using Landa's basic interpretation of the glyphs, he read into those of the Troano Codex meanings which could substantiate the Atlantis legends.

His critics, anxious to put down Brasseur's linguistics, were equally delighted to put down his historical reconstruction of Atlantis, which did not fit their notion. Yet even Brasseur freely admitted the tenuous nature of his interpretation.

His critics, who considered him a better writer of fiction than of fact, believed his work was directed at proving preconceived ideas which they judged fanciful.

Later scholars, who discovered in the texts the most remarkable and sophisticated calendrical computers, could sympathize with Brasseur for his attempted readings in depth. He was on the scent but off the track. Brasseur believed the Troano Codex contained descriptions of part of a catastrophe which had resulted from the end of the last glacial period. He believed that the figures of the codex, though often gross in appearance and usually interpreted as the capricious efforts of superstitious genius, contain in fact the



identifying the twenty days of the month and the eighteen months of the year, as well as glyphs that personified various powers of nature, all of which was a steppingstone, but still not the Rosetta stone required for the unravelment of the mystery of the Maya glyphs.

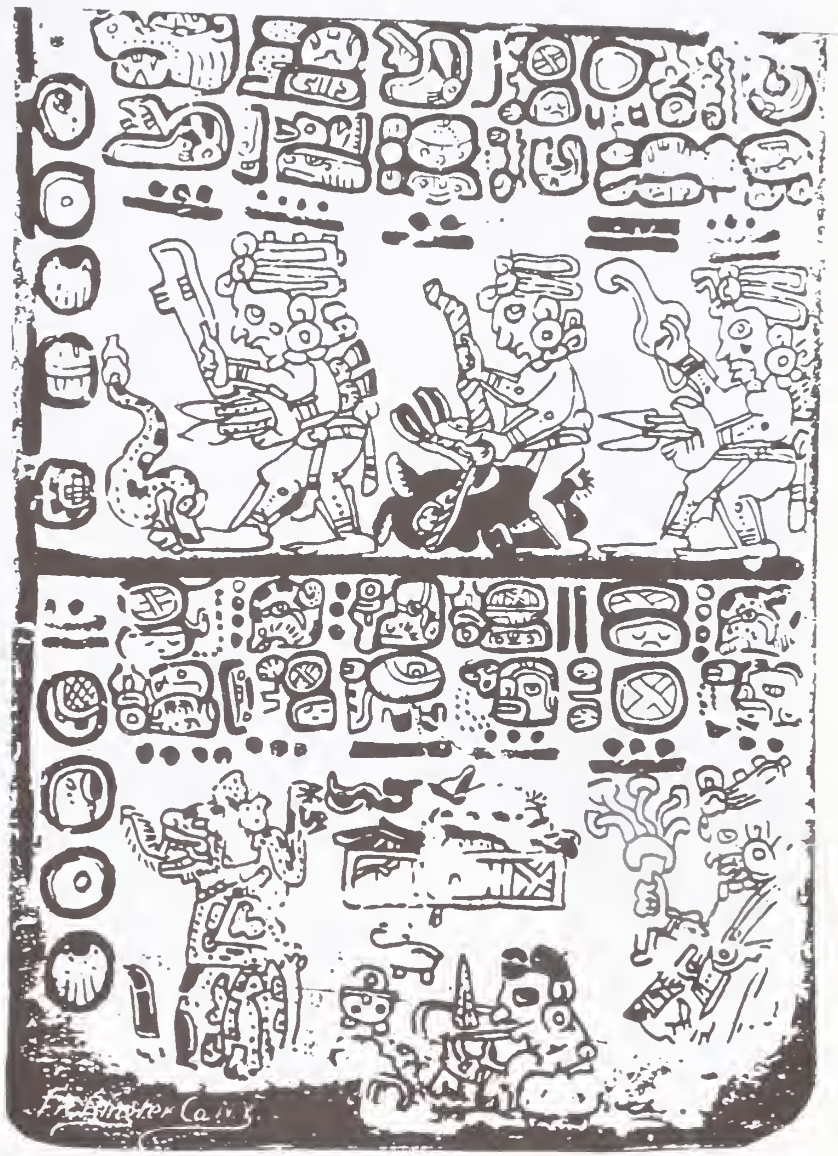
In Madrid Brasseur became acquainted with Jean de Tro y Ortolano, a descendant of Hernan Cortes, professor of paleography at the university, who showed him a document which had been in the family for centuries, a Maya book of divination first known as the Troano Codex till sometime later another half of it turned up and it became the Codex Tro-Cortesianus. In these early documents Brasseur found support for the myths still current among the natives of Mesoamerica that a great terrestrial convulsion had sunk an island in the Atlantic extending eastward in a crescent as far as the Canary Islands.

science of the ancient world; within the bizarre drawings he saw codified data about the geography, geology, and natural history of the ancients.

Brasseur believed that early migrations had been caused by passing comets, falling meteors, and other such calamities of extraterrestrial origin. He quoted Humboldt to the effect that primitive cultures were sometimes the debris of higher civilizations destroyed by natural catastrophes; and because he took seriously Humboldt's statement that myth could be history in disguise, Brasseur was accused of seeing history in every American myth.

Though he was derided for his method of attempting to unravel the secrets of the glyphs in this codex, he explained his reason for reading the manuscript from right to left with the sensible answer that the profiles of the figures faced in that direction. Modern experts have discovered that glyphs of the codices can be read not only up and down and left to right, but also diagonally to reveal sophisticated data.

The Codex is made up of two separate parts: the Troano, found by Brasseur in Madrid in 1864, consisting of 35 leaves or 70 pages which he chromophotoed in 1864, and the Cortesianus of 42 pages, which was found in Estremadura in 1867 and was believed to be a separate codex. The latter, refused by both the Royal Library in Paris and by the British Museum, was acquired by a private collector, José Ignacio Miro, who showed it to Leon de Rosny, discoverer of the "Paris" Codex. Unified into 112 pages, the full codex became the largest Mayan manuscript and was first displayed to the world in Paris in 1892.

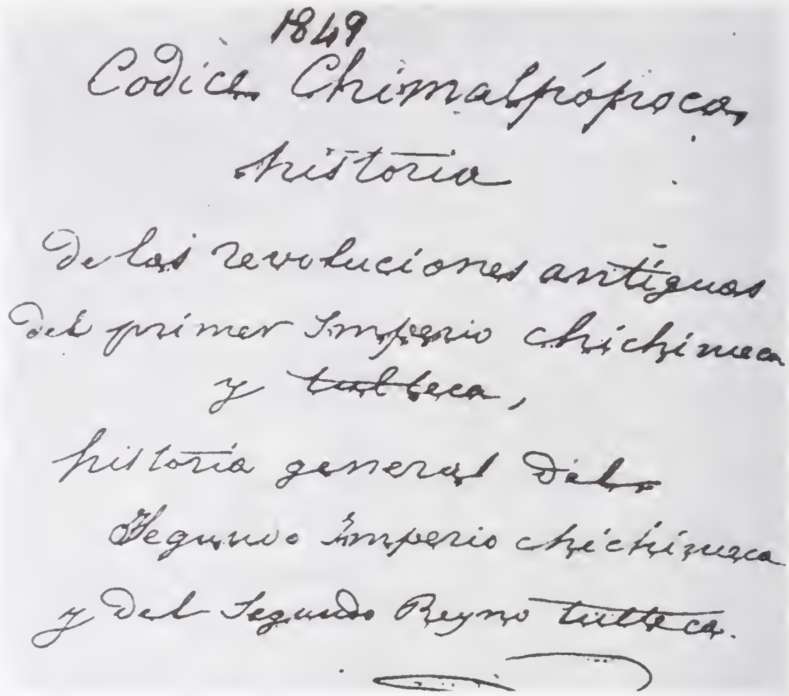


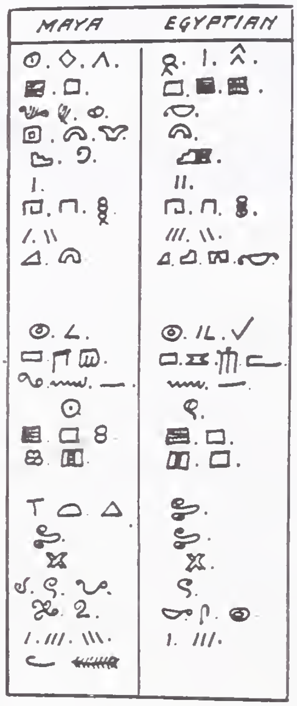
According to Brasseur, the Troano Codex placed the disappearance of this Atlantic continent in the year 9937 B.C. From this codex and from a Nahuatl manuscript purporting to be the history of the Kingdom of Calhuacan and Mexico, which Brasseur labeled the Codex Chimalpopoca, he deduced the revolutionary notion that civilization had originated not in the Middle East, as maintained by European historians, but in the West—in a large continent that stretched from America across the Atlantic, whence civilization had spread to Europe and to Egypt. Thus Brasseur explained the puzzling affinities he had found between the Mayan and the Quiché languages with Greek, Latin, French, English, and German. These languages appeared to him derivatives of Maya-Quiché.

Into the Nahuatl texts Brasseur read the story of a mighty cataclysm which had submerged the cradle of civilization

In the College of San Gregorio in Mexico City, Brasseur discovered a manuscript in Nahuatl to which he gave the name of Chimalpopoca Codex in honor of his teacher of Nahuatl, Faustino C. Galicia, who was a descendant of Montezuma's third son. Brasseur believed the codex to have been written in code so that each word had two or more meanings depending on the rhythm and cesura designed to enable the priestly scribes to conceal the history of the cataclysms and their cycles in a more banal and harmless-sounding text. From his translation of the Codex, Brasseur concluded that there had been not one cataclysm, as described by Plato, but a whole series which had shaped the world as it is today.

In his *Chronologie Historique des Mexicains,* Brasseur relied on the codex to say that in about 10,500 B.C. four periods of cataclysms had changed the world, and that each had been caused by a temporary shifting of the earth's axis.





A later comparison between Mayan and Egyptian alphabets.

millennia before Bishop Usher's still widely accepted Garden of Eden that dated back to 4000 B.C. From the text, Brasseur concluded that the American continent had originally occupied the Gulf of Mexico and the Caribbean Sea, extending across the Atlantic as far as the Canaries, but in some remote period it had been engulfed by a tremendous convulsion of nature. Subsequent upheavals, he believed, had restored parts of Yucatan, Honduras, and Guatemala to the surface.

Brasseur also traced the myth of Quetzalcoatl back to Plato's Atlantis and concluded that the Toltecs could have been descendants of survivors of that catastrophe.

Gradually Brasseur ascribed an increasing antiquity to the native cultures of Mesoamerica and came to believe that many of the truths of modern science had already been anticipated by the inhabitants of Mesoamerica many centuries previously. As he grew older, his cultivated notions grew out of step with those of his academic contemporaries. His penchant for seeing in the myths of antiquity explanations for what might have been actual history was too much for them. As one historian summed up the situation: "Unfortunately, as book after book appeared, his ideas grew more strange and his explanations more attenuated, so that serious leaders who had respected him increasingly lost confidence in his utterances."

Brasseur complained that no serious archeological work was being done in the Americas. That it was foolish to try to write world history leaving out one-half the world—the

Americas. He believed the Carians of Central America to have been the oldest known civilization, an industrious and commercial people who could handle metal and precious stones, great sailors and astronomers who had traveled the world, colonizing Atlantis, the Mediterranean, and ancient Egypt, whose astronomy, physics, and religious practices were similar, including a strong cult of Sirius, the Dog Star, and deification of the crocodile. From all of which Brasseur concluded that either Egypt had been a Central American colony or vice versa.

The American historian and bibliophile Hubert Howe Bancroft was to say of Brasseur that "In actual knowledge pertaining to his chosen subject no man ever equalled or approached him," but Brasseur's later writings were received by critics who were for the most part utterly incompetent to understand them; and more than a century was to pass before his prophetic intuition could be validated.

9. Reconquest of Mexico

William Hickling Prescott was born in Salem, Massachusetts, in 1796. His father was a lawyer; his grandfather, Colonel William Prescott, commanded at the Battle of Bunker Hill. Blinded in one eye by a crust of bread flung in the Harvard Commons, young Prescott was obliged to give up work in his father's law office in order to preserve his second eye, which had become paralyzed. So he devoted himself to literature, working in a darkened office with a noctograph, taking notes with an ivory stylus from what was read to him by a secretary. So proficient did Prescott's memory become that he could retain in his head the equivalent of sixty pages of printed matter, writing them and rewriting them as he walked or drove.

Meanwhile, William Hickling Prescott with his monumental *History of the Conquest of Mexico* had brought to the world the staggering story of the destruction of Montezuma's empire, making the exploits of Cortes common knowledge to the schoolboy. Using his family money to best advantage, and without ever moving from his native Boston, Prescott managed to accumulate the most extraordinary library of original data. First he gave large sums to a London bookseller to buy any book of interest that turned up on the subject of Mexico—no mean game, as Waldeck's, Del Rio's, Baradère's, and Catherwood's books each cost a fortune, and Kingsborough's nine folio volumes were coming off the presses at £150 apiece, or $3,500 the set.

Edward King, later Lord Kingsborough, an eccentric young Englishman who took seriously Humboldt's expressed desire that someone publish in book form all the known Mexican codices and manuscripts, hired an expert Italian draftsman, Agostino Aglio, and set about lithographing and hand-coloring reproductions of originals available in Europe, which had been brought back at various times since Cortes.

This was done between 1831 and 1848. Long commentaries in Greek, Hebrew, Latin, and Sanskrit, mostly in support of the theory that the Lost Tribes of Israel were the progenitors of the Maya, brought the opus to nine weighty and oversized folio volumes, one of literature's great tours de force, which no government had dared, and few individuals could have afforded or executed, but which executed its author because he too could not afford it. For failure to meet the price of the handmade paper on which the publication was printed, Kingsborough died miserably of typhus in a

Kingsborough took up the notion from Las Casas that the Lost Tribes of Israel had peopled Yucatan. Support for Kingsborough's version of the Mayan origin of the Lost Tribes of Israel also came from the Mormon story as told to the world by young Joseph Smith in 1827. According to Smith, in 1820, when he was 15 years old, a figure appeared to him in a vision claiming to be Moroni, son of Mormon, "sent from the presence of God."

During a second appearance, when Smith was 18, Moroni informed him where a number of gold plates were hidden containing writings in strange characters which Moroni termed as "revised" Egyptian. According to Smith's translation of these plates, the Israelites (progenitors of the Nephites, who were led by Lehi, a Jewish prophet of the tribe of Manasseh) had landed on the shores of Yucatan sometime after 600 B.C., when the tribe was divided.

The more unusual part of the Mormon version is that it tells how the Israelites came to America not via the Atlantic but via the Pacific.

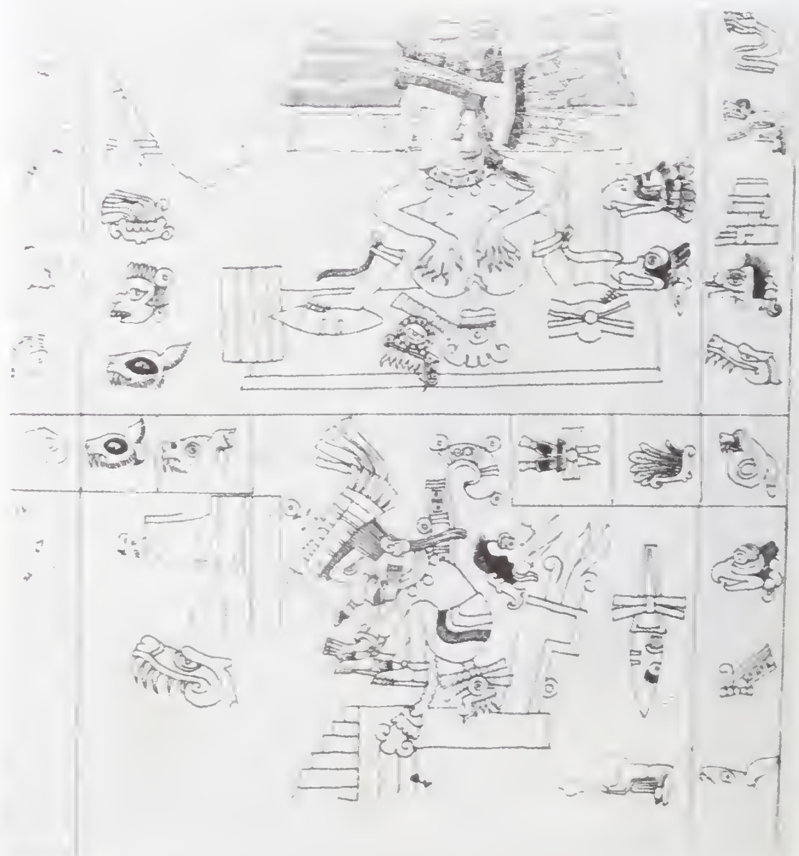
debtors' prison in Dublin, a demerit which prompted the British Museum to omit his name from its catalogue, mentioning only Aglio the artist. But Kingsborough, for his pains, did manage to force the world's societies of savants to focus their attention at last on ancient Mexico.

With such powerful but little-known ammunition, Prescott decided to corner the market and out-best-seller Stephens. From Boston, he persuaded a Spanish scholar living in London into ransacking the libraries of England, France, and Spain for material on Cortes. Taking advantage of a slightly more liberal spirit in the Spanish peninsula, Prescott then pulled his more stunning coup: he convinced the authorities to allow him to use the vast research accumulated by the official historiographer of the Indies, Juan Bautista Muñoz, who had died at the beginning of the nineteenth century before he could exploit the material. By special royal edict Muñoz had been allowed free access to the National Archives as well as libraries—public, private and monastic—in the Kingdom of Spain and its colonies.

To copy this material, Prescott hired a phalanx of scribes in Madrid under the supervision of a member of the Royal Academy of History, the German historian Friedrich Wilhelm Lembke. In Boston, Prescott received some eight thousand virgin folio pages of manuscript "on which," in his words, "the public breath had never blown."

Kingsborough's illustrations from the Codex Borgia of a strange figure representing Camaxtli, the Mexican god of fate, with the twenty day-signs attached to different parts of the body indicating different astrological effects they were believed to have on the various human organs. The interpretation is similar to Rodney Collin's thesis, detailed in his *The Theory of Celestial Influence,* that life energy is diffused from the sun through the various planets to the corresponding glands in the human body which they control.

Aware that noxious effects could also come from the cosmos, the Mexicans thus depicted their Goddess of Lust.



General Winfield Scott.

During his shorter conquest of Mexico for the U.S. Army in 1847, General Winfield Scott, known as "Old Fuss and Feathers," was accused by the Mexicans of having removed from the University of Mexico the remaining manuscript volumes of the works of Don Carlos de Sigüenza y Gongora, and of having transported them to Washington, D.C., where they were reportedly seen by the Mexican minister. A century earlier when Francisco Clavigero had consulted the remains of Sigüenza's works bequeathed to the Jesuit College of San Pedro y Paulo, he reported that only eight of the twenty-eight known volumes were available. A careful search in Washington, D.C., at the library of the Department of State, at the Library of Congress, and in the National Archives has so far been fruitless.

To this bonanza of unpublished material many learned historians from all over the world made contributions which helped Prescott produce his great *History of the Conquest of Mexico,* an instant success, quickly translated into scores of languages.

From the Kingdom of the Two Sicilies Prescott got more invaluable material: some from Count Camaldoli in Naples, more from the Duke of Senifalco in Sicily. In Mexico the incumbent representative of Cortes, the Duke of Monteleone, opened his family files, and the minister of foreign affairs, Don Lucas Aleman, gave Prescott his assistance both official and private, as did a man whom Prescott qualified as "a gentleman whose high and estimable qualities, even more than his station, secured him the public confidence, and gained him access to every place of interest and importance in Mexico," Don Angel Calderon de la Barca, minister plenipotentiary to Mexico from the court of Madrid.

Prescott, no longer able to read because he had nearly lost the sight of his remaining eye personally scrutinizing Stephens' four volumes on his travels in Yucatan and Central America, was obliged to produce his masterpiece from data read to him by a secretary in his Beacon Street studio, writing with a special case made for the blind which did not permit him even to see his own manuscript, the original draft of which he was never able to peruse or correct.

Knowing—as Humboldt had known from reading Careri—that descriptions of localities in Mexico only had that touch of verisimilitude when observed in person, Prescott relied for descriptions of living flora and fauna, and especially for details of such historic sites as the pyramids of Teotihuacan, on reports sent to him by Calderon de la Barca and, more especially, by Calderon's wife, Fanny. This Scottish lady had lived so long in Mexico that her book, *Life in Mexico,* based on letters to her family and friends, was used by the U.S. Army to indoctrinate the troops of "Old Fuss and Feathers" General Winfield Scott during his campaign against Mexico City in 1847, there being so little information available about the country.

Unfortunately, Fanny Calderon's description of the pyramids of Teotihuacan told more about herself and her style of living than it did about Mexico's antiquities.

As she approached San Juan Teotihuacan, the road, says Fanny Calderon, grew more picturesque and at length her attention was arrested by the sight of the two great pyramids, "which are mentioned by Humboldt and have excited the curiosity and attention of every succeeding traveler." Unfortunately, she adds, "our time was too limited to give them more than a passing observation."

Fanny Calderon de la Barca.

Fanny Calderon de la Barca and her husband, the Spanish minister to Mexico, set off at dawn on a spring day to visit the pyramids of Teotihuacan en route to a friend's hacienda. Their transport was a gilded calèche which had belonged to Charles X of France, drawn by six horses, driven by two coachmen with silver-buttoned and embroidered deerskin jackets, enormous sombreros and the high boots of a postilion, who produced wild shrieks to encourage the horses to gallop. For fear of bandits, several well-armed outriders galloped beside the calèche as it passed the cathedral of Guadalupe and crossed the marshy plain which had once been covered by the waters of Lake Texcoco. As Mexico had been for some years in the midst of a civil war, everywhere they saw the ruins of houses, whole villages crumbling, convents with broken-down walls, the abandoned country palace of a viceroy.

"Robbers" living in a half-ruined house helped them with a broken wheel, while several men with guns—"sporting looking characters, but rather dirty"—observed them but did not molest them, thanks to their own tough outriders.

Instead, the Calderons changed horses at San Juan and refreshed themselves on rancid sheep's milk and biscuits so hard that Calderon asked his host if they had been made in the same year as the church! The innkeeper, says Fanny Calderon, "seemed mightily pleased, and could not stop laughing till we got into the carriage."

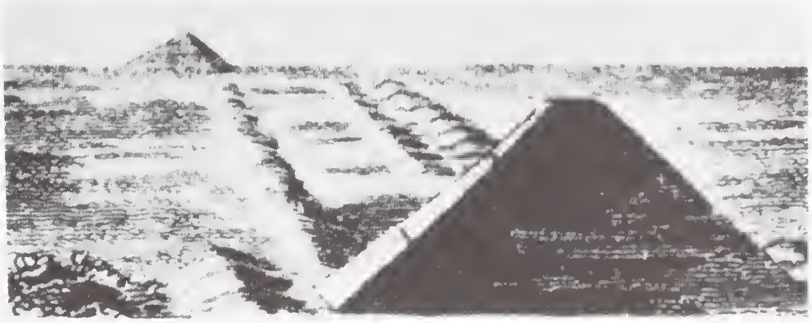
Mistaking Teotihuacan for Tenochtitlan, Fanny Calderon berated Cortes for his fanaticism in having ordered "the destruction of these bloodstained sanctuaries."

As a result, Prescott's description relied more on Humboldt than on Calderon, and is pleasingly atmospheric but none too correct.

> There are [wrote Prescott] no remains on the top of the pyramid of the sun. But the traveler, who will take the trouble to ascend its bald summit, will be amply compensated by the glorious view it will open up to him: towards the south-east, the hills of Tlascala, surrounded by their green plantations and cultivated corn-fields, in the midst of which stands the little village, once the proud capital of the republic. Somewhat further to the south, the eye passes across the beautiful plains lying around the city of Puebla de los Angeles, founded by the old Spaniards, and still rivalling, in the splendor of its churches, the most brilliant capital of Europe; and far in the west he may behold the Valley of Mexico, spread out like a map, with its diminished lakes, its princely capital rising in still greater glory from its ruins, and its rugged hills gathering darkly around it, as in the days of Montezuma.

Romantic Prescott! To have observed such a view from the Sun Pyramid, to have seen Puebla de los Angeles sixty miles to the southeast as the eagle flies, would have required a giant such as was described to the Spaniards by the Aztecs, or an airy Quetzalcoatl.

To describe the shape and condition of the steps of the Sun Pyramid, Prescott found himself with the conflicting reports of Bullock and of Henry Tudor, a barrister at law from London, who had visited the pyramids shortly after Bullock.



View for Prescott of the pyramids of Teotihuacan from Fanny Calderon de la Barca's book *Life in Mexico.*

Prescott went Humboldt one step further on the question as to whether the pyramids were built from outcroppings or from a flat plain. He compared them to the North American mounds and said they were built from scratch.

Tudor maintained that "it requires a particular position united with some little faith to discover the pyramidal form at all." Whereas Bullock contended that "the general figure of the square is as perfect as the Great Pyramid of Egypt."

As Tudor and his companions consumed—along with their picnic of turkey, tongue, and cold fowl—two dozen bottles of claret and Madeira, with which they "contrived to keep famine from the door," and then "rose from our rustic table like giants refreshed with wine" to visit the pyramids, it is perhaps Bullock's report that is the more sober.

Remarking that both men had been eyewitnesses, but that Bullock "has sometimes seen what has eluded the optics of other travelers," Prescott finessed the problem by taking refuge in a French lay to the effect that he was passing on information as he read it: *"Si com je l'ai trouvé éscrité/Vos conterai la verité."*

Relying on Humboldt, Prescott described the pyramids as being constructed of clay mixed with pebbles, encrusted on the surface with the light porous stone *tetzontli,* so abundant in the neighboring quarries. Over this, he said, the builders had placed a thick coating of stucco, "resembling in its reddish color, that found in the ruins of Palenque."

For a description of the hole found by Sigüenza in the south flank of the Moon Pyramid, Prescott relied on Charles Joseph Latrobe, former governor of Australia, who visited Mexico in 1834 in the company of Washington Irving and penetrated about fifteen feet into a gallery which he said was faced with unbaked brick, terminating in two pits or wells. Prescott mistakenly assumed these pits could have been "designed to hold the ashes of some powerful chief; like the solitary apartment discovered in the great Egyptian pyramid."

Like the first explorers of the mysterious passages and wellholes in the Great Pyramid of Cheops, Latrobe and a fellow-traveler, whom he referred to as McEuen, ventured into a snake- and scorpion-infested passage, the entrance to which has since been lost. "After undergoing a partial stripping," wrote Latrobe, "I proceeded to share in the glory and danger of the enterprise. I laid myself flat upon my face

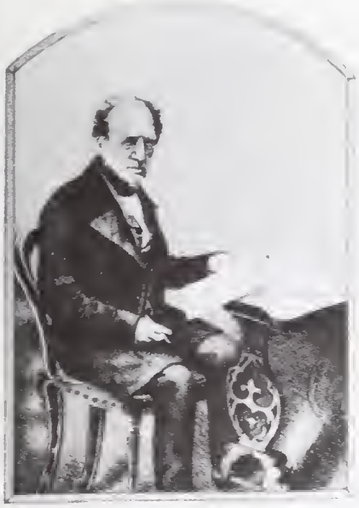
View of Tampico, where Charles Joseph Latrobe landed in 1834 to find everyone in the country armed to the teeth and bandits as plentiful as nopal bushes. From Mexico City, Latrobe lumbered off to San Juan Teotihuacan in a coach drawn by ten mules with faded trappings and brass-studded leather tailpieces. Looking back over Lake Texcoco, he saw the City of Mexico as a mirage, "the white edifices and colored domes of the capital appearing afloat, like a fleet of snowy sails, upon the blue surface of the water."

Between Lake Texcoco and Lake San Cristobal he noted that the 1500-foot dike and causeway, ten feet wide and four feet deep, which prevented the salty waters of one lake pouring into the other, had been built by forced labor with lassoed natives, hundreds of whom had died in the effort. He reported that in excavating for the building of the Guadalupe cathedral huge bones had turned up which he believed had belonged to mastodons used by ancient Mexicans to move great blocks for an earlier causeway.

Latrobe found Teotihuacan "emblossomed in shady groves irrigated by plenteous streams," and admired many moving pillars of dust as high as a hundred feet in the plain where "the great pyramids are perfectly distinguishable at a distance of many miles."

Climbing the Sun Pyramid, he found its surface to be a "stew of porous scoria and amygdaloid" and correctly estimated that the real base of the structure "lies below the level of the present soil, concealed by the wrecks cast down upon it."

In a hollow between two smaller pyramids at the foot of the House of the Moon, he described a large square mass with a sculptured face, saying the popular belief with regard to it was that anyone sitting down on it fainted.



Prescott gave the length of the Sun Pyramid as 682 feet, and its height as 180, which are Humboldt's figures translated into English feet, neither figure very correct. Prescott further compounded his error by comparing the size of the Sun Pyramid to that of the Pyramid of Cheops in Egypt, using Dominique Denon's figures obtained from *Egypt Illustrated,* which appeared in England in 1825, wrong by about thirty feet when compared with the almost perfect figures obtained by Jomard in 1799, of which Prescott was evidently unaware.

and ducking into the aperture squeezed myself blindly forward, with my candle, through a passage inclining downwards for about three yards when I found myself in an open gallery, at the termination of which, not many paces distant, I found two wells which I figured to be about the center of the pyramid." There Latrobe's companion McEuen "valorously allowed himself to be lowered by rope into the aperture on the left hand, to a depth of perhaps fifteen feet, without making any further discovery."

As Latrobe had been unable to find any other evidence of internal passages, what most preoccupied Prescott was to know who had built the huge structures. "Was it," he asked, "the shadowy Olmecs, whose history, like that of the ancient Titans, is lost in the mists of fable? Or, as commonly reported, the peaceful and industrious Toltecs, of whom all that we can glean rests on traditions hardly more secure? What has become of the race who built them? Did they remain on the soil, and mingle and become incorporated with the fierce Aztecs who succeeded them? Or did they pass on to the South, and find a wider field for the expansion of their civilization, as shown by the higher character of the architectural remains in the distant regions of Central America and Yucatan?"

Unable to find an answer, Prescott concluded, "It is all a mystery,—over which Time has thrown an impenetrable veil, that no mortal hand may raise. A nation has passed away,—powerful, populous, and well advanced in refinement, as attested by their monuments,—but it has perished without a name. It has died and made no sign."

The sign, had Prescott been able to see the pyramids, might have been before his eyes, a little more hermetic perhaps than in Egypt because of more crumbled walls, but evident nonetheless. At that moment in London the π proportion in the Pyramid of Cheops—that its height is to its perimeters as the radius is to a circle—was being worked out by a bookseller, mathematician, and amateur astronomer: John Taylor. But to extrapolate anything similar from the Teotihuacan structures would have required more careful measurements and scientific reconstruction, projects for which Mexicans were as yet unready and unwilling to expend a peso. They were bankrupt from half a century of civil war.

The liberal revolt, which had overthrown the last-gasp dictatorship of General Santa Anna and ushered in a movement known as the "Reforma" whose objective was the destruction of feudalism in Mexico, had turned into another civil war between conservative royalists and liberal constitutionalists, the latter under reformer Benito Juarez. In the process both sides had become heavily indebted to foreign countries and

Juarez.

Benito Juarez was born a mountain Indian. Orphaned as a child, he was brought to Oaxaca as a servant, where a Franciscan lay brother sent him to school. Quiet and reserved, but with a powerful logical mind, Juarez learned his Spanish and his lessons so well he got to law school. Elected to congress he became governor of the state of Oaxaca—which he found bankrupt and left with a 50,000-peso surplus.

As chief justice of the supreme court, Juarez succeeded to the presidency, but was obliged to flee the capital as the armed struggle renewed between the Catholic Royalists and the liberal republicans, the latter supported by Freemasons in both the Americas. Ironically, the policies of Juarez had been brought to the attention of U.S. readers by the London correspondent of the New York *Tribune,* an international exile by the name of Karl Marx. Juarez, in exile, received arms and supplies from New Orleans.

Early in 1861, after the most destructive war fought in Mexico, Juarez was able to enter the capital riding in a small black carriage. Known as "El Indio," he chose as his slogan "Nothing by force, everything through law and reason." But when the new Mexican congress narrowly chose Juarez president, the country was still in such turmoil that he was obliged to rule by decree, one of which expropriated all Church property and dissolved the religious corporations, leading to renewed civil war.

In the words of Manly P. Hall, the god of Juarez was "The Father of Freedom, served by a priesthood of liberation." His rebellion was not against God but against the theological institutions of Mexico.

The outlook of the higher clergy, who had accumulated and hoarded vast wealth, was authoritarian, monarchist, and anti-democratic, yet they felt bound to continue to interfere in politics.

The Mexican church continued to collect the high fees established under colonialism, higher than in any European Catholic country, as well as mandatory tithes. Marriage fees were so exorbitant that many of the lower classes could not afford them, and poor people raised stable families technically in sin without benefit of clergy.

The clergy refused to absolve, marry, or bury any Mexican who stood for the constitution of 1857. A priest, like an army officer, could not be tried in a civil court for civil crime. He went before an ecclesiastical court even if charged with legal debts. This infuriated Mexican jurists, because for sixty years the principle of equality before the law had been established in the advanced nations.

Vast numbers of monastics became idle, their missions defunct while the orders still retained large chapter houses and managed large estates. These monastics, says historian T. H. Fehrenbach, who had once been the finest, became "probably the most useless and corrupt of the Mexican clergy."

Napoleon III.

Wishing to emulate his uncle's cultural, archeological, and political exploits in Egypt, so as to unify the squabbling political parties of his empire "under a mantle of imperial glory," Napoleon III decided to take action in Mexico.

Jean-Frédéric Maximilien Baron de Waldeck.

When the French government insisted on paying Waldeck by the year instead of outright, because of his advanced age, Waldeck, already in his nineties, had the last laugh. Still an avid girl chaser, he used his yearly salary to entertain the beauties of Paris at government expense, and at the age of a hundred he married a 17-year-old—attributing his virility and longevity to a diet of horseradish consumed for six weeks every spring.

both had defaulted on their debts. Actually, Juarez had merely chosen to ignore an absurd French demand for 50 million pesos, plus 12 million in reparations, for a defaulted loan of a mere 750,000 from a Swiss banker who had subsequently assumed French citizenship. But Charles Louis Napoleon Bonaparte, as Napoleon III, was using the debt as a pretext to install by force a powerful Catholic and Latin empire in Mesoamerica under French protection.

To get a foot in the door, without upsetting either the Mexicans or his constituents in France, Napoleon capitalized on the publicity produced by Prescott, Stephens, Waldeck, and Brasseur to order his minister of public instruction, Eugène Viollet-le-Duc, to form a Commission for the Study of Mexican Antiquities, especially the pyramid complex at Teotihuacan.

Jean-Baptiste-Luis, Baron Gros, Napoleon's adviser on Mexico, who had visited the site and found a considerable analogy between the Mexican pyramids and those of Egypt, was put in charge of organizing a group of French experts to study the problem.

The French surveyors were to explore the site, establish the number of pyramids, as well as their situation and proportion, determine the nature of the blocks of which they were formed, and send some back to Paris. They were also to excavate interior galleries and ascertain whether there were any vaulted ceilings. Furthermore they were to record all the traditions preserved by the Indians in the vicinity, no matter how absurd or trivial those traditions might seem.

To produce some really prestigious works on Mexican antiquities, the French government commissioned Brasseur de Bourbourg to write a text to go with the engravings made in Yucatan by Waldeck, whom the government did not consider sufficiently founded academically to write his own text.

So Waldeck and Brasseur came together in the interest of Napoleon's grandeur.

To get more than a foot in the door of Mexico, Napoleon III overtly pressed the claim that Mexico's republican president, Benito Juarez, had defaulted on payment of the Swiss banker's loan. A military expedition was organized to collect the money, and a Catholic monarch, Archduke Maximilian of Hapsburg, brother of the Emperor Franz Joseph, was selected for enforcement on the Mexicans with the connivance of Mexico's royalist opposition to Juarez.

At noon of May 28, 1864, the Austrian warship *Novara* steamed into the harbor of Veracruz with the new thirty-two-year-old Emperor of Mexico and his twenty-five-year-old Empress Carlota, daughter to the King of Belgium.

Ferdinand Maximilian of Hapsburg and Carlota of Coburg.

Tall, blue-eyed, and blond-bearded, Maximilian was fundamentally a liberal interested in the arts and sciences who wanted to install in Mexico a government of honest ministers. Intelligent and hard-working, he had served well as royal governor and as head of the Imperial Austrian Navy. Carlota was an ambitious princess, daughter of Leopold I of Belgium. After the disaster that befell her in Mexico she went mad and lived in seclusion in Belgium until 1927.

Through practically deserted streets they were driven to the station of a rickety railroad that had been hastily built by the French to rush their troops out of the yellow fever area as far as Paso del Macho.There, Maximilian and Carlota transferred to old mail-coach *diligencias,* only to learn that Juarez' intrepid young republican general, Porfirio Diaz, was in the neighborhood with a body of guerrillas hoping to ambush the imperial suite. They too noted a countryside ravaged by forty years of civil war. For the steep ascent to the rocky plateau of Orizaba they transferred to horses, then back to coaches for a state entrance into Mexico City on June 12, an occasion sensibly celebrated by Maximilian with a general amnesty for all political prisoners.

10. Maximilian and Teotihuacan

Despite Maximilian's grand delusions, which included the hope of establishing a vast Hapsburg empire from the Rio Grande to the Rio Plata with the help of his younger brother, Ludwig Viktor, who was to marry one of the Brazilian princesses, Maximilian was fundamentally a liberal who honestly believed he had been called upon by the people of Mexico to end a civil war and set up an effective noncorrupt government based on "liberty and sincere love of progress."

He did not realize that in a country described by the London *Times* correspondent as "rotten to the core," where education was nonexistent, thieving and corruption general among all classes of officials, the Emperor of Mexico was no more than a prisoner of the reactionary group of clerical conservatives who had sought foreign intervention and the imposition of an autocrat on the people of Mexico solely to reverse the Juarez edicts which had secularized church property, suppressed religious houses, and abolished the privileges of the clergy. As for a mandate from the people, the situation was summed up by the British minister to Mexico, Sir Charles Wyke, who wryly observed that Maximilian might have had it in a few villages "possibly inhabited by two Indians and a monkey."

At the end of his first tour of the country Maximilian found its worst features to be the judicial functionaries, the army officers, and the greater part of the clergy. "None of them," he wrote, "are familiar with their duties, but live for money alone. The judges are corrupt, the officers have no sense of honor, and the clergy are lacking in Christian charity and morality."

To add to his problems, Maximilian promptly outraged Pope Pius IX, who had warned him in Rome that "the rights of the

Chapultepec Palace.

On "the hill of the grasshopper" on the outskirts of Mexico City, the palace of Chapultepec was built by Viceroy José de Galvez in the eighteenth century on the spot where the Mexica had first settled and where Montezuma had his summer quarters, surrounded by a garden enlivened by wild game under towering cypresses sixty feet round at the base. A powerful source of water which sprang from the hill had been tapped by the early Mexica and carried by aqueduct to the great city of Tenochtitlan, where its flow, according to Cortes, was as thick as a man's body.

people are great and it is necessary to satisfy them, but the rights of the church are greater and more sacred." By crossing the Pope and insisting on a separation of state and church, on freedom of religion, and on nationalization of Church property, Maximilian unwittingly signed his own death warrant.

Seeing himself as an enlightened humanitarian, he had quickly turned to improving the cultural and educational level of his adopted country and to cleaning up and beautifying its capital, wandering, like Montezuma, through the streets incognito to see that everything was progressing as it should.

With Carlota he first tried to live downtown in the Palacio Nacional, but the rooms were so small and cramped, leading from one to another like a railroad train, that he decided to move to the former viceregal palace on Montezuma's favorite spot, Chapultepec Hill.

There the young couple found the premises so filthy and in such poor repair that Maximilian had to spend his first night on the billiard table to avoid the vermin in his bed. More romantic in her outlook, Carlota was enchanted with the view over the city and the valley ringed by lakes, green fields, and the snowcapped volcanic peak of Popocatepetl in the distance, a view she considered superior to that of the Bay of Naples.

Childless—apparently because of a venereal disease communicated to her by Maximilian, who had contracted it from a Brazilian prostitute in his travels—the Empress had much time to devote to the affairs of state and to cultural pursuits. With her beautiful young Indian lady-in-waiting, Josefa Varela, a direct descendant of the Aztec poet king, Netzahualcoyotl, she visited many of the antiquities of Mexico, going as far as Uxmal, where she was struck by the extraordinary emblems of phallic worship, a painful reminder that her own lovemaking days were over. Whereas Maximilian, with the pick of the court at Chapultepec, was having a child by his gardener's wife at the Borda Gardens in Cuernavaca, a haunt he so favored that he had it linked to the capital by a better road, patrolled by French troops against bandits. Maximilian's taking of an Indian mistress, far from being frowned on by the Mexicans, was regarded as a token of his affection for his adopted country; but the result of the union was to have a sad consequence. Maximilian's son, named Concepcion Sedano y Lequizano, for his "legal" parents, grew up in France as somewhat of a wastrel who sported a beard like his father and took pride in being known as "the imperial bastard." On October 10, 1917, in Vincennes outside Paris he was executed by a firing squad as a convicted spy for the Germans.

To link the residence at Chapultepec with the Palacio Nacional in the Plaza Mayor, Maximilian directed the construction of one of the grandest avenues in the world, intentionally outdoing the Champs Elysées of his patron Napoleon III. First called the Calzada del Emperador, it was later more democratically renamed the Paseo de la Reforma.

On the first anniversary of his acceptance of the throne, Maximilian founded the Academy of Science and Literature, negotiating with a well-known Mexican book collector, José

Throughout Mayaland there is evidence of a former phallic cult similar to that of the Phoenicians, and to the cult of Osiris, which was concerned with life and death and fecundity in all its forms. Almost all the ancient races worshiped the yoni and the phallus as appropriate symbols of God's creative power. According to Manly P. Hall, the Garden of Eden, the Gate of the Temple, the Veil of Mysteries, the *vesica piscis*, or oval nimbus, and the Holy Grail are all important yonic symbols. Whereas the pyramid, the obelisk, the cone, the candle, the tower, the Celtic monolith, the spire, the campanile, the Maypole, and the sacred spar are all symbolic of the phallus.

An anonymous conquistador describing phallic worship in Mexico wrote, "In other provinces, particularly Panuco, they worship the member of the body which is between a man's legs: they have it in the mosque and also set in the square, together with figures in relief showing all the kinds of pleasure that can exist between man and woman and they have these pictures with legs raised in various ways."

Maria Andrade, for a magnificent 5,000-volume library of printed books and manuscripts relating to Mexican history and culture with which to form the nucleus of an imperial library for the use of the entire nation. He also established a national theater under the direction of the poet José Zorrilla, offering from his own private funds substantial prizes for the best plays written.

The National Museum was transferred from the university to the Palacio Nacional, where it stayed for exactly one whole century before it was moved to the modern Museo Antropologico. For the museum Maximilian sought to regain from abroad various relics such as Montezuma's shield and the original manuscript of a report from Cortes to Charles V, which had found their way into the imperial collection in Vienna. He also set about collecting the portraits of Mexico's former rulers, which had been scattered during the years of the civil war.

In the field of education Maximilian hoped to organize a system on such a scale that Mexico could "take its place by the side of the leading nations of the world." Of Brasseur de Bourbourg he thought so highly that he offered him the directorship of education and museums in his new government; but Brasseur, with a twinkle, declined, saying, "I never like to travel with the army."

So appalled was Maximilian by what he considered a shocking lack of interest demonstrated by Mexicans in the monuments of their own past, he organized the first genuinely scientific commission to study Mexican antiquities, with a

By careful astronomical observations the commission finally obtained more correct coordinates for both great pyramids. They set the Moon Pyramid north of the equator by 19 degrees, 41 minutes, and 52.8 seconds, and west of Paris by 6 hours, 35 minutes, and 18.32 seconds. The Sun Pyramid they placed 26 seconds of arc closer to the equator and 2 seconds of time nearer Paris. (The modern figures for the Sun Pyramid's latitude are: 19° 41′ 30″ north of the equator. Its longitude is 98° 50′ 30″ west of Greenwich.) The commission also established that the Sun Pyramid's west flank did not lie on the astronomical meridian running north-south, as Humboldt and others had suggested, but was angled about 15 degrees east of north. However, Almaraz noted that a line drawn between the vertices of the two pyramids did point very close to magnetic north, which did not particularly impress him, as magnetic north continually varies, but indicated to him that the pyramids' builders might have had a better notion of the apparent motion of the heavenly spheres, caused by the earth's rotation on its axis, than had previously been supposed.

Almaraz assumed that their error of a couple of degrees could have been due to the ignorance of the fact that the pole star is not, and was not, at the actual pole of the heavens, but circles around the pole at a varying distance, which in Almaraz' day was 1 degree 25 minutes.

particular emphasis on the ruins of Teotihuacan. The commission consisted of several eminent Mexican engineers under the direction of engineer Ramon Almaraz.

To reach the top of the Moon Pyramid, Almaraz found a stairway or zigzag ramp which started halfway up the facade, decreased proportionately, and ended in the center of the upper level; the zigzags were clearly visible on the plan he submitted. He also noted that the south facade of the Moon Pyramid had another pyramidal structure applied to it, or *adosado* as he called it, which reached a height of twenty-one meters.

At that level Almaraz found a deep excavation in the face of the pyramid, evidently Sigüenza's and Latrobe's hole, running north-south, with lateral excavations running in different directions, which he attributed to treasure seekers.

The only noteworthy feature appeared to Almaraz to be the square well which descended vertically within it, with walls formed of rows of volcanic brick held together by mud, only the southerly wall of which was slightly dilapidated.

So well preserved was this hole that Almaraz hoped to extrapolate from its measure the basic unit used by the builders of the entire complex. Very carefully he measured the well as being 1 meter 6 centimeters square.

In an intuitive flight of fancy, Almaraz suggested that as all the common units of measure in use in his time—the meter, the yard, the ana, the elle, and the vara—were more or less the same length, a similar unit might have been used at Teotihuacan. But wherever else he looked, Almaraz found

Teotihuacan pyramids with Moon Pyramid in foreground.

Almaraz described the Moon Pyramid as being on a rectangular base 156 meters long by 130 wide, covering a surface of 20,280 square meters, or 5 acres, which was within 2 percent of being accurate. He estimated its height as 42 meters, which is within a meter of the most sophisticated estimate to date.

Almaraz also saw the Moon Pyramid as originally being formed of three superimposed bodies, each about 10 meters high, only one level of which could be clearly distinguished at 21 meters from the base. He said he could see no evidence of levels on the east side, which had the aspect of an inclined plane with no break or fissure. Time, weather, and the hand of man, said Almaraz, had destroyed much of the original surfaces, causing crumbling and the obliteration of the ridges, so that the pyramids, without their original outlines, seemed at first sight to be hillocks rather than raised monuments.

To what was known of the exterior of the Sun Pyramid the commission did not add much, other than to confirm that it appeared to be divided into three stories and had a zigzag path leading to the summit, which was in better condition than the path up to the Moon Pyramid.

buildings too dilapidated and covered with rubble and earth to be accurately measured. At last in the ruins of a nearby mound, or *tlaltel,* as the Mexicans called it, Almaraz found a well-preserved piece of sculpture lying face down in the mud, which had preserved its sharp contours. Raising the statue, he found it to be a carved parallelopiped 3 meters 19 centimeters high with a square base of 1 meter 65 centimeters. This clearly gave it a height almost exactly three times the 1.06-meter width of the well, and a width 1 1/2 times that of the well.

But for some reason, instead of selecting this 1.06-meter unit, which varied no more than 6 percent from any one of the units in common usage, Almaraz chose 3/4 of that length, or 80 centimeters, which varied from all of them by more than 20 percent, on the theory that the statue was intended to be 4 units high by 2 units wide, instead of the more obvious 3 by 1 1/2 or possible 9 × 18 palms.

Almaraz also settled on the 80-centimeter unit because the distance between the Moon and the Sun pyramids was effectively 800 meters, giving a round 1000 units—a figure which pleased his francophile decimal point of view.

No attempt was made by Almaraz to compare this unit of 80 centimeters with any of the ancient units of measure found by Jomard to have been incorporated into the Great Pyramid of Cheops, presumably because Almaraz was unaware of the work of Jomard.

Because of earth and rubble around the base of the Sun Pyramid, it was difficult for Almaráz and his fellow engineers to even measure its length; but they obtained a figure of 232 meters along the west facade, very close to the 231 meters of the base of the Great Pyramid of Cheops, correctly estimated by Jomard. Though Almaraz also had no way of knowing this, as the correct length was not officially established until 1925, when the base of Cheops was cleared of a thousand years of accumulated rubble.

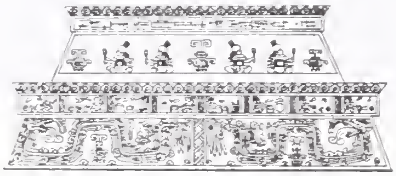
Scouting around the base of the Sun Pyramid, the members of the commission came upon a huge platform forty meters wide and six meters high which bordered the Sun Pyramid on the north, east, and south sides, forming a raised platform with *talud* facings.

South of the Sun Pyramid, in the area which the early Spaniards had called the Citadel, the commission found a similar platform twice as wide with walls ten meters high, except for the one facing the Way of the Dead, which was only five meters high. On these platforms were fourteen mysterious *tlalteles,* or mounds, symmetrically arranged, four each on the north and south sides, three on the east and west.

In the center of the large quadrangle formed by the platforms were the remains of another *tlaltel* with a stairway on the west face, and slightly ahead of it another smaller *tlaltel.*

Almaraz says that throughout the pyramid complex he found scores of smaller *tlalteles* that looked like hillocks, some built in a symmetrical pattern, others scattered with no apparent regularity. In the plaza before the Moon Pyramid he found a group of *tlalteles* which appeared to form a sort of circle around a central one. These had been much excavated, partly, says Almaraz, by searchers after archeological remains, but mostly by "rapacious and ignorant" persons in search of treasure. What most outraged Almaraz was the evidence that the entire area had been used as a quarry for stones for "the barbarous habitations" of the natives. In the houses of the village of San Juan he saw that many valuable carved stones had been broken up to form walls.

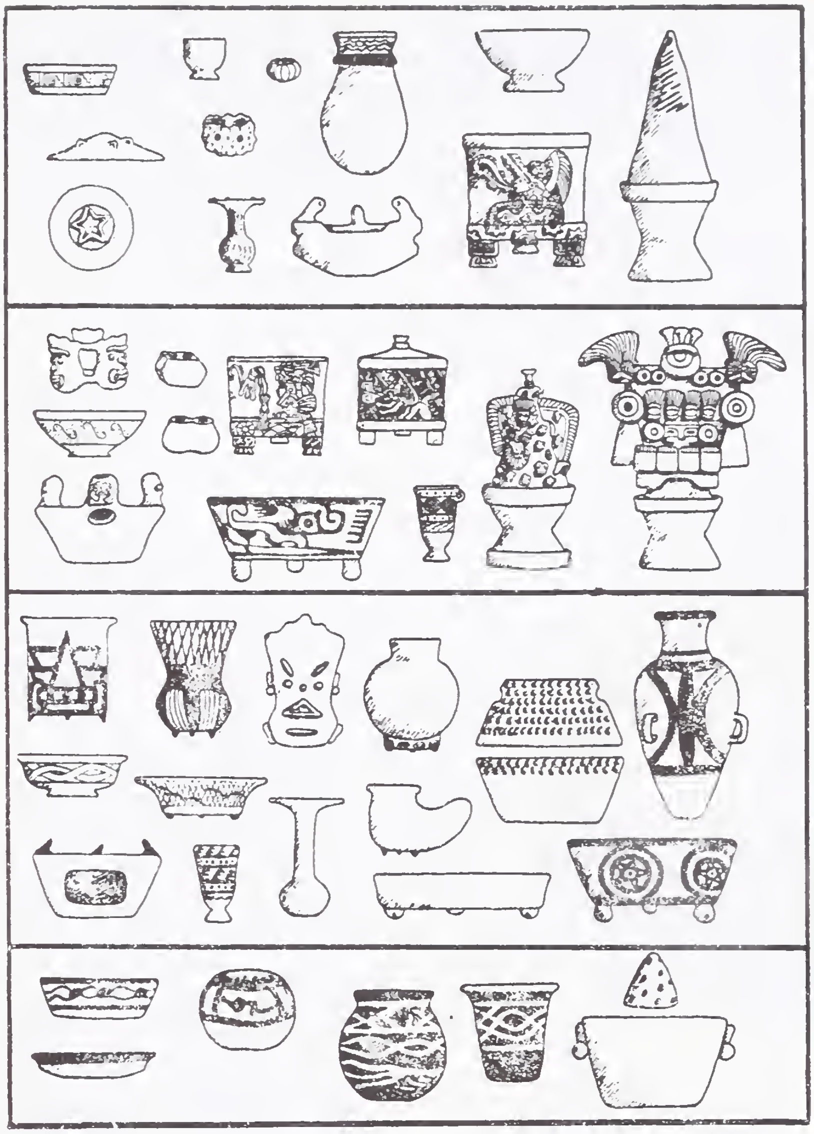
In one of the *tlalteles,* Almaraz found eight worked stones, also just over a meter wide, whose outer faces were carved to represent grotesque figures with the heads of serpents and tigers. The carving had apparently formed a circular monument just over five meters in radius, now chipped and broken, though one carving was sufficiently preserved for him to make a sketch. In the same *tlaltel* there were other sculptured stones in which Almaraz recognized the lineaments of a jaguar and a figure he could not make out.



Reconstructed *tlaltel* or platform temple.

Told that in an earlier excavation of one of the *tlalteles* a small stone coffer had been found containing a skull, various *cuentas,* and curious objects of beryllium, serpentine, heliotrope, and obsidian, as well as large quantities of gold dust in golden vases, Almaraz would have liked thoroughly to gut one of the *tlalteles,* and perhaps even dig a passage through the base of the two great pyramids, but was prevented from both endeavors by lack of personnel and funds. He also suggested that the entire area of ruined houses should be properly and thoroughly mapped, "as intelligent and respectable men have been suggesting for some time."

Almaraz says that at the very beginning of his efforts at Teotihuacan he decided not to draw conclusions about ancient times, but only to occupy himself with relating how he found things as they were. In the end he could not resist expressing an opinion—an opinion which only went to confirm that first impressions are inclined to be best. He said he first thought the pyramids had been intended to represent a system of planets, but in the end concluded they were merely temples and sepulchers dedicated to illustrious men. Almaraz also concluded that the ruins represented the work of several different epochs, because he had found buildings raised above the foundations and ruins of earlier buildings, as if to hide or protect the more ancient ones. It also appeared to him



Various styles of pottery found in Teotihuacan.

that many of the houses had been abandoned by their masons because of some great catastrophe.

Almaraz was greatly puzzled by the evident antiquity of the monuments and the mystery of the people who had built them, whose history was entirely unknown.

He marveled at the enormous work involved, the quarrying and moving of such great amounts of stone over long distances, all of which, he remarked with a touch of pathos, "did not even serve to keep alive the names of the architects, gods, or potentates in whose regime the structures were built."

As a final warning, he said he had to admit that all of what he had surmised was nothing but conjecture, without fundament or sort, resting on neither historical material, "which I did not have the means to consult," nor on archeological knowledge, "to which I did not have the opportunity of dedicating myself," but mostly on what he had picked up at the table from his mess companions.

Achille Francois Bazaine, born in 1811, served in Algeria, the Crimea, and Lombardy before coming to Mexico where he was made a Marshal of France in 1864. At Maximilian's court he developed a penchant for very young girls, one of whom he married in the presence of Maximilian, and was soon distracted from his military duties. To cover up his negligence and incompetence, Bazaine double-crossed Maximilian and left him in an untenable position both militarily and politically.

Responsible for the disastrous defeat of Napoleon III at Sedan in 1870, Bazaine was found guilty of negotiating with, and capitulating to, the enemy; but his sentence of degradation and death was commuted to twenty years in jail. In 1874 he escaped to Italy and thence to Madrid where he died in 1888.

For a truly scientific and detailed exploration of Teotihuacan, Almaraz said more money and more personnel were needed. But Maximilian's coffers had been emptied; the imperial government had been required to pay the full penalty for the defaulted Swiss banker's debt, all the costs of the French intervention, plus a thousand francs for every French soldier serving on Mexican soil; and the political and military situation had so deteriorated that no further attention could be paid to cultural pastimes such as the pyramids. The United States, resolutely determined not to acknowledge the existence of Maximilian's government, had continued to accredit its representative to the rival republican government of Benito Juarez. The moment the Civil War in the States was ended and it was clear that the Monroe Doctrine could once more be enforced, Napoleon III gave up his dream of a Catholic state in Central America and decided to cut his losses, leaving Maximilian in the lurch. He ordered his military commander, Marshal François Achille Bazaine, to secretly start withdrawing French troops from Mexico. Perfidiously, Bazaine even offered to sell large quantities of French arms for cash to the opposing

Diaz as a general in the republican army fighting against French interventionists.

Maximilian, Emperor of Mexico, was fetched from his quarters to be executed on a hillside outside Queretaro, on the morning of June 19, 1867, only three years after his arrival in Mexico.

Maximilian and his two remaining generals, Miramon and Mejia, were awakened to a fanfare of bugles and drums. When Maximilian asked Miramon, "Miguel, is this for the execution?" Miramon replied, "I cannot say, señor, as I have not been shot before."

General Porfirio Diaz, who had romantically escaped from prison in Puebla by lowering himself from a window on a knotted rope. When Diaz refused, Bazaine ordered the equipment destroyed rather than give it to Maximilian's weakened forces. At the same time Bazaine, despicably, persuaded Maximilian to save himself by issuing the infamous "Black Decrees," which ordered summary execution for all republicans caught in arms. That was the end. Though Maximilian had acquired adherents by his disarming manners and personal charm, he now found himself cornered. Juarez besieged him at Queretaro with the help of Porfirio Diaz. Betrayed into their hands, Maximilian was executed by firing squad on a nearby hilltop, dying like Hidalgo, crying "Viva Mexico!"

Again there was a dismemberment and disposal of valuable books and manuscripts about Mexico and its antiquities. Maximilian's confidant, Father Augustin Fischer, a Jesuit priest who drank heavily and was rumored to have numerous illegitimate children scattered about Mexico, tried to sell several of Maximilian's private papers.

It was an odd twist of fate, for Maximilian, as the natural grandson of Napoleon I, would have been closer by blood to the Imperial line of France than was his cousin Louis Napoleon III, who stood in line merely as the son of Napoleon I's brother Louis and of Josephine's daughter, Hortense. There is every indication that Maximilian's natural father was the Imperial dauphin, known as the King of Rome and more fondly as l'Aiglon, son of Napoleon I, and of the Austrian Archduchess Marie Louise. As the Duke of Reichstadt, the title by which Metternich insisted l'Aiglon be known at the Hapsburg court, he was much in love with and much loved by Maximilian's mother, the Archduchess Sophie, with whom he may also have fathered Franz Joseph, Emperor of Austro-Hungary, cuckolding his legal father, the dull-witted Archduke Francis Charles of Hapsburg.

The Andrade collection, which had not been paid for, was hastily packed up by its owner during the last days of the empire and transported on muleback to Veracruz, where it was shipped to Europe and sold at auction in Leipzig for $16,500. Many of the rare printed books and pamphlets on Mexico were acquired by the American historian Hubert Howe Bancroft and now form part of the Bancroft Library at the University of California.

Maximilian's execution put the quietus on further archeological speculation about Teotihuacan. Mexicans were more interested in the perils and possibilities of their own immediate future than in the wonders of their remoter past.

11. Foreign Intervention

The world's interest in Mexican antiquities might have withered during the next decades had it not been for the efforts of three Americanized Frenchmen, two of them adventurers, one of them a robber baron, Pierre C. Lorillard.

On vacation from teaching school in New Orleans in 1850, Claude Joseph Désiré Charnay, a young man in his early twenties, was so struck by the mysterious beauty of Mexico that he went back to France to induce Napoleon III's minister of fine arts, Eugène Viollet-le-Duc, to give him an assignment to photograph Mexico's ancient ruins with a recently developed camera obscura. Carrying the dark chamber on his

Désiré Charnay deep in the Mexican jungle with his camera obscura.

back and nursing the large glass plates on which to mix his own emulsion, Charnay got back to Mexico in 1858 for a three-year jaunt from Mitla to Monte Alban, to Chichen Itza, to Uxmal, and to Palenque. The result of these travels was a folio volume containing the first but certainly the drabbest photographs ever taken of Mexican antiquities, for which Viollet-le-Duc produced an equally drab academic text in which he came to the not surprising conclusion that an advanced civilization had once covered North, Central, and South America, well before the beginning of the Christian era, reaching its apogee several centuries before the Spanish Conquest, by which time it had broken up and fallen into decadence.

Charnay followed his folio volume with a personal memoir in octavo in which he entertainingly described the frustrations of trying to photograph Mexico under the most grueling and uncomfortable conditions. More of a vulgarizer than an academician, Charnay spiced the memoir with salacious anecdotes about the attractive Mexican maids he had encountered, telling of a sixteen-year-old who was highjacked from the coach in which they were both traveling to be raped by six tall bandits; of a sterile young wife whose Yucatecan husband, believing all foreign archeologists to be doctors, begged him to examine closely his wife's malfunctioning organ, for which Charnay successfully prescribed the dexterous use of astringent aloes and a camphorated candle; and in Mexico City of the whores who would reward a statue of the Virgin Mary with portions of their nightly earnings in return for a regular flow of clients.

In the hope that the government of Napoleon III might finance him on another trip to Mexico, Charnay unctuously dedicated his opus to "the Emperor whom nothing escapes

Charnay climbed Mount Popocatepetl, from which he was able to view simultaneously through the crystal air the shining cupolas of Mexico City and the belltower of Puebla sixty miles away.

of that which is useful, noble or grand, who knows how to honor merit and encourage modest work."

Unlike the Abbé Brasseur, whom he admired, Charnay was not averse to traveling with the army. As a result he got himself back to Mexico in 1864, only to be told to hurry up and wait, finally succumbing to the general debacle of Bazaine's army which followed Maximilian's execution in 1867.

Still determined to succeed, Charnay spent the next twenty years looking for a backer, until he managed to convince the Carolina tobacco tycoon Pierre Lorillard to underwrite for him, in conjunction with the French authorities, a proper research expedition to Mexico. Charnay complained, not altogether unjustly, that because most writers, especially North Americans, had taken to describing the ruins of Mexico more on the basis of what casual travelers told them than on any careful exploration of the sites, he wished to obtain permission from the Mexican government to actually dig in the soil for remnants of the past.

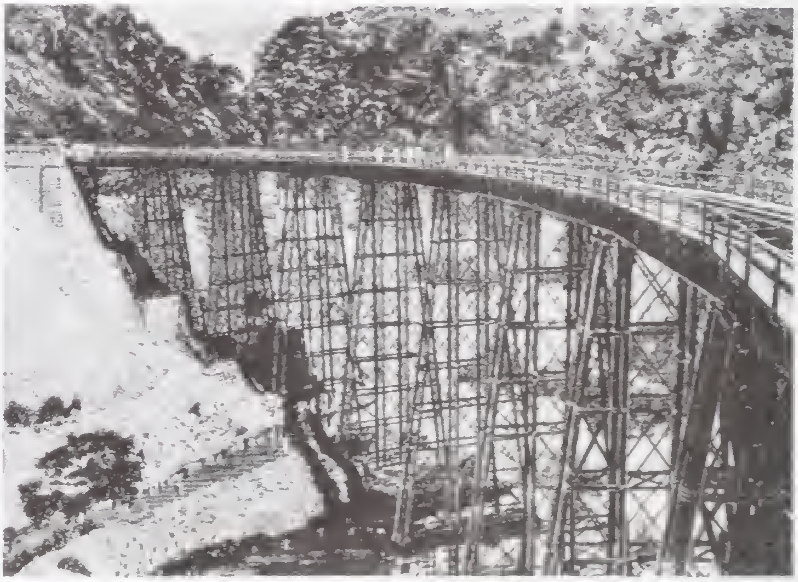
By the time Charnay returned to Veracruz, the port was being regularly serviced by motor sailors.

Exactly twenty-two years after his first visit to Veracruz, Charnay returned in April of 1880 to find the town much improved, houses freshly painted, steeples whitewashed, cupolas ornamented with pyramidal shapes, enameled in pink and blue.

The formerly squalid square, which had been crisscrossed by muddy watercourses, was now charmingly paved with marble and adorned by a park of shade trees in which squirrels gamboled. As much of a girl watcher as Waldeck, Charnay spent his evenings admiring the pretty women in checkered and phosphorescent *cucuyos* taking the air in the arcades with their "beautiful shops and magnificent cafes." Thanks to the influence of the French, the food had also improved. There was excellent fish, edible game birds, plenty of tropical fruits; and the wines were no more expensive than in Paris. Only the ubiquitous black vultures already remarked by Bullock were the same as on Charnay's earlier visit.

Thanks to some spectacular engineering by the British, Charnay was now able to travel to Mexico City all the way by train. It was a vast relief from his previous trip, when he had been obliged to use the rough post road, being jostled in one of the "chariots" drawn by fourteen mules which moved in convoys of a dozen, each headed by a majordomo. These convoys would set off at midnight, after the wandering bell-laden mules had been recaptured with lassos by groups of picturesque muleteers.

This time the train rose from the tropics into the temperate zone in serpentine leaps across barrancas more than a thousand feet deep, at the bottom of which the vegetation still remained tropical.



On the newly built railroad, Charnay ascended from sea level through grander and grander scenery, past coffee, tobacco, and banana plantations where little houses, embowered in orange groves and creepers, peeped out from enormous shade trees. Ahead were the silhouette outlines of the Sierras, dazzlingly bright and richly colored mountains dominated by the snowcapped volcanic peak of Orizaba.

As the train left the thick forests of the temperate zone, full of songbirds, changes in the scenery were brusque and varied. After crossing an arid desert, they entered mountains with deep ravines, perfect for armed robbery.

The only feature unchanged from the previous voyage was the prevalence of bandits, which obliged the train to travel with an armed escort.

At Apam the train loaded casks overflowing with "a yellowish, thick and stringy liquid, repulsive to the smell," the best pulque in Mexico, according to Charnay, "as superior to others as Chambertin is to ordinary claret."

When the train reached the plain of Otumba, it passed close to the pyramids of Teotihuacan, still covered in grass and underbrush.

On the outskirts of Mexico City Charnay noticed many pretty villas where once there had been only marshland. Inside the city, the principal square, or Zocalo, which had

Mexican bandits holding up a stagecoach.

In the brand-new railroad stations, rural guards armed to the teeth and adorned with large felt sombreros trimmed with silver, ribbons, and tassels lolled about waiting for bandits, whom they were expert at tracking to their hidden lairs, as most of them were converted ex-bandits. These were the famous Rurales of President Porfirio Diaz, whose method of recruiting them was to hold five bullets in his left hand and stretch out the other for a handshake. The recruit could make his choice.

been ill paved, had become a fine garden shaded by eucalyptus trees seven feet in girth and over a hundred feet high; beneath them spread a beautiful garden with a pavilion for concerts.

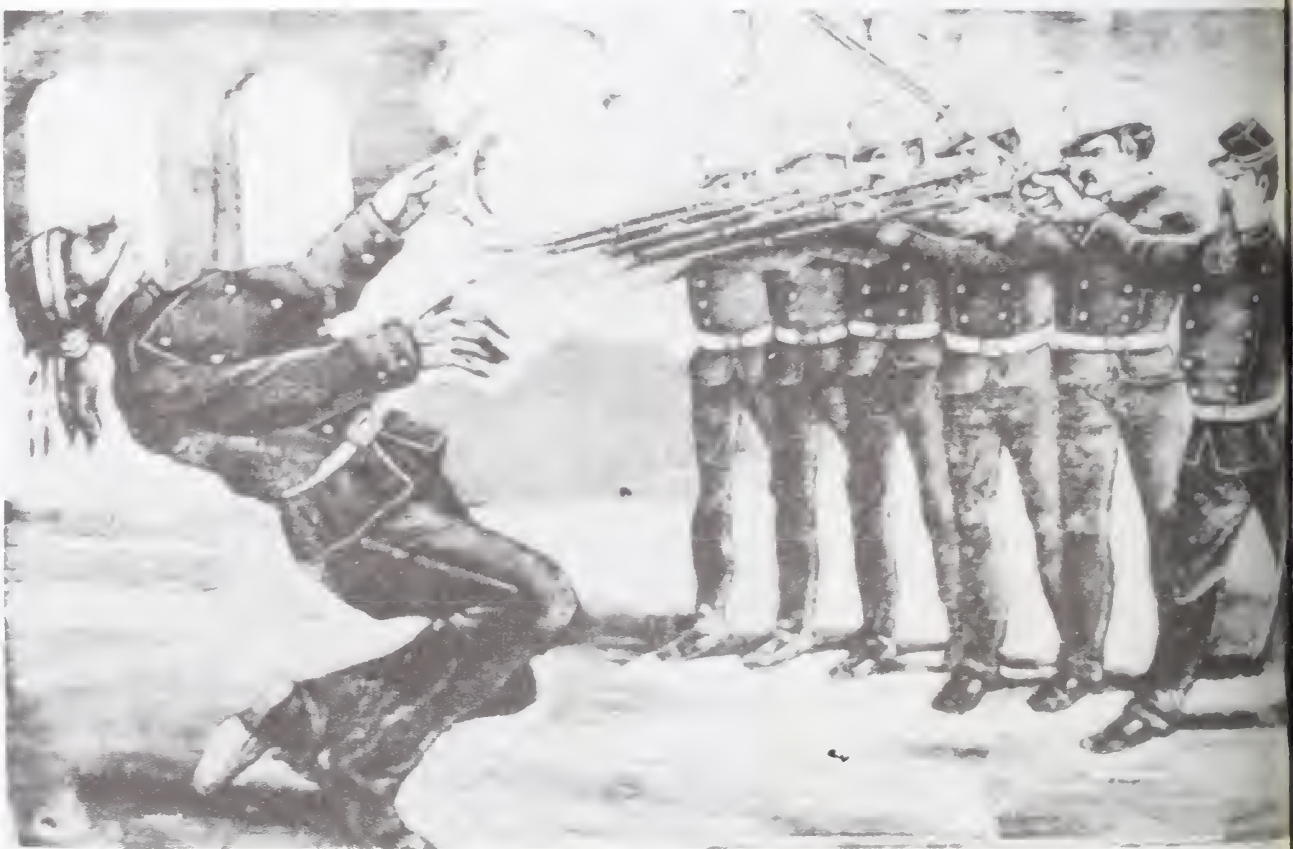
But the biggest change to Charnay was the absence on the streets of any priests. Since Juarez had entered the city in 1867, all the priests had vanished, going into exile or becoming private citizens, taking up business and getting married. Even the monks had taken wives or turned Protestant to serve the Bible societies from New York and Boston which had mushroomed with the influx of foreign capital solicited by General Diaz.

When the train reached Puebla, Charnay found it the cleanest and best-built city in Mexico, adorned with eighty belltowered churches decorated in faience of a thousand colors.

Operating on the theory that "two cats cannot live in the same bag," Diaz made himself supreme dictator of Mexico, a position he held for over thirty years by the simple expedient of disposing, one way or another, of any political rival. To those who helped him, he gave jobs, on the theory that "a dog with a bone neither barks nor bites."

Manuel Romero Rubio, originator of the *cientifico* minority to fight democracy in Mexico, became Diaz' minister of interior, head of the Rurales, and strong man behind the scenes. With funds from his illegal brothels and gambling dens he organized a gang of apaches who were paid monthly to do nothing but attack enemies of the system.

José Ives Limantour.
A skinny little man of French origin who considered Indians "dark, quarrelsome, lazy, thieving little men," he inherited his boss Rubio's mantle as head of the *cientificos* when Rubio died. As Minister of Finance, and power behind Diaz, he finally betrayed his new boss out of power.



Mexico's Cientificos.

While Charnay was in Mexico the *cientificos* concocted a law by which they were able to expropriate the public lands communally used by the peons so that some 50 million acres passed into private hands, often for as little as a centavo an acre. One beneficiary, Luis Terrazzas, had just become

owner of an estate of seven million acres, larger than New Jersey, on which he kept a million and a half head of cattle, while 95.5 percent of Mexico's rural families found themselves with no land. Ten million serfs were created, easily impressed into factories built by foreign investors, where the serfs were obliged to work for a pittance fourteen hours a day without even Sundays as automatic holidays. Recalcitrants, though technically free citizens, could be whipped for any infraction. Petty theft could draw two hundred lashes. Women were strung up and syringed with chili water.

If peons refused to give up the land, the Rurales and federal soldiers moved in, raping and murdering. Stubborn Yaquis, who showed title maps to their lands signed by the King of Spain, were rounded up and sold into slavery to Yucatecan sisal planters at seventy pesos a head—an extra profit for the *cientificos*. Many of the Yaqui women, like the Greek Suliotes in Byron's time, preferred to throw themselves with their babies into the sea.

Surviving Indians were left without woods, water, or any way of making a living off the land. In the United States, General U. S. Grant announced to investors that "seven million Aztecs are waiting to build railroads." Rockefellers, Aldriches, Goulds, Harrimans, Guggenheims, and McCormicks seized the opportunity to buy cheap land and hire dirt cheap labor to operate rail and mine concessions. The Creole *cientificos,* acting as middle men and legal advisers, amassed quick fortunes through large legal fees, stock manipulations, kickbacks, payoffs, and such subtle trickery as selling arms and ammunition to the Indian rebels that the government was officially exterminating.

Though millions vanished into the pockets of the *cientificos,* little of the wealth trickled down. Practically nothing was spent on schooling or education. Real wages were reduced to less than they had been a century earlier under the Spaniards.

Considering Mexicans too stupid for parliamentary democracy, the *cientificos* succeeded in making a farce of the electoral process, openly stuffing ballot boxes and intimidating voters with bands of armed Rurales. All appointments to congress, cabinet posts, or governorships were dictated by Diaz with the connivance of the *cientificos,* yet governors and judges could be removed by a simple majority of Diaz' rubber-stamp congress.

Labor organizations were outlawed, strikes put down by the army. Rebellious individuals conscripted into its ranks could be disposed of by the *ley de fuga,* "shot while trying to escape."

For opponents too much in the public eye, Diaz kept a stable of *pistoleros* who would challenge any required opponent to a duel, with usually fatal consequences. If jailed, the *pistolero* was promptly amnestied.

Judges did as they were told, and only official lawyers won their cases. The chief of police was Diaz' own nephew, Felix Diaz. Newsmen who came too close to the truth were beaten up or assassinated. One unwanted editor was sentenced to jail for material published in a fake issue of his own paper fraudulently concocted by friends of the sentencing judge. Mexican writers who sought asylum in the United States were extradited back to Mexico for punishment in return for grants to the U.S. such as the naval station at Magdalena Bay.

Foreign correspondents were subsidized to sing Diaz' praise to the world, with the result that the U.S. Secretary of State, Elihu Root, declared, "I look to Porfirio Diaz, President of Mexico, as one of the great men to be held up for the hero worship of mankind."

Here was the blueprint for a series of United States–financed dictatorships, from Mussolini to Trujillo to Franco, a system which was to pox the planet for almost a hundred years and which, though detailed by such authors as Carleton Beals, was to lead to bloodshed around the world.

Everywhere, Charnay says, he found a new spirit of initiative which had turned the governor's palace into a rendezvous for citizens, with the exception, of course, as he was quick to point out, of the vast majority of Indians. A thin veneer of progress was bandage to a running sore. In their cotton cloth and straw sombreros the peons were still not allowed on the main streets of the capital. They had to wear European trousers, which could be rented by the day from merchants on the outskirts of the city.

Considered too backward and too ignorant to govern themselves, Mexican Indians had been completely deprived of power or any say in the government by a group of Creole wheeler-dealers known as the *"cientificos,"* who thought they could "scientifically" transform Mexico into a Western state with foreign capital, operating as an elite behind the virtual dictatorship of Porfirio Diaz.

In this atmosphere of false prosperity Charnay tried unsuccessfully to rearouse the Mexicans to an interest in their historic ruins. He had developed the theory that there had once been a vast Toltec empire in central Mexico which had

Promenade of oak trees outside the cathedral in Mexico City's Plaza Mayor. In the evenings, "society" went there by moonlight, so the caballeros could make their conquests among beautiful women discreetly peeping out from behind their Spanish shawls.

spread its dominion from a legendary capital called Tollan as far as Teotihuacan, Toluca, Xochicalco, Cholula, and even Chichen Itza seven hundred miles to the south. From fragments of the works of Fernando de Alva Ixtlilxochitl—whom he considered every bit as trustworthy as Herodotus or Plutarch, and whose works were finally being prepared for publication by Charnay's friend, the Mexican historian Alfredo Chavero—Charnay had become convinced that the remains of the Toltec capital of Tollan were to be found in the subsoil of the modern village of Tula in the province of Hidalgo, sixteen leagues from Mexico City.

Armed with the necessary permit from a friend in the Ministry of Education, Charnay was at last able to board a train which took him past Tacuba, where he could still see the great solitary cypress under which Cortes had cried after the disaster of *La Noche Triste*. At Cuautitlan, armed with a powerful shotgun against bandits, which made his fellow passengers smile with reassurance, Charnay boarded a *diligencia* drawn by mules for a ride over a road so dusty and so rocky it caused all his fellow passengers to vomit.

At the foot of Mount Coatepetl, where the river winds through a narrow valley, the *diligencia* crossed its muddy waters at a gallop to deposit Charnay on what he believed to be the site of the once brilliant capital of the Toltecs—a quiet Indian village of 1500 souls—shaded by enormous ash trees. In the nearby fields there were only a few unpromising mounds overgrown with vegetation. But working with a gang of native diggers, Charnay soon came across large sculptured

Diligencia, or horse-drawn coach, passing Tacuba on the way from Mexico City to the town of Tula.

stones of black basalt more than two meters long and thirty centimeters in diameter, which appeared to him to be the feet of gigantic statues apparently used as caryatids (to which he gave the name "Atlanteans") designed to support a very large building.

There were also fragments of an enormous stone rattlesnake whose head had formed the base of a large column and whose tail had supported a capital much like the ones in Chichen Itza that Charnay had seen twenty years earlier. As in Chichen Itza, he also found a heavy stone ring almost two meters in diameter with a thirty-seven-centimeter hole, clearly part of a ball court.

As figures in the friezes found at Tula represented the same rulers and warriors as those at Chichen Itza, it appeared that both had been built by the same Toltecs.

Some distance away, Charnay found the remains of a large pyramid thickly covered in vegetation through which he could make out a surface with a thick coating of plaster. It was an exciting and important discovery, but even with labor so cheap that a man cost less to hire than a mule, to have tried to dig into the pyramid would have been more than Charnay could tackle with Lorillard's funds.

There was no doubt in Charnay's mind that he was on the site of ancient Tollan, and from the strong resemblance between its decorative motifs and those of faraway Chichen

View of Tula in the province of Hidalgo.

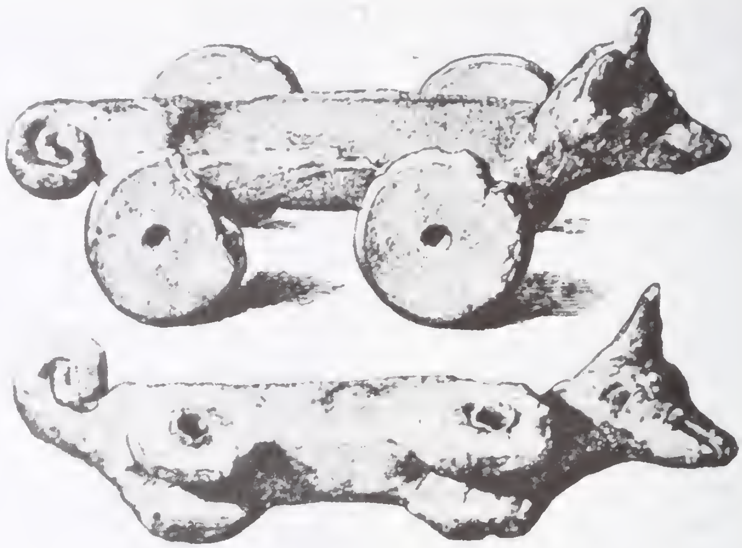
Told it was folly to look for ancient Tollan near the village of Tula, that the city was a fable which like Quetzalcoatl had never existed, Charnay was goaded into digging by the knowledge that twenty years earlier a poor shepherd boy scratching the moist ground of Tula had uncovered a vase containing five hundred ounces of gold, which he had sold for a few coppers.

In 1940 the Mexican archeologist Dr. Jimenez Moreno showed that Tula had indeed been a Toltec capital built about A.D. 900, well after the destruction and abandonment of Teotihuacan. Tula was in turn destroyed in the twelfth century by Aztec invaders who carried off much of its stonework and sculpture to build Tenochtitlan. Among the structures discovered at Tula by Charnay, the Mexican government eventually restored and reconstructed a 30-foot pyramid divided into five levels, beautifully decorated and frescoed, as well as several enormous 15-foot-high caryatids, known as "Atlanteans," armed with strange weapons.

Itza, he was convinced that a Toltec civilization had been the source of a high culture throughout Central America.

But the world of archeology, which considered Charnay unreliable and romantic, greeted his discoveries with the same reserve they greeted Heinrich Schliemann's contemporary discoveries of ancient Troy and Mycenae. They firmly denied Charnay had found Tollan.

As Charnay dug farther into the Tula fields, he found the remains of what appeared to be a whole palace, 62 feet long on one side, with an inner courtyard and garden altogether covering 2,500 square feet. On one wall was a bas-relief depicting two bearded men, which puzzled him, as they were clearly non-Indian.



On Monte del Fraile at 13,000 feet, from where he could view the Pyramid of Cholula, Charnay discovered a cemetery which he believed to be Toltec. Excavating its tombs, he came upon some chariots of terra cotta which he believed to be ancient toys that demonstrated Mesoamerican knowledge of the wheel. When told they were modern fabrications, he dropped the subject saying: "J'ai laissé tomber l'objection, qui serait une insulte à ma bonne foi." Later, more wheeled toys were found in Mesoamerica similar to the terra-cotta toy chariots modeled by the Phoenicians. The most appealing explanation for the Maya having known but not used the wheel comes from Stacy-Judd, who suggests that Yucatecan survivors from Atlantis took warning from the destruction of their former civilization engendered by over-indulgence in the wheel!

Not until the 1930s, when his excavations were finally reexamined by George C. Vaillant, who also laid the foundations for a systematic stratigraphy of central Mexico, was it realized that Charnay might have been correct. Vaillant was able to show that the artifacts at Tula placed it squarely with the Toltecs, just as Charnay had said, only at a slightly later date, between the eclipse of the great city of Teotihuacan, sometime in the eighth century A.D., and the arrival of the Aztecs in the thirteenth.

12. The First Real Digs

Charnay was surprised at the variety of human types portrayed on masks, often with considerable artistic skill: there were the features of Caucasian, Greek, Chinese, Japanese, and Negro; also Maya type heads with retreating foreheads, such as he had seen in Yucatan. They seemed to validate the theories of Viollet-le-Duc about an influx of Europeans and Asiatics, leading Charnay to comment that numerous races must have succeeded each other and amalgamated on the continent, "which, until lately, was supposed to be so new, and is in truth so old."

During fifteen years of investigation of thousands of pre-Columbian terra-cotta pottery heads and figures, art historian Alexander von Wuthenau found portraits of five different racial types: Mongoloid, Chinese, Japanese, Negroid, and all types of white people, especially Semitic types with and without beards.

Saddened by the treatment received from his contemporaries over the Tula digs, Charnay decided to attack the site of Teotihuacan to see if he could prove that it too had been a Toltec city comparable to Tula, a notion which found even less support.

Thanks to General Diaz' railway concessions, Charnay was now able to travel from Mexico City to San Juan Teotihuacan in the comfort of a railway coach in just over sixty minutes.

From San Juan, Charnay approached the pyramids on foot, his eyes falling on all kinds of fragments strewn across the fields: bits of pottery, masks, and small and large figures. There were ex-votos, idols, broken cups, stone axes, and all manner of fragments of obsidian, the volcanic glass, most often black, which could be worked into a hard cutting edge and had evidently served the ancient dwellers of the valley for cutlery, tools, and weapons. Crossing the river bed which runs through Teotihuacan, Charnay found countless obsidian pebbles of a grayish and opaque green color.

In a blistering sun Charnay climbed the larger pyramid, which he gauged to be angled at 47 degrees where the coatings of cement still adhered. It was a bright clear day, and from the summit of the pyramid Charnay was rewarded with a view of the lakes in the Valley of Mexico, the snowy peak of

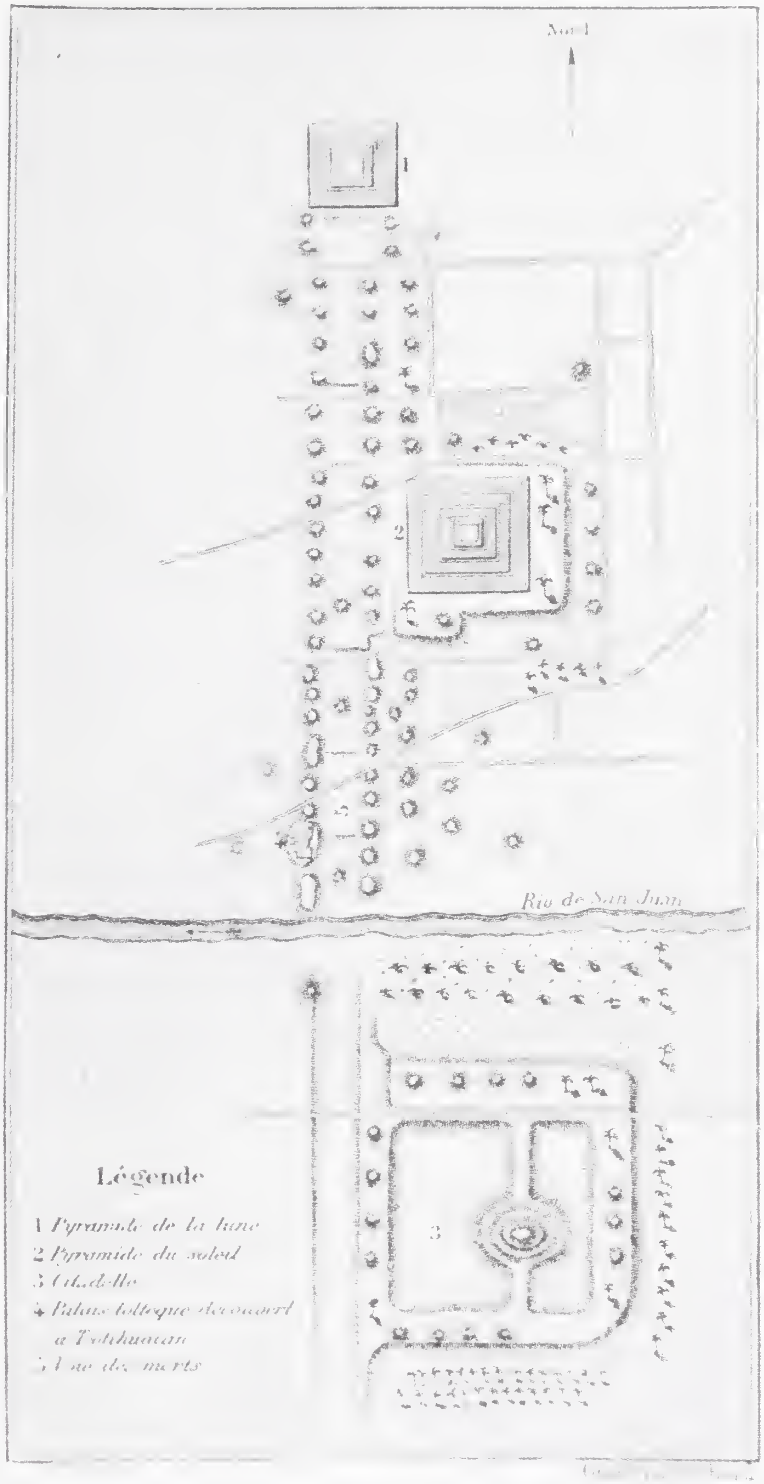
Like Humboldt, Charnay found the Sun Pyramid to be divided into four stories, three of which were still visible, but his description tallies so closely with the hearsay stories repeated by Humboldt that it hardly seems original. More vivid are his descriptions of finding atop the Pyramid of the Moon a perfect obsidian earring, thin as a piece of paper, brought to the surface by ants burrowing for a nest.

Iztaccihuatl towering above the Malacinga range, and, far, far away, the faint outline of the Cordilleras.

Going Prescott one better, Charnay pictured in his imagination a great dead city as it must have once surrounded the pyramid, recreating in his mind's eye its dwellings, temples, and smaller pyramids, "coated with pink and white plaster, surrounded by verdant gardens, intersected by beautiful roads paved with red cement, the whole bathed in a flood of sunshine."

With his Indian escort, Charnay next explored the remains of the mounds known as the "Citadel," which he poetically compared to a vast tennis court whose embankment he measured as 19 feet high and 260 feet thick. Noting fifteen medium mounds and a high one in the center, he intuitively concluded that the place must have been used for public ceremonies rather than as a citadel.

Two and a half miles west of the Pyramid of the Moon, Charnay was led by his guide to some cavernous quarries, or *cuevas,* from which much of the stone to build the pyramids appeared to have been dug. There Charnay found three narrow galleries, branching off in different directions at 45-degree angles, which led to different caves, one a conglomeration of large halls supported by incredibly thin pillars, another like a rotunda, filled with human remains, which he was told were attributable to brigands who used the cave as a burial place for their victims.



According to Charnay's guide, the caves extended three miles to the Pyramid of the Sun, and beyond, where the whole countryside was said to be undermined with caves.

As Charnay's prime interest was to dig, as he had at Tula, for remains of the ancient city of Teotihuacan, in the hope of finding remains of palaces or apartment houses to establish for the city a Toltec origin, and as diggers were needed for

Approaching the lovely baroque church at the end of a great avenue of well-watered poplars and cedars, Charnay was appalled by the way it contrasted with the hovels of the Indians, barely six feet square, within which whole families lay huddled on the beaten ground, half naked or in tatters, "suffocating in summer and freezing in winter, subsisting on a few beans and tortillas which the women ground from corn on *metate* boards kneeling in front of their hovels."

Noting in his diary that the children died mostly in their first year, and that a man earned barely a shilling a day to support a family of eight or nine, Charnay distributed a few coppers to the Indians to drink his health in pulque.

the purpose, he and his guide returned to the village of San Juan to muster volunteers.

With his accommodations in the village, Charnay was far from happy. The only place to sleep was on the floor of a bare-roomed building around a courtyard paved with brick. It was devoid of furniture, because, as he put it, "anyone who wished to, could lie beside you, and your ablutions have to be made at the well in the presence of half the village congregated in the yard."

Before the construction of the railway, Charnay remembered, the village had been a bustling relay point for mules plying to and from Mexico City, more than two thousand of them daily, when "the clapping of hands of the tortilleros was heard all day, along with copious libations of pulque." Now the village was a morgue.

Charnay attacked a terraced court fronting the Way of the Dead and found among the constructions and substructures stucco walls crisscrossing each other in all directions, over layers of ornaments, pottery, and detritus, which led him to conclude that a city had been built and rebuilt several times, and that when one building was demolished the new occupant, instead of clearing the ground of old rubbish, had simply smoothed it down and laid a new floor on the compacted detritus.

Charnay says he ate his dinner that night more to spare the feelings of his host than because he liked the menu, and also to insure by his good manners that the municipality would give him men on the morrow sufficient to start his digging.

Convinced that the village of San Juan covered part of the old city of Teotihuacan, Charnay decided to open four trenches right in the small square not far from the Plaza Mayor that was normally used for bull fighting.

The first two trenches produced no results. In the third the diggers came upon a dozen children's tombs and half a dozen adult tombs, the bones in which crumbled to dust as Charnay handled them.

The graves contained, along with a few obsidian knives, the remains of edible dogs and birds intended to feed the dead in their afterlife journey. The children were buried in circular vases with upright brims, the skeletons almost perfect, but the skulls, thin as paper, fell to pieces at a touch. From the fact that the bodies had not been cremated, Charnay deduced that he had struck a poor quarter of the ancient city.

Determined to show that Teotihuacan had been as flourishing as Tula, Charnay looked for a better spot to dig. North of the river he had noticed parts of walls, broken cement, and terraces. Settling on these, he managed in three days' digging to uncover ten rooms which formed part of a large house with inner courts, apartments on different levels, roofs supported by pillars, one chamber being 732 feet in circumference. The walls were nearly six feet seven inches thick, built of stone and mortar, incrusted with thick cement; at the

foot they sloped about three feet before becoming perpendicular.

Charnay labeled the house a "palace" because it had what appeared to be several reception rooms with stuccoed walls frescoed "like an Aubusson carpet" whose red, black, blue, yellow, and white markings were still discernible. Charnay would have liked to have unearthed a number of "sleeping accommodations" that he felt extended beyond the palace, but most of them were under an Indian's cornfield and could not be touched.

Manuel y Berra.

Convinced that he had only scratched the surface of a huge dormant city that might reveal great treasures, Charnay telegraphed messages to his friends in Mexico City, the historians Alfredo Chavero and Manuel Orozco y Berra, both professedly interested in Mexican archeology, urging them to join him to see what he had found, and to urge the Mexican government to initiate regular excavations at Teotihuacan. Neither government nor friend paid him the least heed. One friend sent word he had a headache, the other pleaded "a less poetic ailment."

As a consolation, Charnay was able to peel off some of the frescoes he had unearthed and send them to Paris, where they were put on display at the Trocadero, to arouse, in due course, enough interest among later archeologists to keep alive the prospect of further digs at Teotihuacan.

Determined also to make moldings of the stone reliefs at Palenque which he had been unable to photograph on his previous visit, Charnay finally managed to obtain the grudging approval of the Mexican government to travel elsewhere in the republic, including the rebellious areas of Yucatan, but only on condition that he take with him a colonel of artillery who was "to watch and share his labors and discoveries." Assuming, most probably correctly, that Charnay

Charnay crossing one of the more difficult Mexican passes.

Charnay's kitchen at Palenque. Unlike Stephens and Waldeck, who had subsisted on cornmeal and iguana, one of Charnay's dinners, thanks to Mr. Lorillard, consisted of soup of purée of black beans with snail broth, Valencian olives with Arles sausage, corn-fed chicken with garlic and red peppers, fried *morne* with chives garnished with hearts of palm and asparagus tips, black bean rissoles, crêpes, American cheeses, Bordeaux and Aragon wines, coffee and Havana cigars, with Xtabentun liqueur.

was doubling as someone's agent, the government selected an amiable veteran of the war against Maximilian, Don Perez Castro. To record whatever they might discover on their travels, the Mexicans also selected a young Frenchman born in Mexico, Albert Lemaire.

At Palenque the travelers found that a stranger could still pass within a few yards of the hidden city and not see it. Much of the Temple of the Cross had given way since Charnay had first seen it twenty-two years earlier, and many of the reliefs had disappeared, the work of both scavengers and vegetation. Roots removed by previous explorers had broken up the walls and caused them further to disintegrate.

"But my admiration for this massive place, these ruined temples, these pyramids," remarked Charnay, "is profound, nay, almost overpowering."

To obtain molds of the remaining reliefs, Charnay employed a system invented by a Monsieur Lantin de Laval of France which consisted of squeezing six layers of wet paper onto the friezes and allowing the pulp to dry. With this system Charnay was able to get 325 square feet of impressions for a weight of 500 pounds instead of the 30,000 pounds it would have weighed in plaster of paris.

But the work was not easy. Almost incessant rain obliged Charnay to redo scores of the impressions. The dampness penetrated to their bones and caused vegetable mold to grow on their hats. In the mud they slithered constantly, more often on their backsides than on their feet. At night drops of water trickled down their necks from the greenish moss on the walls.

By day they were prey to swarms of insects, mostly *rodadores* and *garrapatas,* the Mexican ticks. To offset malaria they now had the benefit of quinine, made from cinchona bark, discovered in 1820 by two Frenchmen, Caventou and Pelletier, whose use had been promoted by the wife of the Spanish ambassador to Peru.

Another improvement over Charnay's first trip to Palenque —when he had survived on frightful quantities of raw cornmeal soaked in water, along with snail soup from the river— were some delicious French dinners prepared by a sophisticated cook, complete with Havana cigars, coffee, and the local liqueur called Xtabentum.

Once the paper impressions of reliefs were safely packed off to France, Charnay and the colonel set off for Chichen Itza with a guard of fifty soldiers put at their disposal by the governor of Merida to protect them against the rebellious Yucatecans, still uncontrolled since their uprising in 1847, who made forays from their safe bases in the wilder parts of eastern Yucatan and Quintana Roo.

The castillo Kukulkan.

This 75-foot-high pyramid has four staircases of 91 steps for a total of 364; when the upper platform is added, the sum is 365, for the days in a year. The 18 larger steps represent the 18 months of a year. The 52 panels in the large steps give a Mayan century of 52 years.

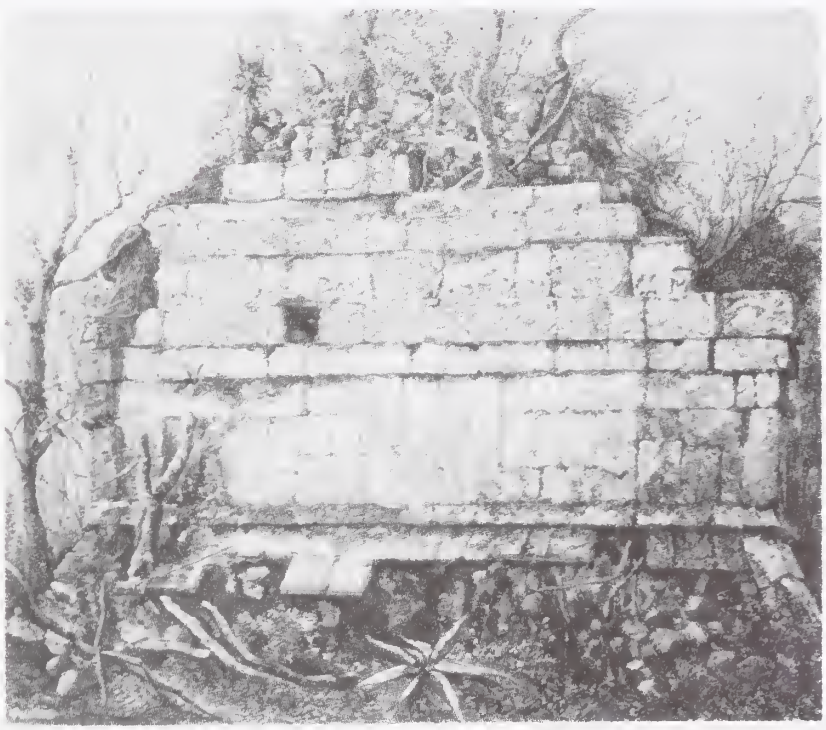
During the past decades most of the major cities of Yucatan had been burned by the rebels and half the population still lived with a weapon under one arm while the other half worked in the fields or slept.

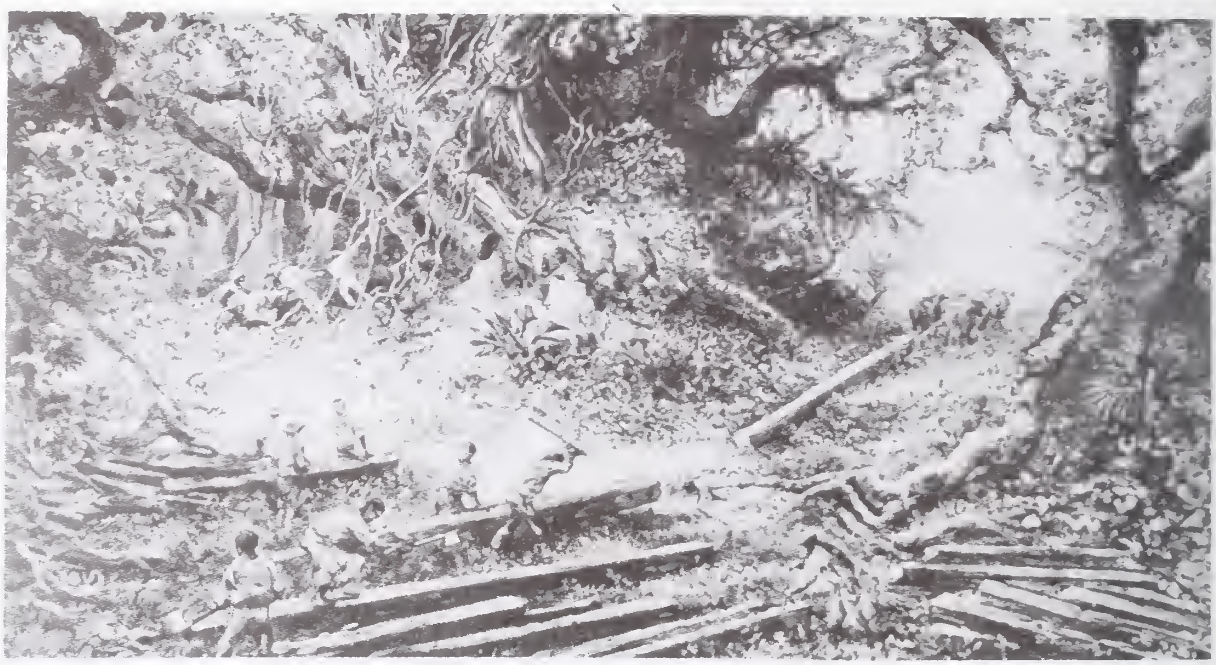
At Chichen Itza, Charnay and his military companions climbed to the top of the Castillo, which they found still overrun with vegetation, birds, snakes, and iguanas. To avoid being ambushed by the rebels, they ensconced themselves in the main chamber and set up regular sentries.

To Charnay there was something about Chichen Itza, especially the enormous figures of idols ornamenting the frieze around the Palace of the Nuns, that reminded him of Hindu art. At Izamal, barely sixty miles away, he had been reminded by the gigantic faces built into the side of a man-made pyramid of the Sphinx in Egypt. At Uxmal he had found a Greek influence in the governor's palace; at Palenque an Assyrian motif; at Mitla Chinese motifs. Other statuary reminded him of Malaya, Cambodia, and Java, where he had traveled in the interim between his trips to Mexico. He found the storied pyramids of Yucatan much like those of Angkor Thom and Angkor Wat. All of which validated for him the theories of his first patron, Viollet-le-Duc. But to please his present patron, Pierre Lorillard, Charnay wished to do something original; he wished to rediscover and name for Lorillard what was reputed to be the greatest and least-known of Mayan ruins, Yaxchilan, on the border of Guatemala, reported by Stephens to be a phantom city.

The nunnery of Chichen Itza, much more dilapidated and overgrown than when Stephens saw it for the last time half a century earlier.

With great difficulty Charnay mounted an expedition to make his way slowly up the Usumacinta River and was within a day's journey of his goal when he discovered he had been beaten to the mark by a solitary Englishman, Alfred



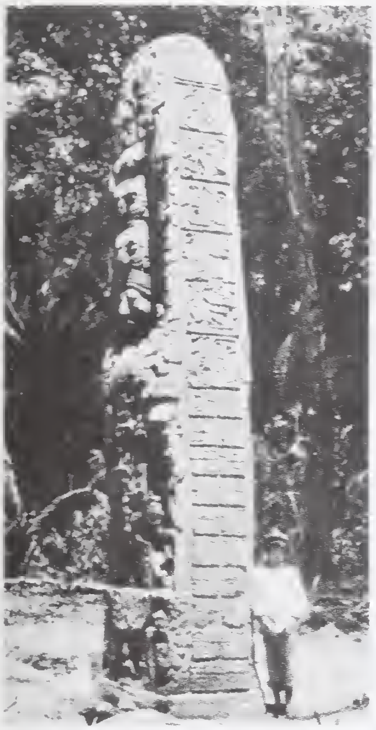


Remains of a temple at Lorillard.

Percival Maudslay, who was busy clearing the site and making remarkably beautiful drawings and photographs of its many stelae.

When Charnay finally arrived at Yaxchilan in a canoe sent down the river by Maudslay, the Englishman took one look at his expression and said with a cordial laugh, "It's all right. There is no reason why you should look so distressed. My having had the start on you was a mere chance, as it would have been mere chance had it been the other way. You need have no fear on my account, for I am only an amateur, traveling for pleasure. With you the case of course is different. But I do not intend to publish anything. Come, I have had a place got ready; and as for the ruins, I make them over to you. You can name the town, claim to have discovered it; in fact, do what you please. I shall not interfere with you in any way, and you may even dispense with mentioning my name if you so please."

After replying that he was deeply touched by the Englishman's kind manner, and "only too charmed to share with him the glory of having explored the city," Charnay proceeded to ignore his host. He named the city Lorillard "in honor of the munificent man who partly defrays the cost of the expedition," a name which hardly outlasted Charnay's stay in the Phantom City, and would have been unknown to the world except as an advertisement for tobacco had Charnay not devoted a chapter to it in *The Ancient Cities of the New World,* which he brought out on his return to France, a book more remarkable for its lithographs, mostly copies of the work of others, than for its pedestrian text. After one last



Employed by the British colonial service, Maudslay insisted he had come to Central America merely to escape the rigors of an English winter. Altogether Maudslay made seven expeditions to Central America, spending considerable periods at the ruins of Copan, Quirigua, Palenque, Yaxchilan, Tikal, and Chichen Itza. The results—in the form of casts, magnificent photographs of the ruins and particularly of the hieroglyphic texts, maps and plans, and the extremely good drawings of the glyphs, made by his companion Miss Annie Hunter—were published between 1889 and 1902, in a twenty-volume edition under the perhaps purposely vague title of *Biologia Centrali-Americana or contributions to the knowledge of the flora and fauna of Central America*.

Maudslay had struggled into Copan with a team of mules hauling tons of plaster of paris, determined to make molds of the stelae. When the molds eventually reached England they were ignominiously consigned to the basement of the South Kensington Museum.

At Lorillard City, Charnay found a stone lintel which he considered to be by far the most wonderful monument he had seen in America. Assuming it depicted a ceremony in honor of Quetzalcoatl, he interpreted the kneeling figure to be a priest passing a rope through his tongue. Charnay quoted Sahagun and Bishop Landa to the effect that priests did penance by running as many as four or five hundred sticks, twice as thick as a thumb, and fastened together in long cords, through their tongues, their ears, and their private parts. He also quoted Clavigero, who says the blood which flowed from these self-inflicted wounds was carefully kept on the leaves of a plant with symmetrical leaves called *acxoyatl.* The worshippers of Siva, the Hindu god of destruction, and those of his wife Kali, were wont to torture themselves by drawing a rope through their pierced tongues.

LES

ANCIENNES VILLES

DU NOUVEAU MONDE

VOYAGES D'EXPLORATIONS

AU MEXIQUE ET DANS L'AMÉRIQUE CENTRALE

PAR

DÉSIRÉ CHARNAY

PARIS

trip to Yucatan in 1886, Charnay retired to Algiers, where he wrote two romantic novels entitled *An Indian Princess* and *Across the Virgin Forest,* dealing with the beauty of the Indian and mestiza women of Mexico, whose "clear skin, beautiful flesh and thin embroidered shirts outlining their firm breasts" he could not get out of his system. One of them, "with ebony hair, a tunic of light gauze which barely disguised the beauty of her body, eyes full of timid promises," he admitted nearly having stayed to marry: "Only with great courage was I able to rouse myself in the night, saddle my mule, and make a rapid exit."

Before he died Charnay translated into French the letters of Cortes to Charles V and the *Histoire de l'Origine des Indiens* of J. F. Ramirez; but his main contribution was to have taken pick and shovel to the ruins of Mexico and shown that beneath the soil the remains of great cities were there for the digging.

13. Probing in Depth

On a reportorial and descriptive level, Charnay had walked in John Lloyd Stephens' footsteps. On a more philosophical and anthropological level, Brasseur de Bourbourg was followed by one of the most extraordinary and perhaps unjustly neglected of Mayaland adventurers, Augustus le Plongeon. The son of a French navy commodore who had married the daughter of the governor of Mont-Saint-Michel, Le Plongeon was neglected because his notions about the Maya and their possible connection with the lost continent of Atlantis became such anathema to academicians they were treated with the contempt reserved for the notions of his contemporary, Charles Piazzi Smyth, Astronomer Royal for Scotland, on the subject of the Great Pyramid of Cheops.

Both men, instead of propounding long-winded treatises on the available ignorance about their subjects, were bold enough to explore in the field notions outrageous to their blinkered Victorian compeers.

Alice Le Plongeon.

In New York in his middle forties, Le Plongeon married an English girl of twenty-two, then living in Brooklyn, Alice Dixon. Together they sailed for Central America in the spring of 1873 for what turned out to be twelve years in the wilds of Yucatan, most of it spent in the bush. In Merida, the capital, Le Plongeon learned to speak Maya before setting off for an intensive survey of the ruins of Chichen Itza, which had once more been engulfed by the jungle and was under attack from the Yucatan *sublevados*. When the army could no longer protect the Le Plongeons in the charred shell of the hacienda at Chichen Itza, they moved to a fortified church three miles away at Pisté. From there they walked each day to the site of the ancient ruins, where they surveyed scores of buildings,

Augustus Le Plongeon.

Born on the island of Jersey in 1826, the year that his idol Stephens discovered the work of Del Rio, young Le Plongeon's first adventure occurred at the age of 14 on his way to the Americas, when he became one of two survivors from a shipwreck. After a stint in South America learning Spanish, he found himself in California in time for the Gold Rush of '49. There he became county surveyor for the city of San Francisco, practiced law, and acquired the degree of doctor of medicine.

After some round-the-world traveling, he was back in Peru in the 1860s to set up a private hospital in which he applied electricity to medicinal baths for the poor and for victims of revolutions. In his spare time he studied the architectural ruins of the Incas and pre-Incas, producing a couple of religious books on Jesus and a manual on photography. His sensitivity to unorthodox but avant garde ideas was such that he concluded from the strata of oyster shells around the Bolivian ruins of Tiahuanaco that the great and mysterious city must once have been at sea level, foreshadowing by more than half a century the work of H. S. Bellamy.

took more than five hundred photographs, and made twenty careful sheets of mural drawings.

Because of his mastery of the Mayan language and his intrepid but gentle nature, Le Plongeon, who often ventured with his wife deep into the forest far from village or inhabited place, found the natives "always respectful, honest, polite unobtrusive, patient and brave." He attributed the ferocity of the *sublevados* to their reaction against a ghastly system of peonage enforced by the sisal planters of Yucatan, against which the natives had no redress but to revolt.

Gradually endearing himself to the Maya, who gave him the affectionate nickname of Great Black Beard, Le Plongeon got his new friends to confide in him much of the lore they normally kept rigorously secret from the hated Spaniards, lore for which many of their ancestors had been hanged or burned at the stake.

Like Carlos Castañeda in our day, Le Plongeon learned that the native Indians in his day still practiced magic and divination, that their wise men were able to surround themselves with clouds and even appear to make themselves invisible, materializing strange and amazing objects. Sometimes, says Le Plongeon, the place where they were operating would seem to shake as if an earthquake were occurring, or whirl around and around as if being carried away by a tornado. Sometimes they appeared to be bathed in bright and resplendent light, and flames seemed to issue from the walls only to be extinguished by invisible hands in the most profound obscurity where flashes of lightning made the dark appear darker.

Beneath the prosaic life of the Indians of his day in Yucatan, Le Plongeon concluded that there flowed "a rich living current of occult wisdom and practice, with its sources in an extremely ancient past, far beyond the purview of ordinary historical

Le Plongeon says that a third account of the sinking of Atlantis was written on the lintel of a door of the inner chamber at the southeastern end of the building at Uxmal called Akab-Oib, as intact in his day as when it was finished by the sculptor's chisel. The inscription, says Le Plongeon, "is a memorial commemorating the destruction of Mu, the Lands of the West, whence came the Sacred Mysteries." But his method of decipherment left much to the imagination.

Every day, all over the land, says Le Plongeon, working men in the haciendas were pitilessly and arbitrarily flogged by their overseers, then put in stocks overnight so as not to miss a day's work. Were they, says he, to lay their grievances before the owner of the hacienda, their only redress was to receive a double ration of lashes for daring to complain. If they lodged a complaint before a judge, "as by law they had the right," he, of course, "is the friend or relative of the planter. He himself may be a planter. On his own plantation he has servants who are treated in like manner."

Nor could Le Plongeon interfere on behalf of some poor man being whipped for some trifling cause, lest the victim receive a more severe punishment later.

research." He felt that occasionally the mask was lowered sufficiently for him to glimpse "a world of spiritual reality, sometimes of indescribable beauty, again of inexpressible horror."

From what he learned of the lore of the Maya it became clear to Le Plongeon that the pre-Columbian Maya had practiced mesmerism, induced clairvoyance, and used magic mirrors to predict the future. From a 150-year-old Indian, Le Plongeon learned that men still existed who could decipher meanings in the mysterious hieroglyphs scattered about the ruined cities of the Maya, which contained the history of the people who had inhabited the land.

From glyphs on the southeast wall of what Le Plongeon called the Gymnasium at Chichen Itza, he says he was able to interpret the word Chac-Mool and pinpoint a spot on which to dig for what he was lead to believe might be an effigy of this ancient character.

The undertaking seemed wildly implausible. The diggers descended painfully more than twenty-four feet, and they were about to give up when they struck a hard surface, revealing what Le Plongeon considered one of the greatest archeological discoveries of the Americas, an astonishing piece of sculpture, not in relief but in the round.

So impressed was he with his find that he wished to display it to the world at the centennial ceremonies in Philadelphia in 1876. Only how to get it there?

With nothing but his engineering ingenuity and some tree trunks and vines, Le Plongeon and his Mayan workers managed to raise the multi-ton monolith to the surface and drag it by oxcart through the jungle toward Merida. There the local authorities immediately claimed the trophy, only to be relieved of it by a warship from the central government, which decided it belonged to Mexico City, where it reclines to this day, still as

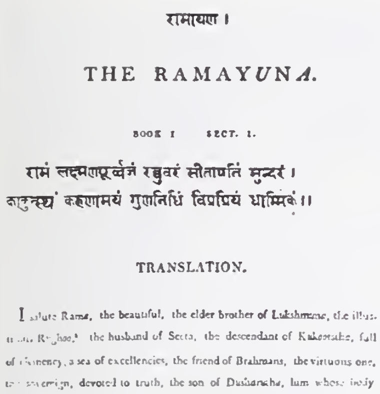
Augustus and Alice Le Plongeon with the Chac-Mool they unearthed from twenty-four feet beneath the soil at Chichen Itza, which they wished to exhibit at the 1876 Centennial.

Accused of promulgating notions on ancient America contrary to the opinion of men regarded as authorities on American archeology, Le Plongeon replied, "But who are these pretended authorities? Certainly not the doctors and professors at the head of the universities and colleges in the United States; for not only do they know absolutely nothing of ancient American Civilization, but, judging from letters in my possession, the majority of them refuse to learn anything concerning it. Can they interpret one single sentence of the books in which the learning of the Maya sages, their cosmogonic, geographical, religious and scientific attainments are recorded? From what source have they derived their pretended knowledge? Not from the writings of the Spanish chroniclers, surely. These only wrote of the natives as they found them at the time, and long after the conquest of America by their countrymen. The so-called learned men of our days are the first to oppose new ideas and the bearers of these."

enigmatic and unexplained as when it was dug up by Le Plongeon.

Disappointed, Le Plongeon sent a set of photographs and smaller artifacts to Philadelphia, but they too were waylaid and eventually fell into the hands of Stephen Salisbury, Jr., a wealthy bachelor and philanthropist from Worcester, Massachusetts, active in the American Antiquarian Society. As a result, though Le Plongeon failed to make his mark at Philadelphia, Salisbury agreed to publish reports from Le Plongeon in the society's journal. It was a pleasant association, for a while; but Le Plongeon's speculations were soon too much for his New England associates. Anyone who could speak of cycles of existence in more advanced planets and worlds than the present was likely to be in trouble with an establishment, many of whom still subscribed to a Biblical origin for the world sometime in the fifth millennium B.C.

Even Le Plongeon's notion that intimate communication had existed between the inhabitants of the Western Hemisphere and Asia, Africa, and Europe at a much earlier date than anyone else considered possible, though subscribed to by Sigüenza and by Brasseur, caused a lot of heads to shake.



रामायण।

THE RAMAYUNA.

BOOK I SECT. I.

रामं लक्ष्मणपूर्वजं रघुवरं सीतापतिं सुन्दरं।
काकुत्स्थं करुणामयं गुणनिधिं विप्रप्रियं धार्मिकं॥

TRANSLATION.

I salute Rama, the beautiful, the elder brother of Lukshmunu, the illustrious Rughoo, the husband of Seeta, the descendant of Kakootsha, full of clemency, a sea of excellencies, the friend of Brahmans, the virtuous one, the sovereign, devoted to truth, the son of Dusharutha, him whose body

One of several English translations of the *Ramayana*, printed with the original Sanskrit text.

The idea that the Phoenicians might have crisscrossed the Atlantic long before Columbus was shocking enough; Le Plongeon went further. He suggested as an explanation for the extraordinary similarities between the architecture, sculpture, and artifacts of Central America and those of Asia, Africa, and Europe, that Mayan colonists had sailed *westward* from Central America to develop civilizations in Polynesia, Indochina, Burma, India, the Persian Gulf, Babylonia, and Egypt, all of this several millennia before Christ.

In support of this revolutionary thesis he pointed to the Mayan legends of adepts known as Naacal, or "the exalted," who were reported to have set out across the world to teach others their language, architecture, and astronomy. Le Plongeon quoted the third-century B.C. Hindu sage-historian Valmiki's epic of *Ramayana* (in Hippolyte Fauché's translation) to describe the conquest of the southern parts of the Indochinese peninsula in remote antiquity by a people known as great navigators, terrible warriors, learned architects, famous for their beautiful women and inexhaustible treasures.

Valmiki is said to have received the information from Narana, high priest of the Rishi temple at Ayhodia, who read to him the ancient records, but Valmiki is also accused of having used poetic license in his own version.

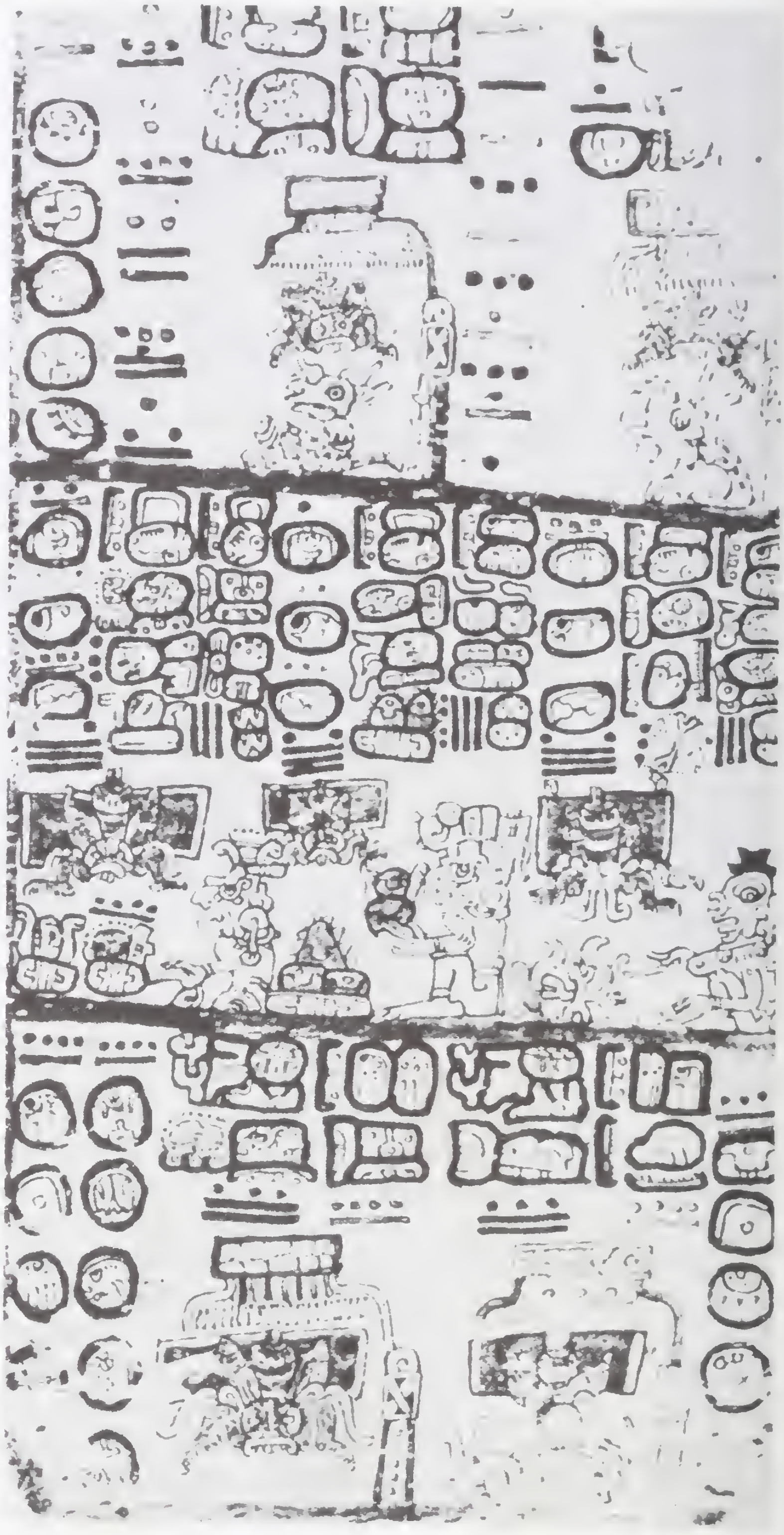
Le Plongeon suggested that Valmiki's Nagas were in fact the ancient Maya who traveled along the shore of the Indian Ocean, reached the Indus River, and then went north to Kabul. Others, he maintained, had continued westward across the Indian Ocean, to the Persian Gulf, whence they had reached Babylon, Syria, and finally Egypt. He quoted the Chaldean historian Berosus to the effect that civilization was brought to Mesopotamia by Oannes, who came from the Persian Gulf, pointing out that *oaana* in Maya means "he who has his residence in the water."

Le Plongeon added that the advent of the early Chaldeans in Mesopotamia was historically coincident with the origins of the art of writing, the building of cities, and the cultivation of the sciences, especially astronomy. He also pointed out that the Egyptians claimed their ancestors were strangers who arrived across the Isthmus of Suez to settle on the banks of the Nile, bringing their worship of the sun, along with the art of writing, several thousand years before the enthronement of Menes and the official inception of the history of Egypt. Among the many similar words in Akkadian and Mayan, such as *ma* for place, *naa* or *nana* for mother, and *tab* for tie, Le Plongeon pointed out that in both languages *kul* was the name for seat or rump and *kun* for the *mulieris pudenda*.

Not content with his blockbusting reconstruction of ancient history, Le Plongeon plunged into the even more controversial

One of the principal arguments against Le Plongeon was his apparently arbitrary interpretation of the Troano Codex. According to Le Plongeon, the author of the Troano manuscript devoted several pages at the beginning of the second part of his work to a minute description of the various phenomena attending the disastrous collapse of Atlantis, referred to in the text as the ten countries of Mu. Le Plongeon's version reads: "The year six Kan, and the eleventh Muluc, in the month of Zac there occurred terrible earthquakes which continued without intermission until the thirteenth Chuen. The country of hills and mud, the 'Land of Mu' was sacrificed. Being twice upheaved, it suddenly disappeared during the night, the basin being continually shaken by volcanic forces. Being confined, these caused the land to sink and rise several times and in various places. At last the surface gave way, and the ten countries were torn asunder and scattered in fragments: unable to withstand the force of the seismic convulsions, they sank with their sixty-four millions of inhabitants, eight thousand and sixty years before the writing of this book."

The fact that the cataclysm was said to have occurred on the thirteenth Chuen, says Le Plongeon, may account for the still lingering superstition about bad luck being attached to the number. According to Le Plongeon, it was as a result of this catastrophe that the Maya started computing their new calendar on a base thirteen with weeks of thirteen days, centuries of four times thirteen years, and a great cycle of thirteen times twenty or two hundred and sixty years. Was it chance, he asked, that the Platonic date of 9500 B.C. coincided so precisely with his date for the inception of the Maya calendar?



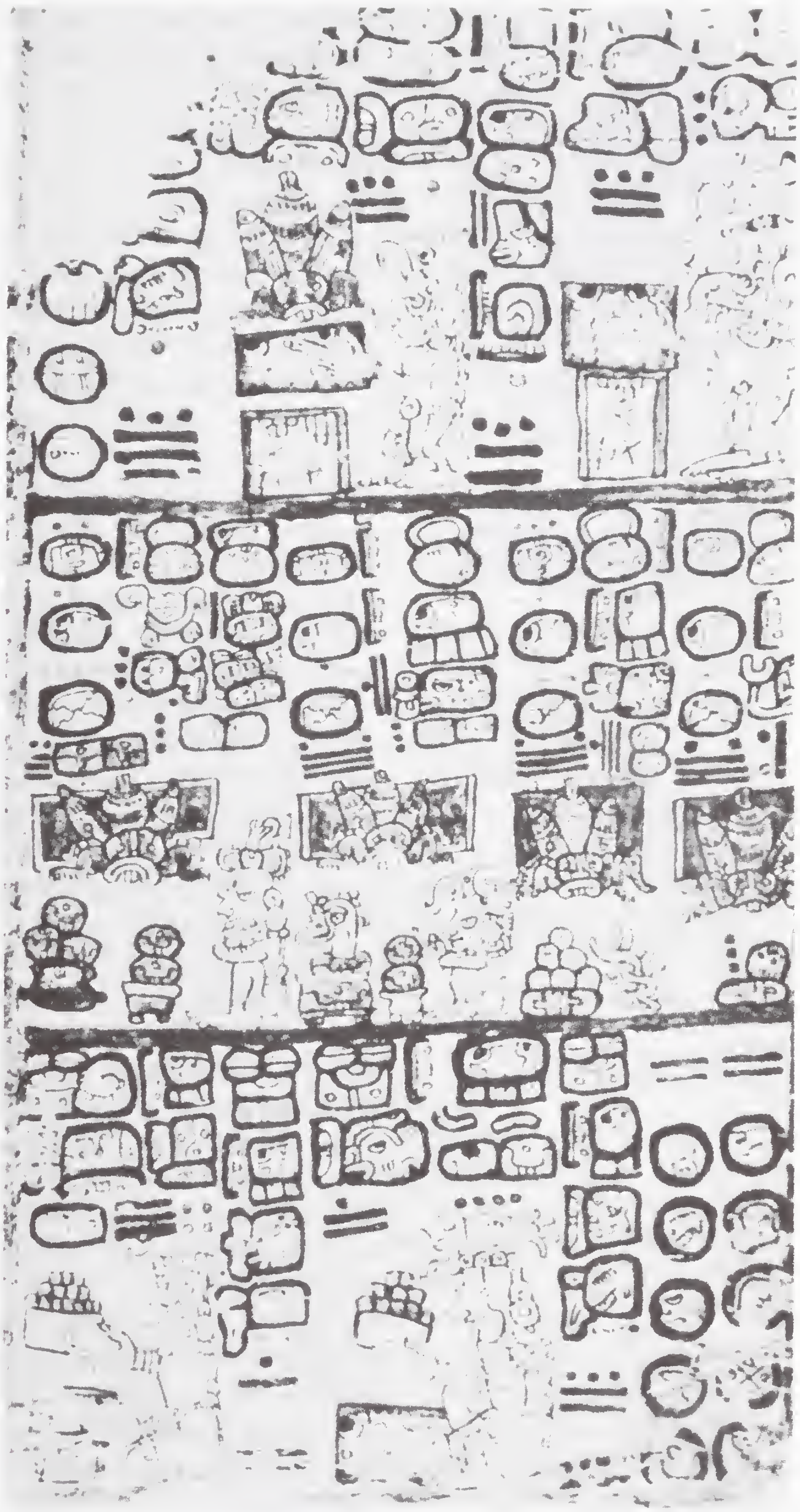
subject of Atlantis. At Chichen Itza he says he found a relief in a room sheltered from the elements which he deciphered as confirmation of Brasseur's "translation" of the Codex Tro-Cortesianus, saying it described in glyphs a cataclysm in which an island continent had sunk beneath the seas.

Later Le Plongeon claimed the discovery of a fragment of a

Le Plongeon quotes the Codex Cortesianus, which he calls more prolix than the Troano, to give further details on the collapse of Atlantis. "By his strong will, Homen caused the earth to tremble after sunset; and during the night, Mu, the country of hills and mud, was submerged." Homen, explains Le Plongeon, was the overturner of mountains, the god of earthquakes, the wizard who made all things move like a mass of worms, the volcanic forces anthropomorphized and then deified. "The Maya," says Le Plongeon, "deified all phenomena of nature and their causes, then represented them in the shape of human beings or animals. Their object was to keep for their initiates the secrets of their science."

Le Plongeon's translation—or, better, his interpretation—continues: "Mu, the life of the basin, was submerged by Homen during the night. The place of the dead ruler is now lifeless; it moves no more, after having twice jumped from its foundations. The king of the deep, while forcing his way out, has shaken it up and down, has killed it, has submerged it. Twice Mu jumped from its foundations. It was then shaken up and down violently by the earthquake."

According to Le Plongeon, one page of the Troano Codex depicts Queen Moo (held by the hair) falling into the hands of her enemies on the ninth day of the tenth month of the year Kan; the seventh Eb of month Yax, year Kan. He says the picture shows the queen traveling to the east across the sea. In the next panels Queen Moo is on her knees in supplication, and, symbolized as a black macaw bird, is losing hold of a Mayaland politically divided, as shown by the severed deer. Ingenious as Le Plongeon's interpretations may be, modern students dispute his identifications and suggest that the deer is more likely the symbol of a constellation.



mural painting on the walls of an apartment in one of the edifices at Kabah which to him again confirmed Brasseur's date from the Tro-Cortesianus manuscript describing the submersion of ten countries, among them the land of Mu, which to Le Plongeon might have been Plato's Atlantis. The codex, said Le Plongeon, also described the formation of a

According to Le Plongeon, this is a representation of Prince Coh in the heat of battle, overshadowed by the winged serpent, the genius of the Maya, who fights at his side and leads his followers to victory. Le Plongeon maintains that this is not a representation of Kukulkan, normally the image of the rulers of the country, but of the winged serpent Nonoca Can, the protective genius of the Maya, a confusion, says Le Plongeon, which authorities on the Maya were constantly falling into.

strangely crooked line of islands known to the Maya as the Land of the Scorpion, and to us as the West Indies.

Later still, at Xochicalco, Le Plongeon says he deciphered another inscription which appeared to memorialize the same catastrophe.

When Americanists disputed his and Brasseur's deciphering of these glyphs, Le Plongeon pointed out that until Brasseur had found the Codex Tro-Cortesianus, and then rediscovered Bishop Landa's work in Madrid, no Americanist even knew in what language the codices were written. He complained that none of the Americanists who claimed to be authorities on American paleography could even interpret with certainty more than a dozen Mayan glyphs and none could translate an entire sentence. In his opinion the greater part of what had been published in his day on the subject of Mayan writings could only be ranked with comic literature—not very amusing at that. "Even the beautifully printed papers of the Smithsonian Institution on the subject are as meaningless as they are pretentious; and I challenge any Americanist, authorized or not authorized, to disprove this assertion."

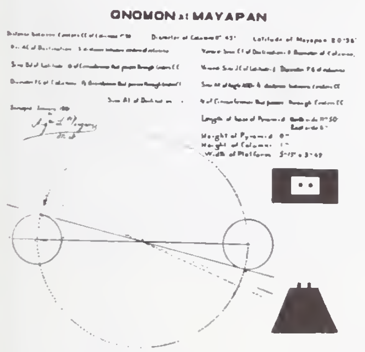
When a member of the Société Ethnologique de Paris warned Le Plongeon not to support Brasseur, "or you will kill your own reputation and lose the fruits of your labors: all authorized Americanists will condemn you as they have Brasseur," Le Plongeon replied in the words of Themistocles: "Strike me, but hear me!"

Anyone looking carefully at Le Plongeon's analysis of a set of tableaux which he found in what he called a mausoleum at Chichen Itza can readily appreciate his imaginative flights of fancy, but also cannot help but be impressed by the originality of his interpretation. From the writings of his opponents it is clear that, as was done to Emmanuel Velikovsky a century later, they usually did not even trouble to check what he had to say, considering his notions a priori too wild to be credited.

Le Plongeon's claim that he had deciphered the totem of Queen Moo as a bird eating hearts, and that of her brother-husband Prince Aac as a turtle, and that their story could be the source of the Egyptian myth of Isis and Osiris was too much for Americanists to swallow, especially when Le Plongeon suggested that Queen Moo had traveled from Mayaland to Egypt to be welcomed and made queen again by her former co-nationals.

When Le Plongeon declared that one-third of the ancient Egyptian words he had deciphered were the same as Maya words and that the grammatical forms of the two languages were similar, he finally got some support. Pierre Lorillard gave him a subsidy with which to decipher more ancient Mayan characters.

Le Plongeon says that the circle divided by a cross into four parts to which wings are added symbolized "the sacred four builders," the Dyan-Chohans of the Hindu occultists which are similarly portrayed in Egypt, Assyria, and in Guatemala. He says they are the Kabiri and Titans of Hesiod's theogony, the Amshaspands of the Mazdeans, the Elohim and Seraphs of the Hebrews, the Archangels of the Christians and Mohammedans, the four Canobs of the Maya, heavenly architects emanating from the "Great Infinite One" who evolved the material universe from chaos.



Most interesting to Le Plongeon, who was evidently a Mason, was his discovery of what he called evidence of Masonic rites in Mayan sculpture, from which he deduced that "the sacred mysteries" had been practiced in ancient Mayaland as early as 11,500 years before, and that modern Masonry was but a great-grandchild of these mysteries.

He also believed that he had learned at the fountainhead the meaning of several of the symbols indicating that the old initiation rites had been similar in all countries, designed to give a better understanding of the laws that govern the material and spiritual world, thus bringing man closer into contact with the deity.

Le Plongeon appears to have been the first to realize that buildings at Chichen Itza were used as astronomical observatories. From the design of a gnomon at Mayapan he concluded that the Maya had been able to calculate both latitude and longitude.

There was no doubt in his mind that the Maya had been accomplished mathematicians, astronomers, and navigators, familiar with plane and spherical trigonometry, which enabled them to compute the size of the world, estimate the distance from pole to pole, and calculate the length of a meridian. He believed they had embodied, as did the Egyptians, their cosmogonic and religious conceptions into their sacred buildings, particularly the pyramids.

When, from the measurements he made of various Mayan buildings, Le Plongeon found that only the meter appeared to give figures in round numbers, he deduced that the Maya may have divided the circle into 400 units instead of the 360 of the Egyptians, and had taken as their unit of measure a 40-millionth of the world's circumference.

In support of Le Plongeon, it is established that the Maya described the circle by three names: *ca-an* or "two-serpent" meaning the upper arch of heaven; *ca-bala* meaning "two occult," or hidden; and *can-bak* for a full circle meaning both "circular serpent" and the number 400.

Le Plongeon further noted that many of the pyramids of Yucatan were twenty-one meters in height and that their vertical planes appeared to be inscribed in half a circumference whose diameter formed the ground line of the sacred buildings; so he figured that esoterically these buildings represented the earth. In this he was also prophetically correct.

Outraged at the vandalism that was being perpetrated in Mayaland, often in the name of science, by individuals breaking up the carvings *in situ* and transporting them for sale to European and American museums, Le Plongeon worked for years to copy, photograph, and make moldings of as many glyphs and carvings as he could manage.

Returning to New York in 1885 after twelve years in Yucatan, blue-eyed and with a brick-dust complexion, but balding, and with a long snowy patriarchal beard, Le Plongeon settled in Brooklyn with his wife Alice.

The many moldings he had laboriously and expensively brought back from Mayaland he offered to the Metropolitan Museum, but the director, who had eyes only for classical European art, put them in the cellar "for want of space"; and there they remained.

Complaining that he and his wife had "lifted in part at least, the veil that has hung so long over the history of mankind in America in remote ages," Le Plongeon asked if it was to be allowed to fall again. "Will no efforts be made by men of wealth and leisure in the United States, to remove it altogether?"

The answer, for the moment, was no.

To arouse further interest in exploration in Mayaland, Le Plongeon hinted at the existence of old Maya books, the writings of the H'Menes, or wise men, of Yucatan, which he said had been buried long before the advent of the Spaniards lest they fall into the hands of the Nahuatl conquerors from Tula. He said he would see to their disinterment, but only on condition the U.S. government agreed to protect such treasures against arbitrary seizure by the Mexicans, something the Department of State was unwilling to consider.

The only real friend and supporter Le Plongeon acquired in New York was a young Englishman, James Churchward, whose ideas on the antiquity of civilization on this planet coincided remarkably with his own, except that Churchward's lost continent of Moo, or Mu, was in the Pacific, different from Plato's continent of Atlantis in the Atlantic. Like Le Plongeon, Churchward based his information on the decipherment of some very ancient tablets which he said had been written by the same Naacal priesthood mentioned by Le Plongeon but which Churchward said originated not in Yucatan, but in the

In Le Plongeon's analysis, this panel represents Queen Moo as a child seated on the back of a peccary, or wild American boar, under a royal umbrella of feathers which Le Plongeon says was the emblem of royalty in Chaldea, India, and Egypt, as well as in Mayaland. Queen Moo, says Le Plongeon, is consulting a H'Men, or wise man, who is revealing her fate by reading the tints of vapors rising from an armadillo shell that is being slowly cracked by the fire of a brazier.

Le Plongeon says that facing the Queen sits the soothsayer, whom he judges by the blue and yellow feathers of his ceremonial mantle to be a priest of high rank. The scroll issuing from the seer's mouth is seen as representing his prognosis, and the position of his hand is said to have a special significance for occultists. The winged serpent represents the protective genius of the Mayan Empire. Behind the priests, says Le Plongeon, are the Queen's ladies in waiting.

Here, says Le Plongeon, Queen Moo is no longer a child but a comely young woman seated under the royal umbrella accompanied by a suitor; she is consulting a priest, or H'Men, whose face is concealed by an owl's head. According to custom, says Le Plongeon, an old lady acting as spokeswoman tells the priest the young man sitting on the stool wishes to marry the queen. But the young queen refuses, as is indicated, according to Le Plongeon, by the reversed direction of the scroll issuing from her mouth.

Le Plongeon adds that it was the custom among the Maya, as among the Egyptians, Chaldeans, and Greeks, for girls of royal blood to marry their brothers, hence the impossibility of the present marriage.

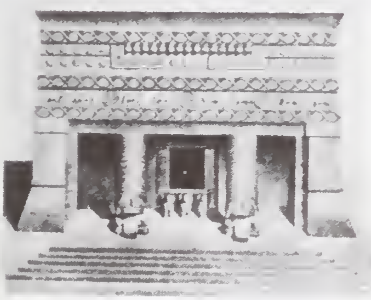
lost Pacific continent of Mu, mother country of colonists who had later developed Mayaland.

Churchward described having come across the Naacal tablets as a civil servant working for famine relief in India—though transparently an agent of British Intelligence. Churchward described entering a monastery in a valley near the headwaters of the Brahmaputra, where he was befriended by a high priest who eventually began to teach him to decipher inscriptions in a language the priest believed to have been the original language of mankind. Finally the old priest, then in his seventies, whom Churchward described as a "great master," last survivor of the Naacal priesthood, brought forth some sun-baked old tablets, written in the language of the Naacal priests, very dusty, which he said were records of the geology, history, and religion of Mu as well as of the cataclysmic disaster which had overcome that continent.

Le Plongeon's regard for his fellow Mason Churchward became such that he showed him much of his unpublished work on Yucatan and in the end bequeathed him his literary estate. As birds of a feather, Le Plongeon and Churchward became fair game for any academic with a shotgun.

In 1908, at the age of eighty-three, Le Plongeon died without anything having been done about the "hidden books" and without having been able to return to Yucatan. Twelve years later, in 1920, when his wife, Alice, realized her own death was imminent, she entrusted to a Mrs. Henry Blackwell the notes, photographs, and floor plans of the location of the Maya books in the ruins of Uxmal and Chichen Itza. But nothing was done with this tenuous lead, at least not for another twenty years; meanwhile the spiritual and intellectual achievements of the Mayas were once more ignored, and the archeological quest in Mayaland reverted to a materialist search for loot to adorn the world's museums.

Le Plongeon's chronology, which filled the gap between Plato's destruction of Atlantis in about 9500 B.C. and the historical record of Babylon and Egypt some five thousand years later, was too outrageous for his contemporaries, as was his



Le Plongeon's reconstruction of Chichen Itza building, from Stacy-Judd.

It was said of Le Plongeon that his "carefully detailed analyses and conclusions were founded upon conditions in the facade which never existed." It was a problem of restoration and reconstruction. According to Stacy-Judd, Le Plongeon mis-reconstructed the "Temple of the Tigers" at Chichen Itza and made several mistakes.

overtly expressed distaste for the endless bloodshed perpetrated on the planet by the Church in the name of Christ.

Disappointed in Le Plongeon, Stephen Salisbury, Jr., contrived with Charles P. Bowditch, the guiding light of the Peabody Museum of Anthropology in Cambridge, to send a more controllable young man to Yucatan to be their eyes and ears in Mayaland. To pay his way and insure him a free hand to explore, they hit upon the stratagem of having him appointed U.S. Consul to Yucatan and Campeche, using the influence of their fellow member, the senator from Massachusetts, George F. Hoar, to get the President to make the appointment.

Stephen Salisbury, one of the founders of the American Antiquarian Society.

Edward H. Thompson after he had been in Yucatan for almost a quarter of a century.

Ironically, the young man, Edward H. Thompson, a jovial blue-eyed six-footer, also from Worcester, Massachusetts, came to the attention of Salisbury because of an article he had written for *Popular Science Monthly* while still a student at Worcester Polytechnic Institute, pointedly entitled "Atlantis Not a Myth," in which Thompson suggested that the mysterious civilization of the Maya on the peninsula of Yucatan might have been a broken branch of the civilization that had once existed on the lost continent of Atlantis.

Fired by Brasseur's books, Thompson argued that although there was no proof of the Atlantis theory, a tradition so widespread and a legend so persistent must have some basis in history, which made it legitimate "to hold as probable the notion that at some time in the remote past a group of people representing a civilization of which we have lost all trace, made their influence felt upon the races indigenous to Mexico and Yucatan."

Thompson pointed to the traditions of widely separate peoples concerning a mysterious appearance on the shores of the Gulf of Mexico of the People of the Serpent, or Chanes. According to the legends, light-skinned beings, tall and blue-eyed, had landed at Tamoanchan, near Tuxpan in the Tampico district, wearing strange garments and emblems like entwined serpents on their foreheads. The sides of their vessels were said to have shone like the scales of serpents' skins. Thompson pointed out that the leaders of the "Ulmecas" were known as Chanes, or among the Mayas, as Canob, "Serpents' Wise Men," or Ah Tzai, "People of the Rattlesnake."

As the article appeared three years before Ignatius Donnelly brought out his best seller on Atlantis, Thompson's article attracted enough attention to get him the job as the youngest U.S. consul ever to be sent to Mexico.

With his bride and baby daughter, Thompson arrived in Yucatan in 1885, the year that Le Plongeon left for good.

Like Le Plongeon, Thompson threw himself into the job with enthusiasm, learned to speak fluent Mayan and took off

into the bush to hear from the natives firsthand their legends as they macheted their way along jungle trails, surveyed ruined cities, or squatted at night around campfires. Traveling light and living on the food of the Indians, Thompson soon visited over a hundred ancient cities and temple centers. In his own words he became "almost a Maya in the belief that a close study of the descendants of the ancient builders and cabinet makers might be of aid in reconstructing the ideas and methods of times long past."

Atlantean figure of a painted stone from Chichen Itza's upper Temple of the Jaguars.

But somehow Thompson either lacked the spark of Le Plongeon or did not make the proper contacts. He says he soon numbered among his friends members of the H'Menes, or wise men, of the modern Maya, and that he became an initiate of the Sh'Tol Brothers, one of the dominant secret societies of the Maya; but it was evident, even to him, that the society was no more "than a fading remembrance of some body among the ancients comparable to the Masons."

Unlike Le Plongeon, to whom the Maya had given one of the nicknames they reserved for those they admired, Ahmeexnal, "he of the long beard," Thompson was always respectfully referred to as Don Eduardo.

With neither the knowledge of Mayan glyphs nor the imaginative curiosity of Le Plongeon, Thompson had little basis from which to interpret the carved figures on the buildings he discovered. Yet the dry descriptions of the ruins he found and forwarded to Cambridge were evidently more satisfactory to his patrons than Le Plongeon's fanciful and potentially boat-rocking conceits.

Thompson was most adept at satisfying his patrons with the enormous efforts he expended on producing for them molds of the facades of buildings such as those at Labna, which measured more than a thousand square feet, the arrival

One of the intricate facades Thompson was requested to reproduce for exhibition in the United States.

of which in Boston only prompted them to ask for even bigger examples from Uxmal. This next job cost Thompson fourteen horrendous months in a fever-stricken area where one by one his forty workers turned into "yellow-skinned caricatures of their former selves." Delirious at the end, Thompson nevertheless managed to deliver to Chicago the enormous molds for their 1890 World's Fair. His reward was to be befriended by the meat magnate Allison V. Armour, who provided him with sufficient funds to achieve his life's ambition: to become the owner of the ruins of Chichen Itza. For the equivalent of about seventy-five dollars Thompson bought himself almost a hundred square miles of jungle and untold acres of prime Mayan ruins, the whole parcel accessible only by jungle footpath, along which on the night he took possession Thompson stumbled over the bones of the last inhabitant of the burned-down hacienda, murdered by the *sublevados.*

The ancient ruins were familiar to Thompson from having acted as Maudslay's assistant there two years earlier, surveying, measuring, and photographing, though no digging had

The Chichen Itza Cenote, alive with iguanas, is an oval-shaped opening in the rocky crust with a diameter of 180 feet, and craggy sides, which fall perpendicularly 60 feet to the rim of the water. Forty feet below the dark green surface is a layer of mud. One of the legends that spurred Thompson to submerge himself into this mud was contained in a report to Charles V from the mayor of the nearby Yucatan town of Valladolid written in 1579: "The Lords and principal personages of the land had the custom, after sixty days of abstinence and fasting, of arriving by daybreak at the mouth of the Cenote and throwing into it Indian women belonging to each of these lords and personages, at the same time telling these women to ask for their masters a year favorable to his particular needs and desires. The women being thrown in, unbound, fell into the water with great force and noise. At high noon, those that could, cried out loudly and ropes were let down to them. After the women came up, half dead, fires were built around them and copal was burned before them. When they recovered their senses, they said that below, there were many people of their nation, men and women, and that they had received them. When they tried to raise their heads to look at them, heavy blows were given them, and when their heads were inclined downward beneath the water, they seemed to see many deeps and hollows, and they, the people, responded to their queries concerning the good or the bad year that was in store for their masters."

been done other than what had been accomplished by Le Plongeon.

During the nearly three decades Thompson spent in Chichen Itza from 1885 to 1910 he somehow did not manage to produce as much data as had Le Plongeon in three months. He did, however, find a lintel with a date deciphered as A.D. 618, which was considered a coup. But most of his reports still lie unpublished in the vaults of the Worcester archeological library.

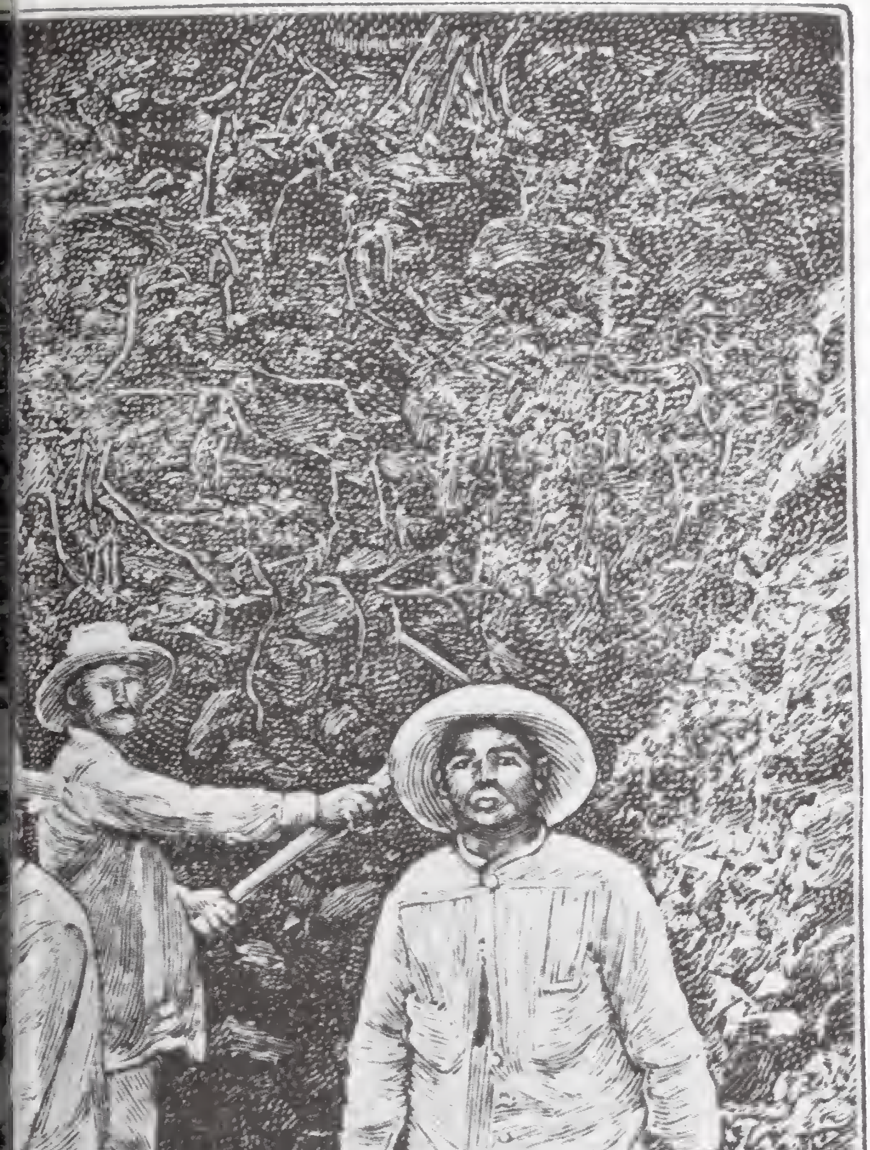
Thompson's main claim to fame was to end in his undoing: the dredging of the Sacred Cenote at Chichen Itza. Having read in Landa that the well was used for sacrificial offerings, both human and precious, Thompson was determined to produce from it artifacts to adorn the Peabody Museum in Cambridge. The prospect of descending sixty feet below the surface of the water into forty feet of pitch black mud meant getting some efficient diving gear and a certain expertise, both of which he obtained on Boston's Long Wharf from a Captain Ephraim Nickerson.

After years of dredging, and several almost fatal dives during which he ruptured his eardrums, Thompson eventually came up with enough gold, jade, and pretty artifacts to satisfy his Boston sponsors, to whom the artifacts were clandestinely smuggled and discreetly kept from public notice. Only when Thompson rashly publicized the results of his dives in the New York *Times* was the Mexican government aroused to sue him for the return of its chattels, placing a lien on Thompson's Chichen Itza property for a million pesos.

To collect back rent from his peasant tenants Thompson meanly threatened them with sterner measures and received in return a burned-down hacienda along with the destruction of his entire library and archeological collection. Obliged to return to Boston penniless, Thompson was kept alive by a subsidy from the Carnegie Foundation. Eventually, years after his death, the Peabody Museum obliged the Mexicans by returning them their artifacts, having kept them half a century.

Gradually, as archeology became a science, and the sale of *Kultur* became a means of feeding the academies, interest in the inherent meaning and value of the artifacts began to dwindle, giving place to an increasing appetite and market for looted artifacts around the world.

RAISING THE SHROUD



PART IV


MONOGRAFÍAS DE ARQUEOLOGÍA MEXICANA
IV.
CICLO O PERIODO
DE 13 AÑOS.
PIEDRA DEL AGUA
Descifrada por
LEOPOLDO BATRES

14. Batres' Archeological Pork Barrel

The first native Mexican to be impressed by Charnay's and Le Plongeon's approach to digging beneath the earth to discover the extent of Mexico's antiquities and treasures was one of General Diaz' ex-militiamen, Leopoldo Batres, who was able to approach such an offbeat and potentially expensive pastime because of his particular pull with the dictator, to whom he was illegitimately related. His natural father was Manuel Romero Rubio, who had become Diaz' top henchman by giving the fifty-year-old dictator his teenage daughter Carmen in marriage.

As a natural son of the leader of the all-powerful *cientificos,* Batres' venture into archeology was not such a wild idea; furthermore, he was astute enough to combine his interest in Mexico's hidden treasures with a wholesale and retail dealership in antiquities.

Struck by Ramon Almaraz' report on Teotihuacan that the smaller mounds paralleling the Way of the Dead contained treasure and gold dust which discreetly handled might prove of more than archeological interest, Batres got Diaz—whom he considered a brother-in-law—to appoint him "Inspector and Protector of the Archeological Monuments of Mexico," a sinecure which enabled Batres to poke about for treasure and have digs made wherever the fancy struck him—all at government expense.

To legitimize his efforts, Batres told the world he believed Teotihuacan to be "one of the most interesting cities in the world of archeology."

The Way of the Dead as seen by Batres from the top of the Moon Pyramid in 1884. Digging into a mound on the western side of the Way of the Dead, only a year after Charnay had been in the same area, Batres unearthed a perfectly preserved "temple" with a stairway facing west. Because its walls were decorated with mythological scenes, Batres argued that the building was neither a tomb nor a private dwelling, as had been assumed by his predecessors, but a religious center. Uncovering one mound after the other along the Way of the Dead, Batres showed them to be all "temples" built on platforms of adobe, or sun-baked brick, in groups of five or six around plazas with smaller temples in the center, none of which contained tombs or bodies. He therefore suggested that the entire forty-meter-wide esplanade between the terraces might have once been used for some sort of religious ceremony, and that the Way of the Dead should be renamed "La Via Sacra," or "Holy Way."

Whatever treasures or artifacts Batres may have found in these digs at Teotihuacan, little was heard of them publicly; yet his appetite for digging did not flag and he began to put out monographs to validate his endeavors.

In the rubbish near the Pyramid of the Moon, Batres found the monolithic statue of a woman of "colossal dimensions" known as the "sacrificial stone"; but he argued that the name had been inappropriately applied by the Spaniards, who were overly preoccupied with Aztec sacrifices. The earlier Toltecs, whose work Batres believed Teotihuacan to be, were reputed to have made sacrifices only of flowers, fruits, seeds, butterflies, and occasionally birds.

From the vestiges of pottery and artifacts he unearthed, and from the fact that nowhere did he find objects of war or fortifications, Batres concluded, like Charnay, that the city of Teotihuacan had been built by Toltecs, whom he believed to have been an eminently artistic and religious people, not the least warlike—deductions that turned out to be both facile and wrong.

Near the southeast corner of the Pyramid of the Moon, in the level plaza which fronts it, Batres came across a large mound of earth covered with underbrush. Digging into it, he uncovered a building with striking mural paintings depicting historical and religious personages, animals, butterflies, owls, beetles, human jaw bones, geometric forms, and concentric red and green circles with black outlines. The paintings were in various tones of red, or with green, yellow, blue, black, white, and gray pigment. As understood by Batres, the re-

Teotihuacan wall painting from the Temple of Agriculture.

ligion of the Toltecs was a "zoological mythology" in which the butterfly represented the soul's immortality, an idealized beetle called Pinahuiztli represented their astronomical system, and the owl, or Tecototl, was the demon of evil.

As well as temples, Batres found many more buildings such as had been unearthed by Charnay, evidently designed as dwellings, with large pillared halls connected by passages to smaller rooms, the main entrance being through a lobby supported by square pillars, the bases of which were painted red. On each side of the inner doorways, forty centimeters from the floor, Batres found holes which he assumed to have been used for leather thongs to tie back curtains.

These dwellings, all one-storied, had walls made of lava fragments held together with clay and mortar, faced with coatings of stucco, highly polished and painted red and white. Roofs were made of the same material, supported by wooden rafters ten or fifteen centimeters thick, so durable that they still resisted the blows of a crowbar.

Large jaguar heads carved in stone, with open jaws and large fangs, painted red, yellow, and blue, appeared to him to be symbolic of some power he could not identify.

A curious sculptured relief of lassos, coiled hawsers, and lambent flames, painted red, green, and blue, was interpreted by Batres as symbolizing the knot of years and the feast of the renewal of the sacred flame every fifty-two years.

Thousands of shards which came to the surface exemplified a great variety of pottery with or without feet—square, cylindrical, smooth, engraved, pierced, in monochrome or polychrome, on a fine white stucco base. But the great stylistic variety of these shards, found at different levels, and the fact that many of the buildings in and under which they were found appeared to have been built on the foundations of the previous ones, often many times, convinced Batres, as it had Almaraz, that reconstruction of the city's history would not be an easy job.

The dwellings appeared windowless, but each had a central patio thirty centimeters below the level of the main floor which could gather rainwater from the inward-sloping roofs, where it could either be held in a cistern or taken away through a central drain.

Everywhere Batres excavated he found a network of aqueducts covered by a layer of perfectly polished mortar through which water could flow, and still did flow from the many springs that gushed up from under Cerro Gordo.

He also found what he called an "underground" part of the city with rooms on different levels, the purpose of which he could not fathom, which he reinforced with steel beams in the hope that later archeologists might decipher their purpose.

Looking at the plain which stretched around the large pyramids, Batres found a great many more mounds, ten to fifteen feet high, whose arrangement led him to deduce that the ancient city must have once covered an area of some twelve square kilometers, four running north-south, three running east-west. On the south side of the city he considered the perimeter to be limited by the ruined edifices on the two low terraces known as the "Citadel."

The Way of the Dead and the north and east sides of the Sun Pyramid before Batres began his excavations.

Batres concluded that within the great city there had not been a single square meter not artificially paved with layers of small stones held together by mortar to a depth of ten to a hundred centimeters.

The most striking discovery made by Batres convinced him that some holocaust must have hit the city. Wherever he dug he found evidence of a great fire which had destroyed buildings "like a terrible Troy." He found that the upper parts of walls where they joined the flat roofs were charred, and that many rafters had fallen to the floor, where they lay carbonized.

Inside the dwellings he found the skeletons of men, women, and children in different positions, some still wearing necklaces of small stones which had withstood the heat.

It was hard for Batres to believe that anything but an earthquake followed by a fire could have so thoroughly destroyed a city; yet he kept encountering an extraordinary anomaly. In the excavations which he made he occasionally found roofs of houses perfectly preserved, the interiors filled with stones neatly fitted into place, joined one with another by claylike cement, forming a compact mass which he had to remove, piece by piece, with great care so as to avoid injuring the mural decorations. The anomaly set him to wondering: could the inhabitants of the great city have purposely destroyed it themselves? "Could those who had built it, fleeing before the invasion of barbarous tribes from the north, and with the hope of returning someday, jealous of the respect and veneration due their gods, have covered their sanctuaries with rubbish to protect them from the profanation of the sacrilegious?"

The conceit was stunning; it meant that the work of burying the city, along with all its temples, would have been as great as that of constructing it, a truly gigantic task, and one that required some pretty sophisticated explanation.

Batres would have liked to continue to dig at Teotihuacan to establish the truth of what had occurred, even hoping to unearth the whole city and its potential treasures, but his department ran out of funds. By 1890 it was clear to Batres it would take a million or more pesos to continue the job.

Skull of a grown man found by Batres in the House of the Priests, and skull of a sacrificial child found by Batres at the corner of the Sun Pyramid.

His benefactor, Diaz, at the end of his third term as president, was not yet sure of re-election. The country was in a financial crisis, the treasury empty, and bankruptcy threatened. Among the peons there was starvation, with epidemics of typhoid and smallpox, as well as insurrection among the Yaquis.

So Batres abandoned Teotihuacan and went off to look for greener sites in Mexico, potentially more profitable—also less of a burden on the national exchequer.

To justify his efforts and improve an unsavory image with the public, Batres produced—at government expense—a series of slick-looking illustrated booklets in which he said little of interest or value in very large print, mostly taking issue with opponents who attacked him in the press and accused him of purloining mountains of illicit gold from his digs.

Batres then had a row with Mexico City's Department of Sewers. They were digging new drains so stinking that no one else would go near them, but Batres insisted on spending long days underground with no one but his son Salvador, ostensibly, in Batres' words, to protect "treasure of inestimable value which would otherwise fall into the possession of negotiators who consider nothing but than their own pecuniary interest, destroying, like the horse of Attila, all that obstructs their way."

Each year Batres turned to a new site to exploit.

In 1902 he explored the ruins of Monte Alban, in 1903 the Valley of Mexico and "La Quemada," in 1904 Texcoco and El Garciclan, where he disinterred an enormous monolith. Of Monte Alban he wrote an inane book that attacked all other points of view but substituted nothing. His major complaint was against having had to supply sufficient water for all the diggers, which cost him two dollars for each barrel carried to the site by donkey.

La Quemada.

For the fifteen years between 1890 and 1905, virtually nothing was done at Teotihuacan except for the destructive efforts of an engineer called Antonio Garcia Cubas, who dug into the southern face of the Pyramid of the Moon on the theory that he would find an entrance to passages and chambers in approximately the same spots they had been found in the Great Pyramid of Cheops. He found no entrance, but seriously marred the structure.

Then, in 1904, better times appeared. Porfirio Diaz got himself re-elected president, this time for an extended term of six years. As he drove about the capital in his new Mercedes motorcar over well-paved, well-lighted and well-drained streets, the peons doffed their hats. As T. R. Fehrenbach put it in his spirited history of Mexico, *Blood and Fire,* "The first decade of the twentieth century appeared to be another of those calm, golden late-afternoons in which history seemed to pause."

But outward appearances were deceiving. "In the burning fields of Morelos and Yucatan, for men on their knees with bleeding fingers, and in the dismal mines and shops and airless factories, it was the worst of eras. Almost in hearing of the capital *pelados* still screamed and begged under the overseer's lash."

No sooner was Diaz inaugurated than Batres approached him with the idea that if Teotihuacan were made into a great national monument it might add to Mexico's national image, and that if the Pyramid of the Sun could be unearthed and restored to its former shape in time to commemorate the centennial of Mexico's liberation from Spanish rule, due in September of 1910, coincident with Diaz' eightieth birthday, it might cause enough of a splash to perpetuate the dictator in office.

The idea—which would assure Batres six uninterrupted years of well-funded digging—appealed to Diaz' vanity. Funds were provided, and on March 20, 1905, under the

North and east slopes of the Sun Pyramid before Batres began his excavations.

Northeast corner of the Sun Pyramid where Batres decided to search for the arris line.

Batres discovers an arris line on the northeast corner of the Sun Pyramid.

auspices of the Secretariat of Instruction and Fine Arts, as part of the program to celebrate the centennial of liberation from Spain, Batres began a large-scale dig at Teotihuacan, with enough money, men, and authority to make a noticeable dent. To facilitate his work he took up residence on the spot in a small two-story fort with narrow slotlike windows. His commission was simply to uncover buildings and restore and consolidate their exposed surfaces; but political considerations indicated he concentrate on the Pyramid of the Sun in order to accomplish his ploy for Diaz and justify the money he was spending by uncovering and restoring a really grandiose monument.

To see if an architectural structure actually existed beneath the rough mound of earth, and thus to try to determine the purpose for which it might have originally been built, Batres realized that he would either have to peel off the entire mantle of dirt and rubble from the Pyramid of the Sun, or leave it as it was, a mute and dormant monster. No halfway measure was possible.

Batres assumed that under the dirt and rubble the Sun Pyramid would consist of a five-terraced structure diminishing in size as it rose to a height of sixty-three meters, half as high as the Pyramid of Cheops in Egypt, but on the same-sized base, with a staircase two meters wide zigzagging up one side to a sanctuary on top. Batres suspected that the outer faces might reveal surfaces plastered with mortar and lime, suitable for frescoes. He also suspected, with some justification, that such a pyramid would have been built little by little, beginning with a small central core, growing with successive layers of rock and earthwork to its final dimensions.

Batres' next problem was to figure out at what point to start peeling away the mantle of earth and debris in order to reach a recognizable surface of the shrouded architectural structure which could only vaguely be discerned as a quadrangular stepped pyramid with four apparent levels. After careful scrutiny of the whole mound he found a likely spot near the base on the northeast corner.

Probing to a depth of four meters, Batres exposed a wall made of stone and mortar; the wall had a perfectly defined edge which he believed to be the profile of the northeast arris. Using this wall as a starting point—though he admitted it would have seemed more sensible to start from the top—Batres launched upon his monumental job.

Wheelbarrows and dump wagons were brought to the scene, and eventually even a steam locomotive, whose tracks were laid right to the base of the pyramid. Batres' workers began to remove dirt at the rate of eighty to a hundred tons an hour. Even so, progress was slow. The entire operation

Batres' mule train.

required the removal of several hundred thousand tons before the dormant giant could begin to be liberated.

Critics promptly raised complaints at the unheard-of waste of government funds to remove one mountain of earth simply to reveal another, especially when hungry Mexican mouths needed feeding, which they did. Wags in Mexico City joked that "Señor Batres, excavating in the pyramid, has already gotten out of it two automobiles!" Batres, secure in the head man's approval, continued unperturbed. By modern standards, his operations were remarkably economical. His stonemasons received the equivalent of twenty-five U.S. cents a day; a donkey cost him two cents a day. For his own services, because they were so special, Batres received an expense of seventy-five cents per diem. He did employ what seemed to be an excessive number of guards to police the area day and night, but this was ostensibly to secure all kinds of recovered objects—pottery, ceramics, and sculpture—from the greedy hands of outside scavengers and souvenir hunters.

As the outermost layer of dirt began to be removed from the pyramid, Batres was happy to show that it was not just a pile of rocks and earth, but "a temple, perfectly constructed and planned." He even found surfaces plastered over with mortar and lime, hard and smooth, decorated with polychrome frescoes. To Batres it looked as if the pyramid might have originally been covered with cut stone, fashioned in the *talud tablero* style, that is, with sunken panels and entablatures enclosed in projecting slab cornices, built on sloping sides, anchored by projecting stones. Yet it was clear to Batres—if not to everyone else—that most of the original surface of the pyramid had been broken up, either purposely by some human hand, or by time and vegetation.

(Facing page)
Batres' 25-cent-a-day laborers working to uncover the southeast corner of the Sun Pyramid. With wheelbarrows they could remove a thousand tons a day, which was then carted away on specially built train tracks.

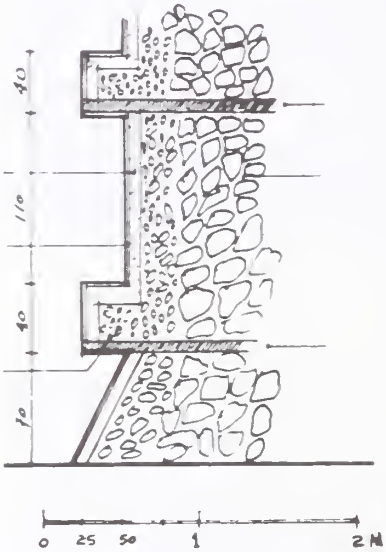
Southwest corner of the Sun Pyramid as the first two levels were exposed by Batres.

Again Batres even suspected that the whole structure might have been purposely hacked about and covered with earth to hide it from human eyes.

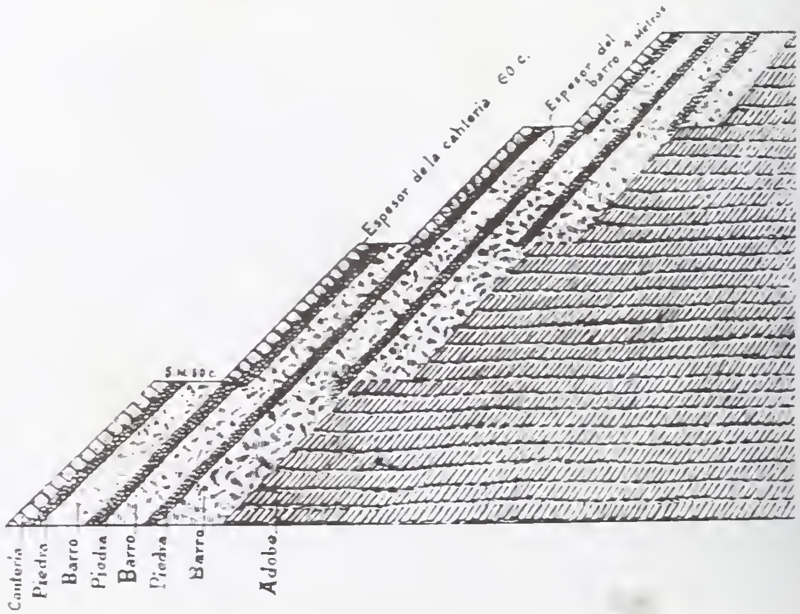
Then came trouble. The surface he was uncovering, clearly not the *original* outer surface, was made of adobe brick held together by mud. In heavy rain the mud began to dissolve, exhibiting plastic flow which threatened to destroy the whole edifice. Had it not been for the viscosity of the dissolving clay, which rendered disintegration slow enough to be arrested by hurried remedial measures, the whole surface of the pyramid might have been dissolved.

"As rainwater coursed downward from the heights of the pyramid in a veritable waterfall," wrote Batres, "it would have carried away completely the covering if I had not restrained the damage by establishing drains of wood to collect the water precipitated from the higher bodies which had not yet been uncovered, and, channeling this water with canals of wood, guided it away from the construction."

To prevent further damage, and to save the outlines of the structure as he uncovered it, Batres hit upon a method of



It was evident to Batres that the builders of Teotihuacan had everywhere employed the *talud-tablero* architectural motif of rectangular panels inset into sloping batters. Adobe bricks, measuring 40 by 30 by 10 centimeters, were laid horizontally for vertical stress and vertically for lateral stress. Over the adobe was laid a thick covering of crushed rock mixed with mud; on top of this was a layer of volcanic rock, four to six meters thick, followed by mixed concrete and mud, then the *tablero* or carved stonework, such as the colossal jaguars or hieroglyphs.

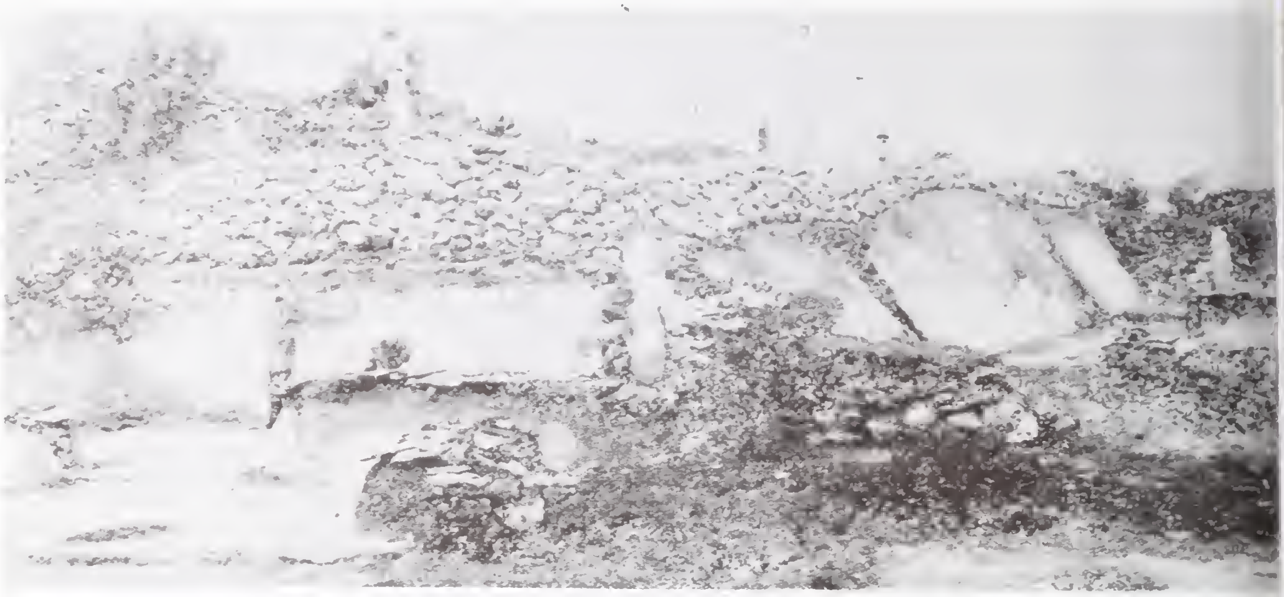


immediately introducing a mixture of lime and cement between the claybound bricks, reinforcing the mortar with fragments of volcanic stone. To this end he organized a group of skillful masons who dug with small spoons into the spaces separating the bricks to a depth of ten centimeters, removed the old mud, and, without moving the bricks from their position, rejoined them with the mixture of mortar and lava fragments.

During the excavation of the southeast corner, Batres found stone walls extending out from the surface like fins; these he assumed had been intended to hold the original surface in place; also there were some buttresses of stone and adobe, evidently intended to provide stability for the structure. This stonework was laid in diagonal rows, each series forming a braid of different widths.

As Batres continued to work upward on the pyramid, but at a slower pace because of the consolidating process, he decided to set other groups of men to digging around the base of the pyramid. At the foot of the west face they uncovered an immense mound fastened to the first level, whose outlines had been visible in the plan published by Maximilian's commission.

After removing a great deal of earth and rubble from a mound attached to the west side of the Sun Pyramid, Batres found atop the first level three temples, an enclosed room, and three stairways leading up to the next level. The central temple was like a three-stepped ziggurat, rising in shorter steps with angled faces. On the south side of the central temple, on its upper plane, Batres found a white and perfectly polished pavement, as well as a shallow cavity, oval in shape, which he believed had been a receptacle for some religious service. In the central temple, Batres found a carved stone with symbols in relief that seemed to be examples of a writing "more advanced than Mexican."



Northeast corner of the "House of the Priests" near the Sun Pyramid at Teotihuacan.

Meanwhile another gang began to explore the far western end of the platform surrounding the pyramid. Under a field of corn they discovered a large group of dwellings which, because it was only twenty meters from the corner of the Sun Pyramid, Batres named "House of the Priests."

Batres was amazed at the beauty of the walls which were uncovered, with massive carvings and polychrome frescoes, realizing they must have been striking when the colors were fresh.

Under a meter-thick layer of debris Batres found that the platform around the pyramid was 39.2 meters wide and 6 meters high, with sides in *talud tablero*. He believed this platform was designed to give stability to the pyramid and to prevent slippage at the base.

Batres' work had been in progress for a little over a year when money began to run out. To prime the pump, he decided to invite President Diaz to view the scene and see for himself that more funds were needed for what might be an imposing result.

At seven A.M. of April 6, 1906, General Porfirio Diaz took the train from Mexico City for the hour's ride to the San Juan station. There he and his company of ministers got into horse-drawn carriages and set off to see the sights under a riveting spring sun, raising great clouds of dust.

They were shown various frescoes and carved *tableros,* recently uncovered temples, and the platform around the base of the pyramid; then the party was invited to make a hot, sweaty climb to the top of the Pyramid of the Sun to admire the view. The retinue of ministers, impressed by Batres' work, were even more impressed by the "virile resistance" of their seventy-six-year-old "first magistrate," who climbed without

President Porfirio Diaz and members of his cabinet visit the pyramids at San Juan Teotihuacan in April of 1906.

visible effort to the top, perhaps because of the Zapotec blood from the Monte Alban hills which ran in his veins.

In the heat of the day the party descended from the pyramid and took refuge in one of the sixty-foot caves visited by Charnay, where they were served a typical Mexican meal. The guests were reported to be in very good spirits, exchanging historical anecdotes. At three-thirty the president took the train back to Mexico, "very gay and satisfied."

The next day newspapers gave details of the president's visit, noting that the caves in which he had lunched had been renamed the "Cuevas de Diaz." Controlled by the *cientificos,*

The older residents of San Martin recall how their grandfathers spoke of the times when the bandits who robbed the silver cargoes from coaches traveling south from Pachuca to Mexico City would disappear underground at Teotihuacan and emerge long after at Amecameca, sixty-five kilometers southeast.

Geologists report that the volcanic activity which took place in the Valley of Teotihuacan millions of years ago left tubular holes and bubble-shaped caves throughout the area. To the north of Cerro Gordo, lava flowed 6 million years ago. One of the giant underground bubbles left by the volcanic flow still lies to the east behind the Sun Pyramid, and is now called "La Gruta." Behind the Moon Pyramid a cave entrance leads to a tubular tunnel that was explored in 1964 and found to almost circle the pyramid.

the papers pointed out that in one year of work the two lower levels of the pyramid had been uncovered and consolidated, suggesting editorially that it would be very worthwhile if in a few years this extraordinary monument could be cleaned up and reconstructed in its original form.

To accelerate the work, and get it finished in time for the centennial of Mexico's independence, Batres said he would need to hire 400 more men and receive another 100,000 pesos. When the money was not forthcoming, Batres resigned in a huff and went off to explore the Mayan ruins in Yucatan.

15. Americans Good and Bad

At Chichen Itza, Batres found Edward H. Thompson busy diving for artifacts in the Cenote. Batres, though official Protector of Mexican Antiquities, made no objection to what Thompson was doing, indicating a certain honor among thieves.

By October, Batres had won his point in the capital: work could once more be resumed at Teotihuacan on the Sun Pyramid. In a few months the outlines of the structure began to be clearly discernible. While removing the debris, Batres found more strange artifacts and curios. From the south face he removed a whistle in the shape of a bird. Whistling into it and moving his fingers over four small holes cut into the back of the bird, he was able to produce seven notes of a scale different from that of our "well-tempered clavichord."

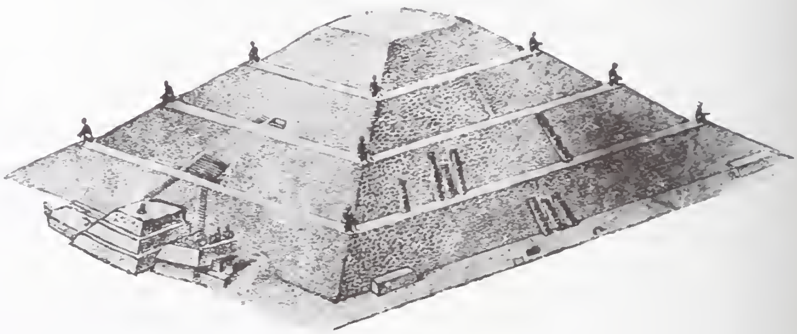
A more macabre discovery was made in the form of the skeletons of several six-year-old children, crouching, and purportedly buried alive, one at each corner of each level of the pyramid. Like the skeletons found by Charnay, they fell

The second level of the pyramid as uncovered by Batres was 16 meters high, sloping at an angle of 47 degrees, with a broad staircase 7 meters wide which provided access to a 3-meter-wide walkway on the next level which widened to 9 meters on the western facade.

A third body nearly 14 meters higher had a split staircase 5 meters wide either side of the center line. It also had more vertical fins held together by mud. A fourth body rose 6 meters higher, with a staircase on the center level, but at a steeper incline.

into dust as soon as they were uncovered, with the exception of one which Batres was able to preserve by immediately varnishing it.

On top of the pyramid, Batres found a horizontal platform with "the remains of a central temple," something no one else had noted since the eighteenth century. Three meters under the rubble he found a large number of clay figures carved out of jade, jasper, alabaster, and even out of human bone, as well as many shells of different sizes, also worked, and snakes of serpentine and obsidian. From these digs Batres deduced that what had been called the Pyramid of the Sun must, at an earlier time, have been dedicated to Quetzalcoatl, the plumed serpent, god of the air.



Batres' reconstruction of the Sun Pyramid with western *adosado,* and the skeletons of children on the various corners where he found them.

An unpublished find on the fifth level has never been adequately explained. While the Sun Pyramid was first being probed by Batres in 1906, an archeologist working with him reported a thick sheet of mica covering the top of the fifth body. This material was apparently carried away during the course of the restoration.

Coincidentally, a "Temple of Mica" was also found to the south of the Sun Pyramid about 350 meters down the Way of the Dead, where the local guard will still let one peek through a glass panel at the floor covered with mica slabs. Mica has two outstanding characteristics: high electrical resistance and opaqueness to fast neutrons. Hence it acts as an insulator or nuclear reaction moderator, which raises the question as to why two separate areas of Teotihuacan were covered with mica. By Batres the question was not even raised; the commercial value of mica was apparently sufficient to his purpose.

To complete the unveiling of the pyramid in time for the approaching celebration of the centenary of the war of independence, due on September 16, Batres pushed his workers to the utmost. His patron, General Diaz, about to celebrate his eightieth birthday on September 15, now allowed himself to believe he had become indispensable and should run for another six-year term. On his successful election depended further funds for Teotihuacan. By September of 1910 Batres had spent 566,798.06 pesos, or $45,000, to uncover the pyramid; more funds were essential to make the result grandiose enough to justify the expense.

In Batres' nearly completed reconstruction of the pyramid, none of its original covering remained, only the anchor stones of the central mass. Batres figured that altogether he had removed a mantle of 7 meters north-to-south and 4 meters east-to-west, leaving a pyramid that measured 225 meters north-south at the base and 219 meters east-west, with a height of 62 meters, 4 meters more than was found by Maximilian's commission in 1864. To finish the job, Batres had to await the re-election of his patron.

Francisco Madero.

Educated at the University of California, Francisco Madero was 32 years old when he tried unsuccessfully to oppose Diaz in the election of 1905. In 1908 Madero published a book—*La Succession Presidencial en 1910*—that was immediately suppressed by Diaz because of its reasoned statement of the problems of Mexico and its criticism of the Diaz regime for its unconstitutional method of ruling. After leading an armed rebellion against Diaz, Madero showed such notable generosity for the vanquished that he won the esteem of the people. After a six-month rule as provisional president he was elected by a large majority.

But Diaz, because of his own foolhardy gesture of saying he would allow the formation of an opposition to his regime, no longer faced a totally unopposed re-election. Opposition had concentrated around a rich landowner from the north, Francisco I. Madero, who although he had been trained at the University of California, was not taken very seriously by Diaz. Barely five feet tall, with a birdlike high-pitched voice, Madero seemed hardly *macho* enough for Diaz, who laughed at his penchant for vegetarianism and spiritualism.

However, when large crowds began to gather around Madero, Diaz quickly had him arrested, with 60,000 of his supporters, on a charge of inciting to riot. Madero, disguised as a mechanic, managed to escape across the border to San Antonio, Texas; elections were held without him.

On September 16 celebrations for the centennial of liberation from Spain and for Diaz' birthday commenced as scheduled, with grandiose festivities which cost the government 20 million pesos, or more than it spent in a whole year for social services. Pageants, viewed by half a million standees, depicted great moments in Mexican history, such as Cortes' confrontation with Montezuma. At Chapultepec Park 50,000 citizens attended a garden party. At the Palacio Nacional, under 30,000 electric stars, 2000 dignitaries banqueted on gold plate, consuming ten boxcars of French champagne served by 500 picturesquely costumed lackeys.

In the course of the festivities Diaz casually announced to the throng the results of the election—99 percent in his favor.

In a cheap hotel room in San Antonio, Francisco Madero and a few fellow conspirators declared, with some justice, that the election was fraudulent; they called for an uprising against Diaz to make him respect the will of the nation. Madero and his followers demanded effective suffrage, expulsion of the *cientificos,* and a law against a president following himself in office.

Diaz' rougher edges had been rubbed off by his wife, Doña Carmelita, who put him in white tie for ceremonies and taught him to use gold plate and bread instead of tortillas to scoop up his beans. In Chapultepec Palace they lived more regally than had Maximilian and Carlota.

To Diaz' surprise, all over the country disaffected citizens rose in rebellion. In various areas armed groups formed around such leaders as Doroteo Arango, better known as Pancho Villa, or Emiliano Zapata, a tall robust peasant with a big black mustache who had long complained about the misappropriation of peasant lands.

Diaz, who had systematically downgraded his army, weeding out officers of ambition and ability in favor of corrupt and docile servers, now found himself with gouty, rheumatic generals over eighty, colonels over seventy, lieutenants over sixty, and a roster half filled with straw men, paid, uniformed, and fed at regular rates, but in fact nonexistent. Even his

When Emiliano Zapata raised the cry of "Land and Liberty," he was quickly supported by an army of small dark *campesinos* in white pants and conical sombreros, armed with sharp machetes and icons of the Virgin of Guadalupe, ready to fight for the return of their stolen lands.

After the civil war, Zapata hoped independently to restore economic well-being to the ravaged state of Morelos but the newly elected president, Carranza, attacked him with federal troops. When the attack failed, Carranza fell back on treachery. A federal colonel, Jesus Guajardo, pretended to defect to the Zapatistas with 600 men. Although warned of the treachery, Zapata agreed to meet the colonel, each with only thirty men. The colonel showed up with 600, and when Zapata entered the hacienda there was a bugle call: the unarmed Zapata was shot to death.

vaunted Rurales (like the later militia of Mussolini's fascism) turned out to be better at gang-beating individual citizens than fighting as an organized group; they soon went down before the rebels.

When a mob gathered outside the palace on the Zocalo shouting for Diaz' resignation, the dictator ordered the presidential guard to open fire, machine-gunning two hundred demonstrators to death. Popular outcry could no longer be stemmed. The leader of the *cientificos,* José Limantour, who had inherited the mantle from Batres' father, deserted Diaz and made a deal with Madero, who was eventually installed as president. Half delirious with pain from a rotting tooth, Diaz

Batres replied to his critics that he had taken all the necessary precautions to preserve the Sun Pyramid while removing the rubble and earth which incrusted it, that "all structures in Teotihuacan" were formed of layers of construction, whether stone, adobe, or volcanic dust and mortar, and that even mural paintings were to be found, one beneath the other, like "colossal palimpsests." He argued that he had been obliged to peel off the outer layer of the pyramid so as to reveal its true shape.
He dismissed the accusations against him as being political, leveled at him by revolutionary enemies for having been a close friend and faithful servant of General Diaz. "Nothing," wrote Batres, "is easier than criticism when one does not have the noble proposition of illustrating, teaching or correcting, and such criticism is reduced to the venomous desire to damage another man personally, as in my case, without it mattering to the accusers the damage done to science and to history by attributing imaginary defects to our archeological monuments."

was hustled under guard to a train for Veracruz, where he was put on a ship for France, never to return to Mexico.

Diaz' exile, despite Limantour's efforts, brought to an end the reign of the *cientificos,* and with it, that of Batres. Deprived of his title of Inspector General of Monuments, Batres was quickly attacked for having gone about his work with more vigor and enthusiasm than care, of having peeled the Pyramid of the Sun "like an onion," for fear of not being able to reveal it in time for Diaz's birthday.

He was accused of having removed all the remains of the original covering of cut stone and of having left nothing but a disfigured core with a few projecting anchoring stones. He was further castigated for having cruelly mangled the pyramid by giving it five platforms instead of the "archeologically correct four," and of having grossly reduced its size, disfiguring its faces with irregular edges.

Bitter and disappointed, Batres retired from public view, leaving the field open to a young rival who had been groomed for the job by his opponents ever since 1906.

Batres' most determined antagonist in Mexico for over a decade had been an American lady, Zelia Nuttall, an amateur archeologist whom Batres had managed to outrage. Mrs. Nuttall, who was as well endowed intellectually as she was financially, had made some interesting discoveries on the Island of Sacrifices off Veracruz, for which Batres stole the credit. He also blocked Zelia Nuttall's friend Alfred P. Maudslay from excavating at Monte Alban, and took for himself the credit for work at Mitla done by Marshall H.

Archeologist Zelia Nuttall.

Gamio.

In 1917 Manuel Gamio, excavating off the main road from Mexico City to Cuernavaca, found an overgrown hill called Cuicuilco enveloped by prehistoric lava streams. It turned out to be an enormous ancient pyramid or truncated cone with four galleries and a central staircase.

Saville, even going so far as to have his own name carved in letters of gold on a lintel of the finest palace.

Savoring her revenge, Mrs. Nuttall now put into print what was common knowledge about Batres, that as a wholesale and retail merchant in antiquities he had rifled the nation of its archeological treasures, consistently smuggling antiquities from sites he was supposed to be guarding in order to sell them for export. At the same time Mrs. Nuttall exposed, with devastating particularity, the arbitrary and misleading nature of Batres' classification of archeological objects. In trenchant terms she showed that archeology in Diaz' dictatorship had been just another pork barrel at which the same old cronies could feed.

Batres was publicly accused of having grafted in illegal permits to take art objects out of the country, of having blown up an arch at Uxmal to steal a statue, of having faked many of the important pieces in the Mexican museum in order to sell the originals abroad, and of covering up his misdeeds by writing a pseudo-scientific book exposing the forgeries.

Zelia Nuttall pointed out that when the famous Codex Sanchez passed to the German minister to Mexico, Batres was shortly thereafter decorated with the high German order of the Red Eagle.

Batres' downfall, for which Mrs. Nuttall had been planning for years, was as complete as was her triumph.

For years she had been grooming as a successor to Batres a young Mexican named Manuel Gamio, for whom she had maneuvered a scholarship at Columbia University in New York, with the help of the head of the Department of Ethnology and Anthropology, Professor Franz Boas, an authority on Mexican antiquities, on the ground that what Mexican archeology most needed was a museum director thoroughly trained in the most modern methods of archeological research. By repeated intercession with high Mexican authorities Mrs. Nuttall had gotten young Gamio a leave of absence from his job in charge of historic items at the Museo Nacional to study at Columbia, expressing the hope that someday he would be made director of the archeological section of the National Museum and inspector of monuments instead of her *bête noire* Batres.

With the revolution of 1910 all of this came to pass, and the International School of American Archeology, subsidized by various U.S. academic institutions, got off to a start in Mexico with Gamio following Boas as director.

Unfortunately, not all United States efforts in Mexico were as beneficial as those of Mrs. Nuttall. The U.S. ambassador, Henry Lane Wilson, virtually a Guggenheim employee, considering his paramount concern to be the protection of the billion-dollar investment by North American capitalists in Mexico, decided to be rid of Madero.

Falsely reporting to Washington Madero's supposed addiction to radicalism, Wilson did his best to make Madero appear to be a Bolshevik. Madero, a good-hearted nineteenth-century liberal, more accurately described by historians as "a do-gooder whose honesty and charity were unassailable," merely urged compromise and reconciliation among all parties, insisting that all change must come through the legal process.

Exaggerating the destruction of foreign property during Madero's revolt against the Diaz regime and falsely arousing alarm in the United States that in Mexico "every north American citizen's life and property are in jeopardy," Ambassador Wilson conspired to replace Madero with a military figure, General Victoriano Huerta, described by one historian as "an immoral drunkard, devoid of loyalty or honor, supported by the Church and the Army."

U.S. Ambassador Henry Lane Wilson seated stage right of Porfirio Diaz and his thoroughly unpopular vice president, of whom Diaz said, "Ramon Corral is a faithful lad who does what I want him to without discussion."

Huerta falsely lured Madero's brother into a restaurant to a parley, where he had him savagely tortured to death. He then arrested Madero and had him brutally murdered. The same night Huerta met with Ambassador Wilson at the U.S. Embassy to receive his official support.

Surrounded by cronies, Huerta tried to run the country from a bar, until Pancho Villa and Zapata and other insurgents marched on the capital to avenge Madero. The result of Ambassador Wilson's intervention was a bloody civil war which lasted seven years, during which unbelievable atrocities were committed, often on both sides. Huerta's federalists refused to take prisoners; they hurled the Chihuahua governor under the wheels of a running train, and staked out men in anthills to be eaten alive.

Pancho Villa.

Oregon-born and Harvard-educated correspondent John Reed (whose body is buried in the Kremlin wall because of his *Ten Days That Shook the World*) became intimate with Pancho Villa during his coverage of the Mexican revolution. Reed described Villa as representing the peasant soul of a whole continent which had brooded over its bitter condition since the Spanish Conquest and since the Diaz sequestration of land.

Before he became governor of Chihuahua, Villa was a bandit for twenty-two years. At sixteen he murdered a government official, reputedly for the violation of his sister. Outside the law, Villa became a Robin Hood, stealing from the rich to feed the poor. In time of famine he drove off thousands of head of cattle from the Terrazzas' vast ranges, feeding whole districts and taking care of entire villages evicted by the Diaz soldiers in their land grabs.

Reed reported that Villa's great passion was schools, because he believed that land for the people and schools for their children would settle every problem in the country. When he came to power in Chihuahua, Villa established over fifty schools and would have liked to send his son to school in the U.S. but could not afford it.

When he took over the government of Chihuahua, Villa also ordered every Spaniard caught within the boundaries of the state in the next five days to be escorted to the nearest wall by a firing squad. When the U.S. consul reproached him, Villa replied, "Señor Consul, we Mexicans have had three hundred years of the Spaniards. They have not changed in character since the conquistadores. They disrupted the Indian empire and enslaved the people. We did not ask them to mingle their blood with ours. Twice we drove them out of Mexico and

allowed them to return with the same rights as Mexicans, and they used these rights to steal our land, to make the people slaves, and to take up arms against the cause of liberty. They supported Porfirio Diaz. They were perniciously active in politics. It was the Spanish who framed the plot that put Huerta in the palace. When Madero was murdered, the Spanish in every state in the Republic held banquets of rejoicing. They thrust on us the greatest superstition the world has ever known—the Catholic Church. They ought to be killed for that alone. I consider we are being generous with them."

When asked by Reed why he did not aspire to the presidency, Villa replied, "I am a fighter not a statesman. I am not educated enough to be president. How could I, who never went to school, hope to be able to talk to foreign ambassadors and to cultivated gentlemen of the Congress."

He believed that armies were the greatest support of tyranny. "There can be no dictator without an army." He suggested instead the resettling of veterans on the land, where they could farm and teach citizens the basics of soldiering so that "if the patria is invaded, we will just have to telephone from the Palace in Mexico City, and in half a day, all the Mexican people will rise from their fields and factories, fully armed, equipped and organized to defend their children and their home. It would be fine," said Villa, "to help make Mexico a happy place."

General Porfirio Diaz at the age of 81 at Veracruz about to go into permanent exile in Paris, where he was joined by Batres. Unwanted at home, Diaz managed one last fame-making action by diving into Lac Leman to save a girl from drowning.

It was a dismal period for archeology, one when most of the digging was done not for artifacts but to bury bodies. Manuel Gamio, one of a few determined spirits, continued working quietly through the years of the revolution. Applying the stratigraphic techniques he had learned at Columbia, he managed to establish by digging into layers of refuse around Mexico City, and carefully noting each stratum of residue, a record of human habitation in central Mexico going back over 1400 years. Working backwards from the top, Gamio found layers of Aztec and Toltec and then traces of an earlier civilization which he labeled "Archaic." It was a whole new field to be explored.

16. Mexicans for Mexico

Not until 1917, and the establishment of a representative democratic federal republic, was sufficient peace restored in Mexico to resume the search into its past. A new liberal constitution opened the way for the renaissance of native talent; such artists as Diego Rivera, José Orozco, and David Siqueiros appeared on the scene. Interest was aroused not only in Mexico's history but in its ethnic development and its general educational advancement.

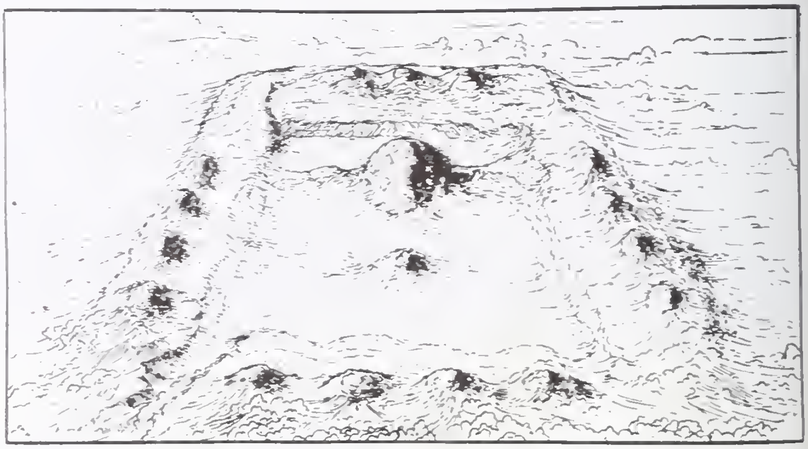
With Manuel Gamio as head of the Department of Anthropology at the Museo Nacional, a thorough study was decided upon not only of the ruins of Teotihuacan, but of the entire Valley of Teotihuacan, from a historical, geological, anthropological, and sociological point of view. For the first time in Mexican history teams of young Mexican scientists went out to make studies on the spot for a long-term investigation of Mexican antiquities. It was hoped that they would be able to reconstruct in detail the various cultures that had inhabited the Valley of Teotihuacan from remotest antiquity.

The earliest vestiges of human habitation found in the lava beds of San Angel were some adobe walls, given the name of Otomi. Gamio's students established that the earliest "archaic" metropolis at Teotihuacan had been built on a gently sloping plain irrigated by a network of crystalline springs which had their source in the volcanic mound of Cerro Gordo. Lava, abundant in the immediate surroundings, had been the main building material for this metropolis. The soil, known locally as *tepetate,* was heavily compacted and impermeable, which made it unnecessary to dig foundations for buildings; walls were not subject to deterioration from humidity.

Large deposits of hard, glassy volcanic obsidian, found in the northeast end of the valley, furnished the raw material for ancient arrowpoints, knives, and other weapons; also for jewelry and ornaments.

By February of 1918, Manuel Gamio was authorized by the secretary of agriculture to resume exploration of the ruins of Teotihuacan. In sixteen separate excavations he attempted to determine by stratigraphical studies the chronological development of the architecture he uncovered. Gamio believed the buildings of Teotihuacan antedated those of the lowland Mayas, which he believed to be two thousand years old; he assumed the earliest ruins of Teotihuacan might be five hundred or a thousand years older than that.

With the end of World War I, and renewed foreign interest in Teotihuacan, Gamio decided to attack an area of the city which he believed would reveal one of the most imposing ceremonial plazas in Mexico, the area known as the "Citadel."



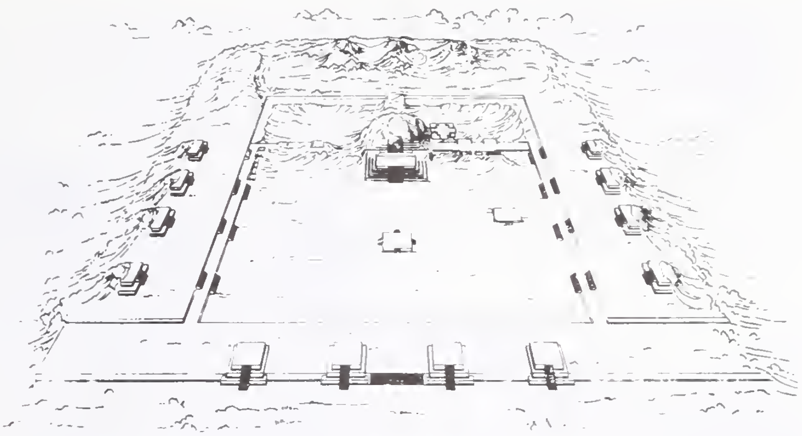
When Gamio first attacked the area of the Citadel, he found it entirely covered with a sheet of earth from under which its lineaments could only just be discerned. Setting aside the question of who could have covered it and why, Gamio decided to excavate what he could.

As with the Pyramid of the Sun—before Batres uncovered it—the Citadel's mounds and embankments, with one exception, were completely shrouded in earth on which flourished indigenous flora and many *pirul* (Peru) trees. The exception was a mound on the east side which had been partially unearthed by Batres to reveal a well-proportioned temple with the usual pyramidal base and *tablero* cornices.

As had been the case with Batres, Gamio realized that as soon as he uncovered a structure it would have to be protected or it would rapidly be disintegrated by rain or the germination of fresh vegetation in the clay mortar; it was also clear to Gamio that no one would be able to appreciate the original beauty of these ancient monuments unless they were restored into clear geometric lines.

Yet Gamio did not wish to incur the heavy criticism which had been heaped on Batres when he had lost the political support of Diaz.

The whole Citadel turned out to consist of a huge quadrangle, 1 mile in perimeter, or 400 meters on each side, covering an area of 36 acres. Facing the Way of the Dead, it had a 40-meter-wide platform 7 meters above the ground; on the other three sides similar platforms were 80 meters wide, around a central patio of almost 40 acres. Atop these platforms, symmetrically arranged, were fifteen mounds indicating the presence of temples. Within the patio were two more small mounds and one very large one. It was misnamed the "Citadel" by the Spaniards because of its high embankments, which they assumed were for military protection, but the true purpose of the complex remained a mystery.



To avoid a similar treatment, Gamio availed himself of the talents of an architectural draftsman of high repute, Ignacio Marquina, who made extremely careful renderings from the fragments of the walls, cornices, and stairways that came to light, recreating each monument as it might have looked in its original state. On the basis of these drawings Gamio concentrated on anchoring any parts of the original building that were found in place, or any part of the original concrete, immediately replacing the fallen rubble with fresh cement. Like Batres, he replaced weak mortar with cement, studded with volcanic fragments, but maintained that his method was more advanced than the primitive technique employed by Batres.

To limit the enormous amount of work such a project entailed, Gamio decided to uncover only the inward facing sides of the Citadel's embankments and temples, leaving the exteriors on the north, south, and east sides safely covered by their centennial or millennial coat of dirt.

Digging into the embankment around the central patio, Gamio found it to be a two-tiered affair with the usual *tablero* cornice, broken at regular intervals by stone stairways which led seven meters up to the flat platforms on which the fifteen temples were arranged. Those on the north and south sides faced inward, those on the east and west sides faced west, toward the Way of the Dead. Each temple had its own staircase leading to a flat top.

Mound in the center of the Citadel before Gamio attacked it.

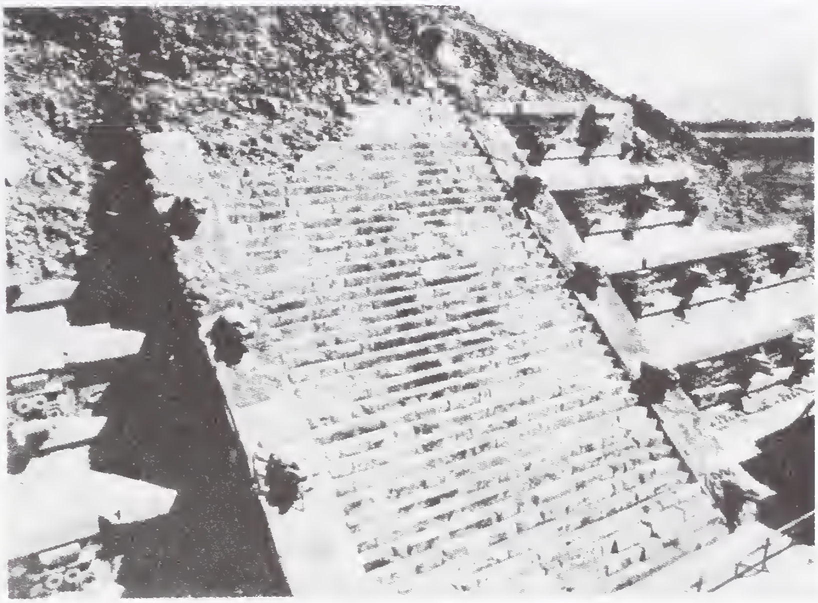
In the spring of 1919 the first soundings were made in the large central mound of the Citadel. By June it was excitedly reported to Gamio that huge sculptured serpents' heads were appearing from the mound, along with indications of other monoliths carved in the shape of curiously stylized animals which at first could not be identified. Unfortunately the rainy season had just begun, and it wasn't till September that Gamio was able to proceed with the excavations.

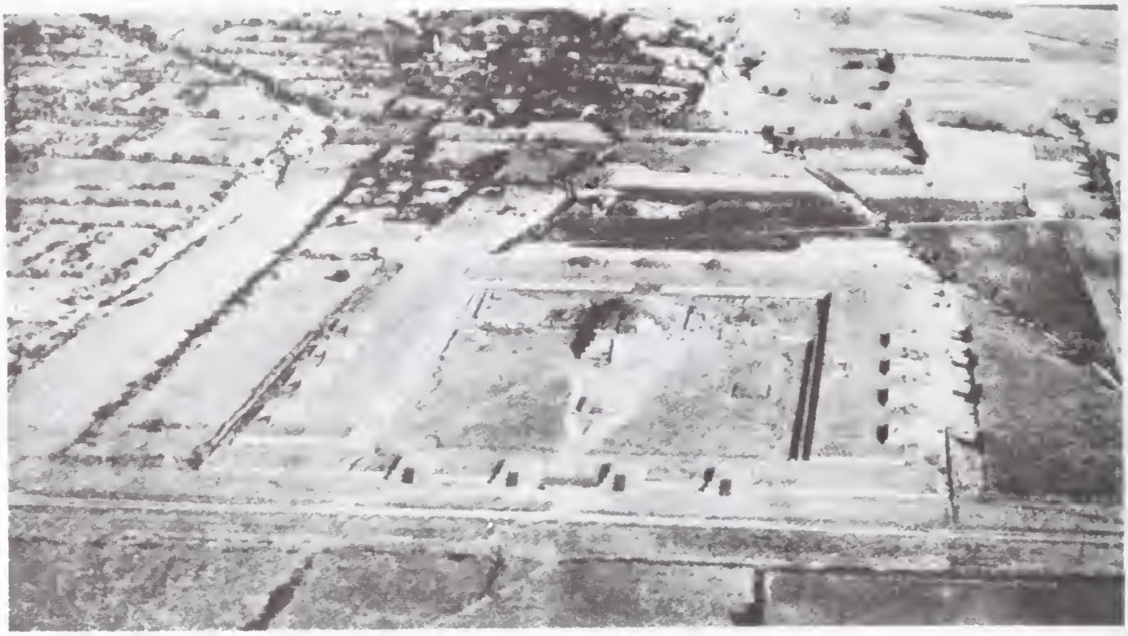
By carefully probing into the side of the mound, the diggers discovered they were dealing with two pyramids, one built up against the other, partly overlaying it. Gamio considered this to be corroborative evidence of two successive epochs having flourished at Teotihuacan. In order to reveal both pyramids it was necessary to make a passage between them. In the process part of the front pyramid had to be destroyed in order to reveal the facade of the back one, which Gamio found to be artistically finer and of an earlier period than the front pyramid; it appeared to have been superimposed during a later and more decadent era.

As earth was removed, an extraordinary sight was revealed; the rear pyramid, built on a base of some 25,000 square meters, rose in six stages to a height of 22 meters, each stage consisting of heavy stone cornices with polychromed sculpture of huge undulating serpents carved in relief with heads protruding from petaled collars to represent Quetzalcoatl. Each snake bore in the center of its body a large humanoid head with fanged jawbone, straight bar mustache, and circular orbs over its eyes, which, because of the sea shells and conchs that accompanied it, were interpreted to symbolize the rain god Tlaloc, though it could just as well have been interpreted as a jaguar representing Tezcatlipoca, the "smoking-mirror god of the rain of fire."

An imposing stairway, from which protruded the heads of plumed serpents, led to the uppermost terrace, where six graves were found by six deep wells containing large wooden pillars. Sculpture and stairway, which had been covered by the front pyramid, were in excellent preservation, considered to be the most successful integration of architecture and sculpture so far found at Teotihuacan. But the front pyramid,

Jutting from the facade of the Pyramid of Quetzalcoatl at regular intervals are great carved heads of feathered serpents, the symbols of Quetzalcoatl. Some of the eyes still glitter with polished obsidian insets. Alternating with the serpent is the symbol attributed to Tlaloc, the rain god, with circles inscribed around his eyes, more likely a representation of the jaguar Tezcatlipoca. Carved in low relief is an undulating design suggestive of waves. The intervening space is filled with carvings of seashells of Caribbean varieties.





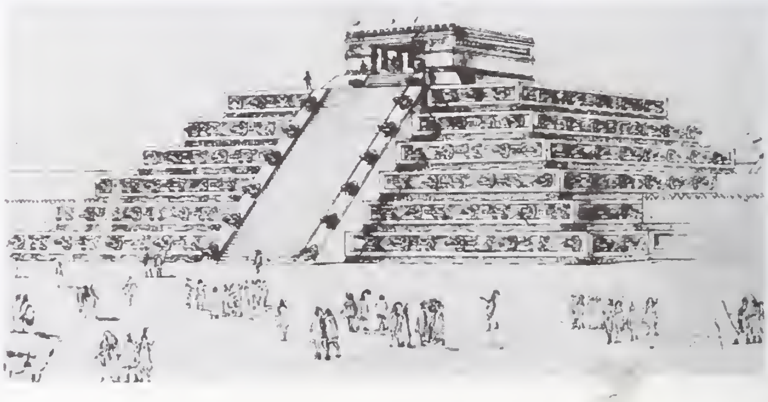
Batres contended that on the west side of the Citadel there had originally been three temple mounds atop the platform facing the Way of the Dead, but that Gamio and his department had leveled the mounds and the structures within them, arbitrarily replacing them—for symmetrical, or aesthetic, or whatever reason —with four "invented" mounds. Batres insisted he knew whereof he spoke, because several years earlier he had uncovered one of these temple mounds and had taken a photograph of it; and on the original survey made by Maximilian's commission only three mounds appeared. Batres accused Gamio and the Department of Anthropology of destroying large parts of the Citadel, literally razing them in order to build entirely arbitrary new buildings, which he called fantastic. Batres said he had devoted his life to the preservation of these monuments, and that now they were being destroyed beyond any hope of repair, to be replaced by "grotesque" reconstructions.

like most of the other mounds, had been largely despoiled of its stonework since colonial times, when the Citadel had been used as a quarry for stone to build churches and bridges.

In his attempt to remedy this vast spoilage Gamio got himself attacked by the man he had replaced. Batres, now old and crotchety, labeled Gamio's work a "savage destruction" of the Citadel, "done by men without understanding or conscience."

It was a serious accusation, but one that went largely unnoticed, as did the more fundamental issue of *arbitrarily* rebuilding ancient monuments. Both Batres' and Gamio's approach to their work had been more anthropological than scientific; they were looking for pretty temples to strange gods rather than to the possibility that the very dimensions of the buildings they were uncovering might contain scientific data.

The argument, often futile, which had been going on for several hundred years as to whether or not the base of the Great Pyramid of Cheops had been intentionally designed as



Ignacio Marquina's reconstruction of the Pyramid of Quetzalcoatl before the second pyramid was superimposed.

a scientific device for recording a fraction of the earth's circumference, thus to serve as a standard unit of measure, was not to be resolved until 1925, when the base of the pyramid was finally cleared of rubble and the British engineer J. H. Cole was able to pinpoint the length of the four sides to within millimeters. The answer, as classical writers had been saying for over two thousand years, was, of course, that the base of the Great Pyramid was an earth-commensurate eighth of a minute of arc, exactly 750 ancient geographic feet, or 500 cubits to the millimeter.

Unfortunately the difference in the length of the base of Mexico's Pyramid of the Sun, as found by Gamio and Batres, was still being disputed in meters rather than millimeters, so that as yet no rational system could be extrapolated from its measure.

If anything but an aesthetic thrill was to be derived from further unearthing of buildings at Teotihuacan, it would have to be done with a more scientific approach.

Ironically, whatever scientific shortcomings Gamio may have had, it was he who was credited with having initiated a new era of "scientific" inquiry at Teotihuacan. Soon the idea spread that the entire city might have to be explored.

But funds were lacking. North America's contribution to Mexican archeology came mostly through such foundations as the Carnegie Institute, whose new director in the field, Sylvanus G. Morley, was more interested in deciphering Mayan stelae in Yucatan than in any reconstruction of Teotihuacan.

He did gasp in wonder when Gamio showed him the freshly uncovered pyramid of Quetzalcoatl, and then took him to lunch in Diaz' grotto. Told that Batres had tried to disparage the accuracy of the work done on the Citadel, Morley gave an impassioned interview to the press in which he attacked Batres and praised the work of Gamio, saying that nothing in the New or Old World matched the ruins of Teotihuacan.

Gamio ond Morley at the Sun Pyramid of Teotihuacan.

Sylvanus G. Morley, a very short, slender Philadelphian, was known throughout Yucatan for the high and voluminous straw hat he sported. Described as a nearsighted bundle of energy, both lovable and exasperating, he had a high-pitched nasal voice and an odd Pennsylvania accent. His Spanish, though he had an extensive vocabulary, was considered atrocious, with mixed-up genders and tenses.

Inappropriately named Sylvanus, he loathed the jungle, especially the jogging on muleback over parched trails or through the smothering atmosphere of the rain forest. "Only liars and damn fools like the jungle," he said; but he stuck it out for twenty years to bring home what he called, "the epigraphic bacon." He was determined to find and decipher every possible dated stele with the long-term object of plotting the rise and fall of Mayan civilization, about which little or nothing was known.

At times only half conscious and afraid he would fall from the saddle, Van, as he was called by his friends, would tie his feet beneath the animal and plunge on despite sunburn, thirst, saddle sores, rock bruises, and cactus stabs. J. E.

Had it not been that the world was just then engulfed in a major depression, funds might have been forthcoming for further research at Teotihuacan. As it was, the site was allowed to languish until the economically solvent Swedes, who in the depths of the 1930s depression could still permit themselves the luxury of archeological exploration, financed Sigwald Linne to take up the spade at Teotihuacan.

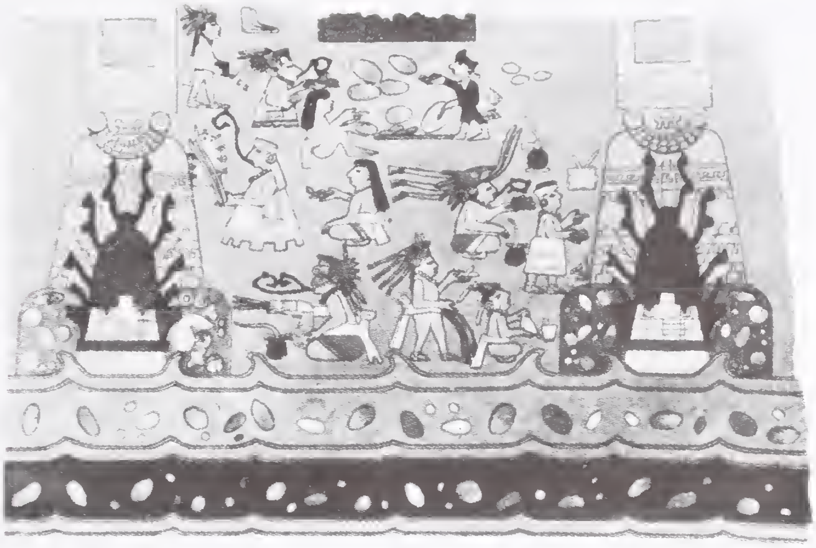
In a short time Linne showed a truly urban side to what had theretofore been considered primarily a ceremonial center. East of the Pyramid of the Sun, Linne discovered a large complex of small houses, interspersed with palatial residences. In one complex, encompassing a total of 4000 square yards, Linne uncovered a conglomeration of 175 rooms built around a network of corridors with twenty-one patios and five large plazas. Here, jammed between the more important religious edifices, were narrow alleylike streets leading off into residential areas where people had lived in crowded quarters separated by small courtyards and alleyways.

Along with the monumental religious structures there appeared the remains of public baths, theaters, and ball courts.

Linne found inner courts to houses with spacious basins for water complete with finely polished stone plugs to stop the drains, still *in situ*. Beneath the floors of these houses were graves replete with domestic utensils, jewelry, pottery, and

Thompson, who was to become England's leading expert on the Maya, describes Morley "squatting before a new-found stela to draw the glyphs, often with handkerchiefs around each wrist to keep the sweat from running down his arms onto the paper."

Eventually he learned to travel in greater comfort with a baggage train consisting of forty boxes, twelve kyacks, and over a dozen bundles of chairs, cots, and other luggage to make life along the trail as bearable as possible. In the bush he required thirty-four mules, two thirds of them for baggage and the remainder for personnel, who included a guide, four muleteers, and a Chinese cook.



obsidian artifacts. From the kitchen utensils, it was clear to Linne that the buildings had been used as dwellings.

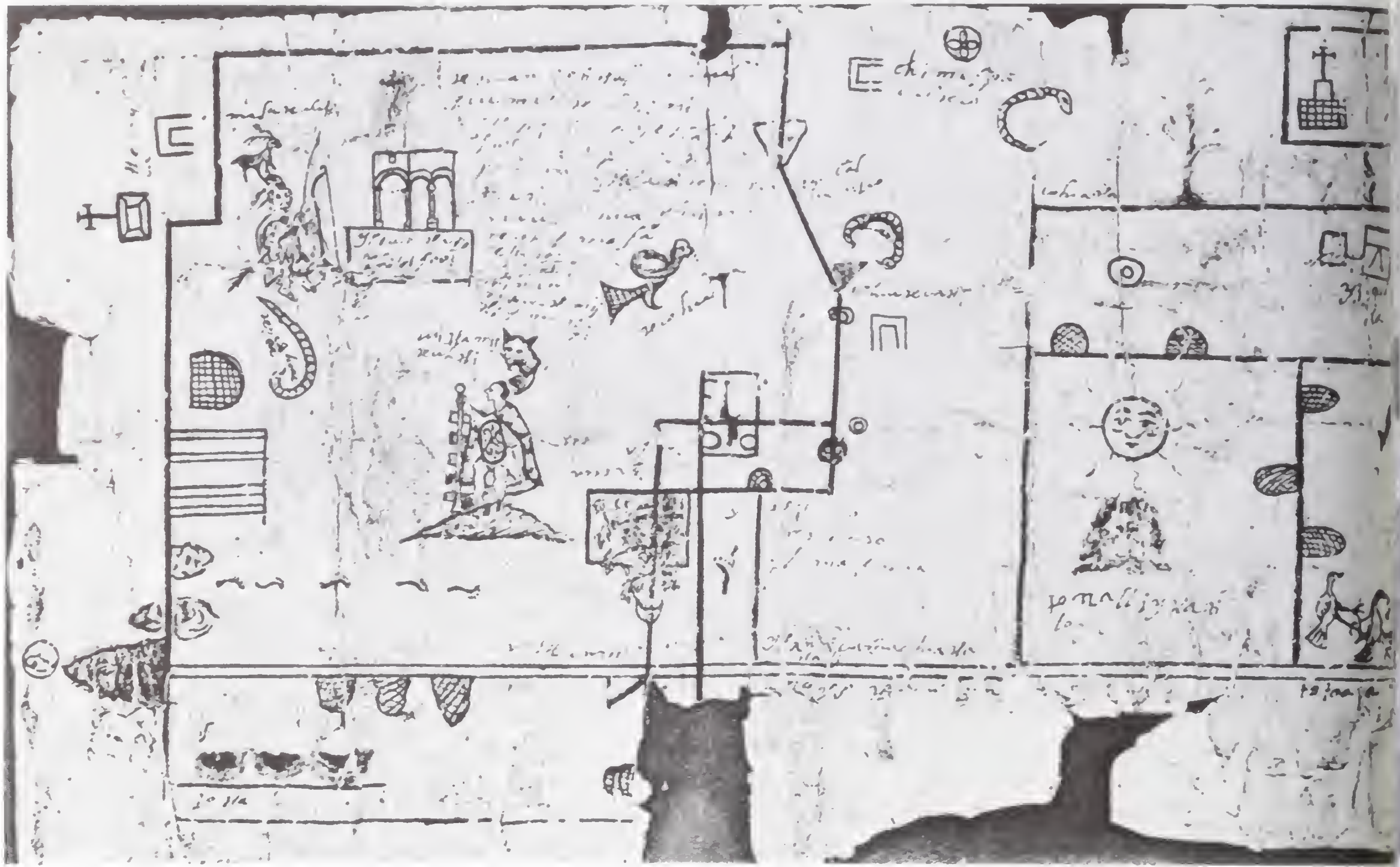
A second group of houses had forty-five dwellings around a rectangular patio surrounded on four sides by platforms, with an altar in the center. Some of the houses appeared to be designed like hotels, indicating the possibility of pilgrim quarters for thousands of visitors.

Linne was followed by Pedro Armillas, who, with money from a foundation called the "Viking Group," uncovered more buildings with frescoes which provided surprising information about the religious customs of the Teotihuacanos. Murals revealed the gods of Teotihuacan in impressive scenes.

Other paintings, made with mineral colors mixed with unfermented maguey sap painted on lime mortar, mixed with quartz dust to make the colors stand out, indicated to archeologists a civilization more of king-priests than of warrior-princes.

Still more gods, some of whom had also appeared in Tenochtitlan, were found on murals by Laurette Sejourné, a Mexican archeologist born in France. Digging into a bean field at Teotihuacan, she uncovered the ruins of a palace called Zacuala, covering 5000 square yards.

Yet all of this was desultory work. The mystery of when, how and why Teotihuacan had been built remained as deep as ever. To open up the ancient city a real financial shot in the arm was needed. It came in 1960 after the election to the presidency of Adolfo Lopez Mateos. A sharp economist, Lopez Mateos realized that a major effort at uncovering and restoring at least the ceremonial center of Teotihuacan might provide an attraction for both domestic and foreign tourists; they in turn might refill the state coffers.



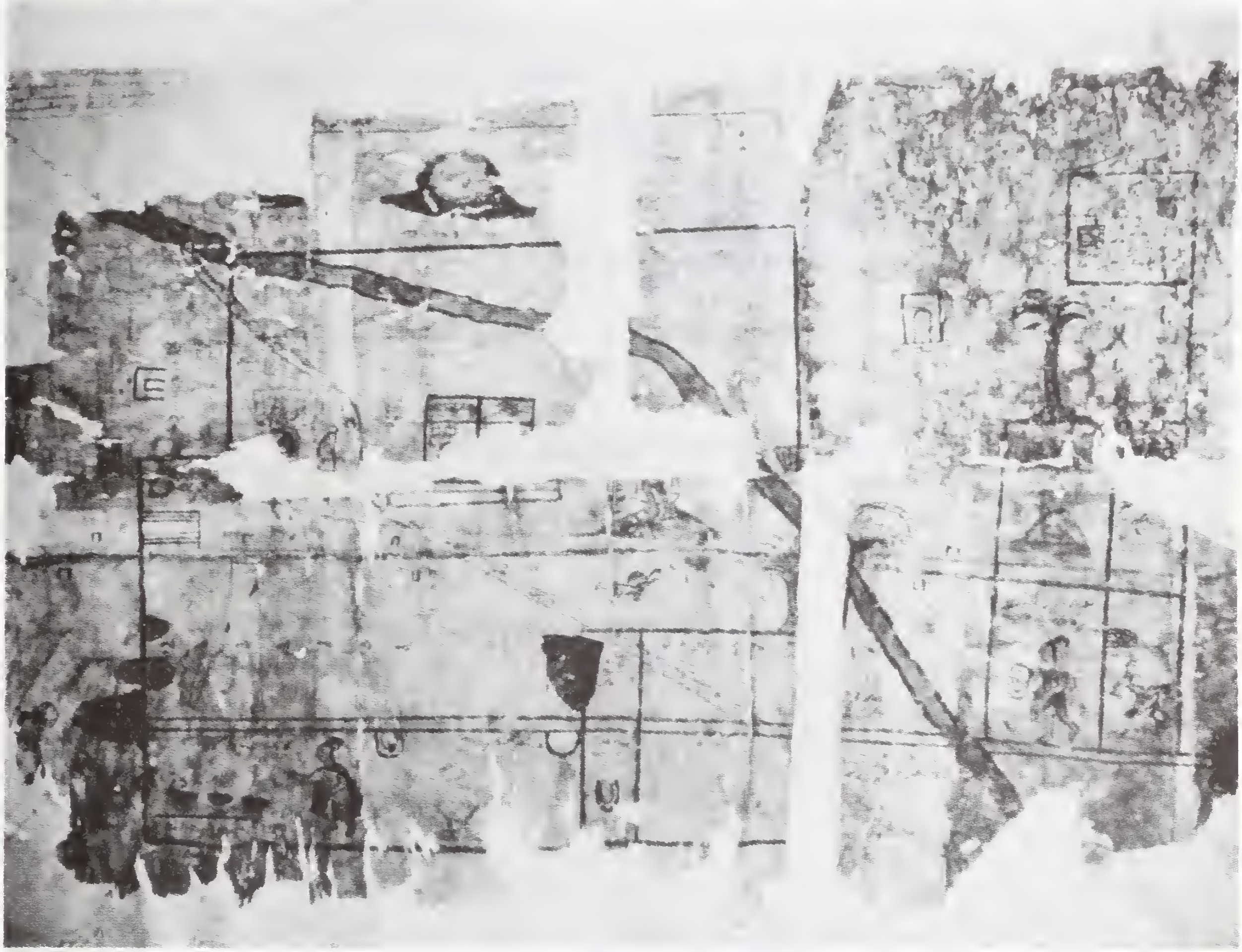
At Teotihuacan, Batres had found in a stone chest two manuscripts, one of which he gave to Marshall H. Saville, who presented it to New York's Museum of Natural History (where it is now stored on the shelves of Gordon Eckholm). The other, which he gave to Edward Ayres, is now in Chicago's Newberry Library.

Both maps, apparently made shortly after the conquest, contain unusual data and symbols not found elsewhere. Recent restoration of the Ayres manuscript revealed a backing paper with writing and the seal of Pope Urban VIII whose pontificate was from 1623 to 1644.

On the Ayres manuscript the Moon Pyramid is marked as "the moon house" and further down the Way of the Dead is "the place of the brilliant serpents." The Pyramid of the Sun, which is drawn in its proper position and correctly proportioned to the Pyramid of the Moon, is labeled "shining house."

Stansbury Hagar, Secretary of the Department of Ethnology at the Brooklyn Institute of Arts and Sciences, one of the first to realize the astronomical nature of Mexican monuments, suggested the smaller mounds could represent the planets or other stars.

Hagar believed the Way of the Dead, which was also known as the Way of the Stars, might represent the Milky Way; he pointed out that to Indians in the United States, the Milky



Way was known as the Path of the Dead because spirits were believed to pass to and from it, between earth and the land of the souls amid the stars.

Hagar suggests that Mixcoatla, the Mexican Cloud Serpent, might represent the Milky Way.

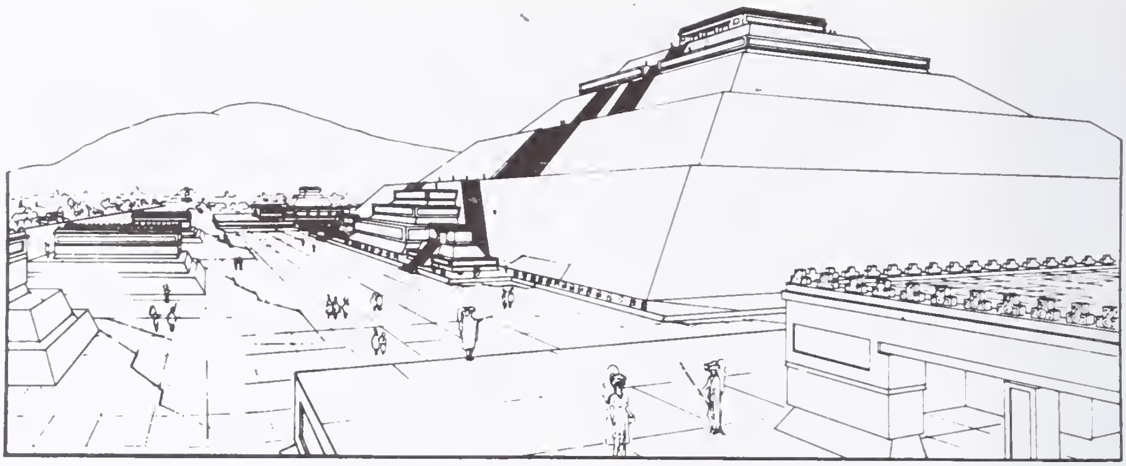
To Hagar, it appeared that Teotihuacan had been a sacred city because it reproduced on earth a supposed celestial plan of the sky-world "where dwelt the deities and spirits of the dead."

He believes the Citadel to have been a solar temple with two enclosures devoted to the solstices and equinoxes, and that its principal mound pertained to the sun and the summer solstice in distinction to the Pyramid of the Sun which was dedicated to the Sun as a celestial body. Hagar suggested that the great size of this zodiacal enclosure probably indicated a predominance of the cult of the stars over that of the Sun at Teotihuacan.

Hagar pointed out that footprints appearing on the maps could indicate the constellation of Capricorn at the moment of the December solstice. He interpreted the red and circular object outside the lower right-hand corner of the Citadel in both manuscripts as probably a tortoise, symbol of the summer solstice.

The word *itzquitla* in the margin he interpreted as a corruption of Dog, name of the day sign attached to the winter solstice.

The third enclosure of the Citadel containing two small mounds and two birds of equal size, one black and one white, Hagar interpreted as symbolizing the vernal equinox, which falls between the day sign Quauhtli, for eagle, and Cozcaquauhtli, for vulture. "Evidently," wrote Hagar, "we have not realised either the importance or the refinement, or the widespread distribution through ancient America of the astronomical cult of which the celestial plan was a feature, and of which Teotihuacan was at least one of the principal centers." But some time was yet to pass before further evidence was forthcoming on the astronomical functions of Teotihuacan.



Impressive but improbable reconstruction of the pyramids of Teotihuacan by Mexican architect J. A. Gomez Rubio.

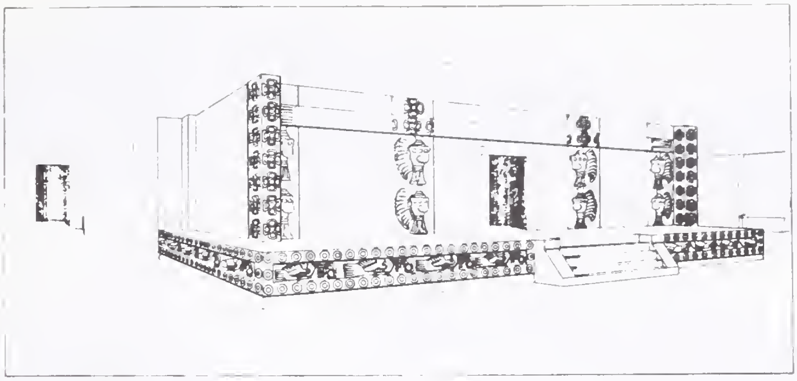
Seventeen million pesos were appropriated for a two-year campaign. Scores of archeologists were hired to supervise some six hundred spade diggers. It was hoped that dozens of the temples buried along the Way of the Dead might be excavated and restored so as to give visitors a more vivid sense of the ancient city's splendor.

Under the direction of Jorge Acosta, a Mexican archeologist born in Peking in 1904, whose digging at Tula had been responsible for confirming Charnay's contention that the ancient city had once been the seat of a prosperous Toltec kingdom, the area around the Pyramid of the Moon was first attacked. In a few months the plaza before the pyramid and three surrounding hectares were completely cleared of rubble. So was a large part of the Way of the Dead. The plaza in front of the Pyramid of the Sun could only be partially restored because of the damage done by previous excavators, including Batres' pet railway.

In the course of operations around the Moon Plaza, the remains were unearthed of a building with another large stairway with enormous snake heads leading to a patio with square sculptured columns, where Acosta found rooms with some of Teotihuacan's finest murals. This was the beautiful place of Quetzalpapalotl, the butterfly god.

Palace of the Butterfly God.

Substructure of the Palace of the plumed shells.

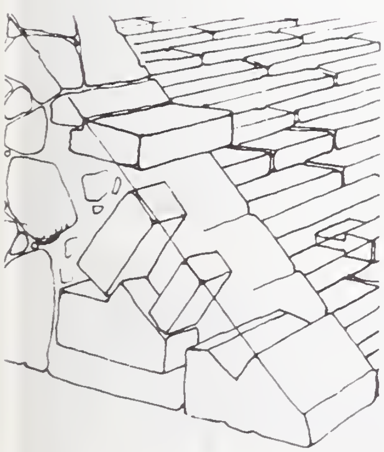


To analyze the enormous quantity of pottery, sculpture, tools, and ornaments dug up in these vast operations, a special scientific lab was created under the supervision of fifty-year-old Florencia Muller, a Mexican specialist in ceramics who had done her early schooling in St. Louis, Missouri.

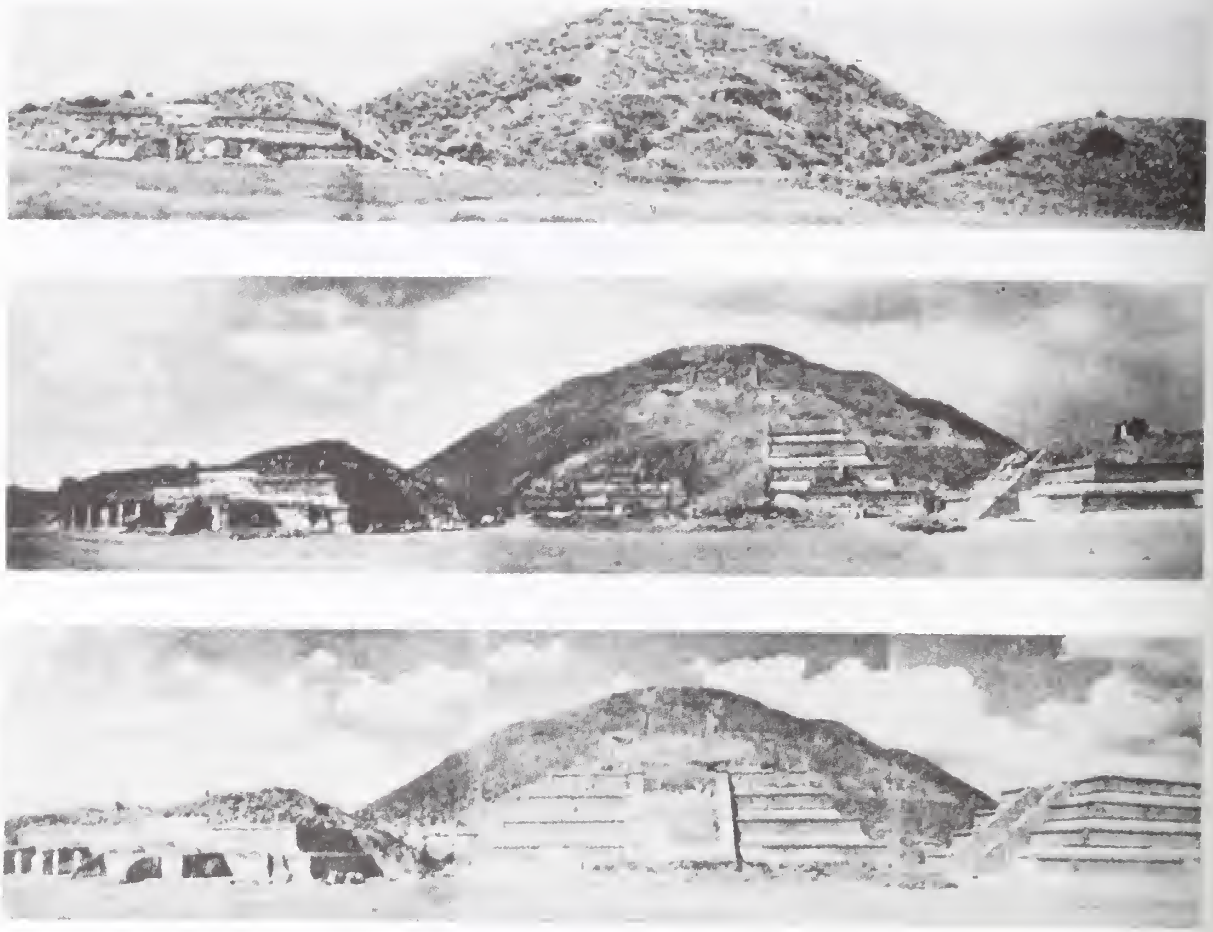
At which point another fifty-year-old Mexican archeologist, Ignacio Bernal, joined Jorge Acosta in the decision to embark on the major project of uncovering and reconstructing the remaining major monument at Teotihuacan, the Pyramid of the Moon.

Gamio had found it a mound covered with earth and vegetation, and so he had left it. Only a few portions of the external structure of the Moon Pyramid had been uncovered, showing the remains of a staircase, fifteen meters wide, on the south side, looking down the Way of the Dead, but largely destroyed by Garcia Cubas, who had left a hole of several thousand cubic meters in its center.

As Bernal and Acosta went about carefully uncovering the rest of the south face, four stages came to light, plus sufficient remains of a fifth stage for them to risk undertaking its reconstruction, in no way an easy job, even for twentieth-century archeologists, especially as no one could be sure that the building had not already been reconstructed two millennia previously. Not only had external stones subsided from their "original" positions and angles, but underneath the outer surface of the Moon Pyramid the archeologists found traces of two more "original" structures which might at one time have been external.



Thanks to some careful exploration by archeologist Ponciano Salazar, 565 original stones to the staircase were recovered from rubble around the plaza. One stone was still in its original position—luckily a cornerstone. From this stone it was possible to reconstruct the entire angle of ascent. As the whole staircase had been ingeniously designed with odd-shaped interlocking stones to prevent slippage, forty-eight courses could be reconstructed, which brought the top of the



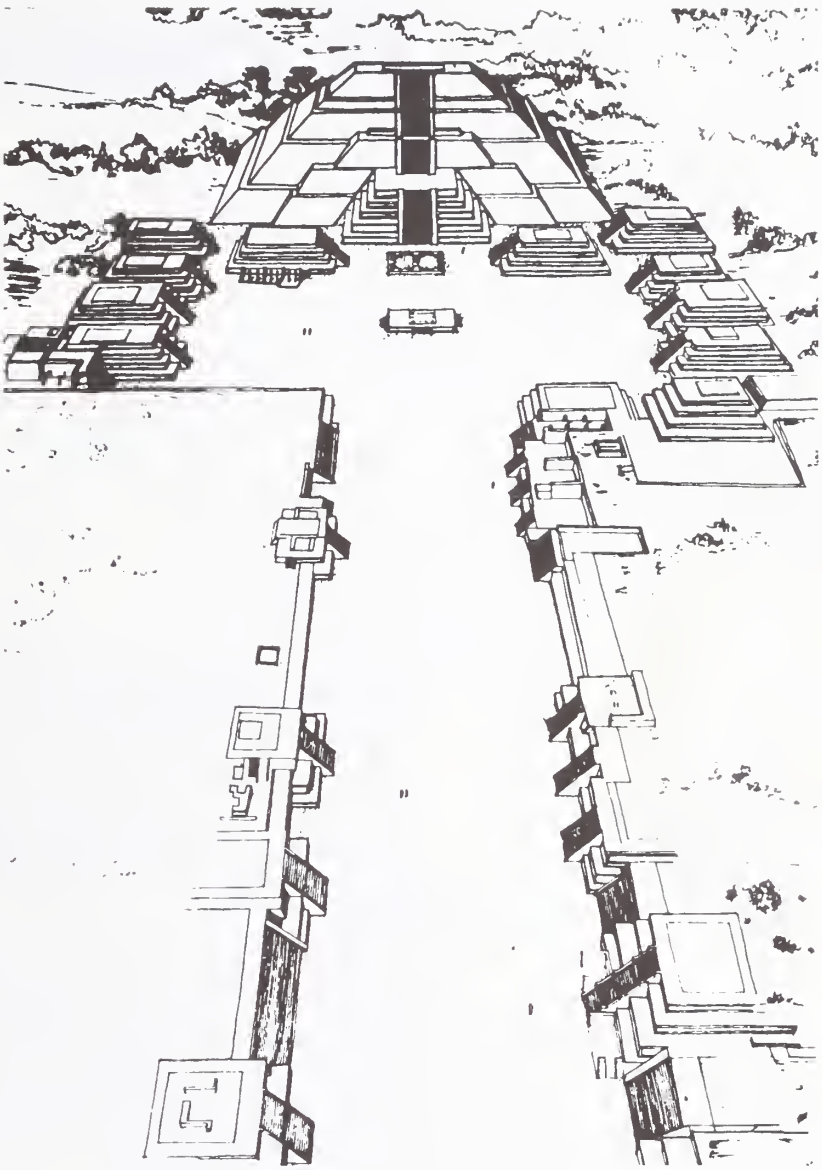
Pyramid of the Moon as Bernal and Acosta began to uncover and restore it.

staircase to a third of the way up the south face of the Moon Pyramid. Later reconstruction added three more staircases to the top of a fourth level.

As the workmen proceeded to clean up the rest of the ceremonial area, Bernal and Acosta were faced with the difficult choice of deciding whether to reconstruct buildings in the later, and to them inferior, Teotihuacan period, or to dismantle these remains in order to reconstruct the earlier, and more impressive, buildings beneath them. Mostly they decided to concentrate on rebuilding the city as it had been at what they considered the height of its glory. At the same time they left standing a number of buildings of the later, more decadent, period, when the city had apparently lost its role as a great capital and had become inhabited by peoples of "a lower cultural level," incapable, according to Acosta, of understanding the grandeur of the past.

Once the east and west sides of the Moon Pyramid had been cleared (leaving the north side in its original earth-covered state), visitors were afforded a spectacular sight of the great reconstructed pyramids joined by a temple-lined avenue prolonged to include the resurrected Citadel.

Theoretical reconstruction of the Pyramid of the Moon from Jorge Acosta's guide to Teotihuacan.



As had been expected, the lavish reconstruction of Teotihuacan caused an influx of tourists, both Mexican and foreign, which soon replenished the state coffers, to the delight of a government which still did not realize it had barely scratched the surface of the great city of Teotihuacan.

17. Imperial City

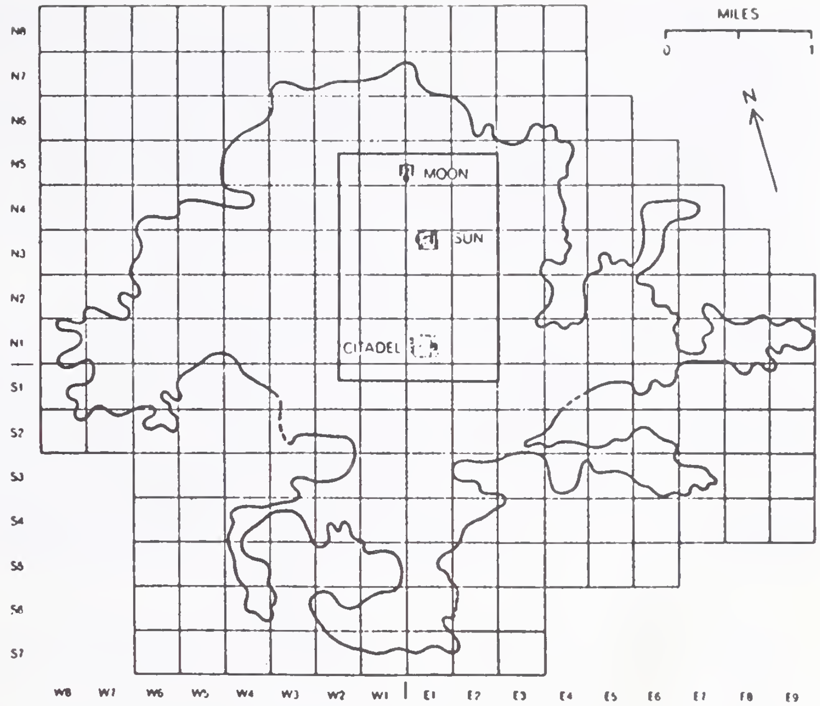
The person who was to spark the discovery of the true proportions of Teotihuacan turned out to be a young American of French origin, René Millon, who arrived in Mexico City in 1950, fresh from Columbia University. At the age of twenty-nine, Millon was so fascinated by what he saw and by how such a city as Teotihuacan could have risen in the Valley of Mexico that he came to devote his career to finding out its true dimensions.

After years of exploratory work at Teotihuacan and its surrounding valley he was able, in 1962, as a professor of anthropology at the University of Rochester, to obtain sufficient funds from the National Science Foundation in Washington, D.C., to start the preparation of a photogrammetric map of the entire area of Teotihuacan as a base for a comprehensive archeological survey to establish the exact dimensions of the ancient city.

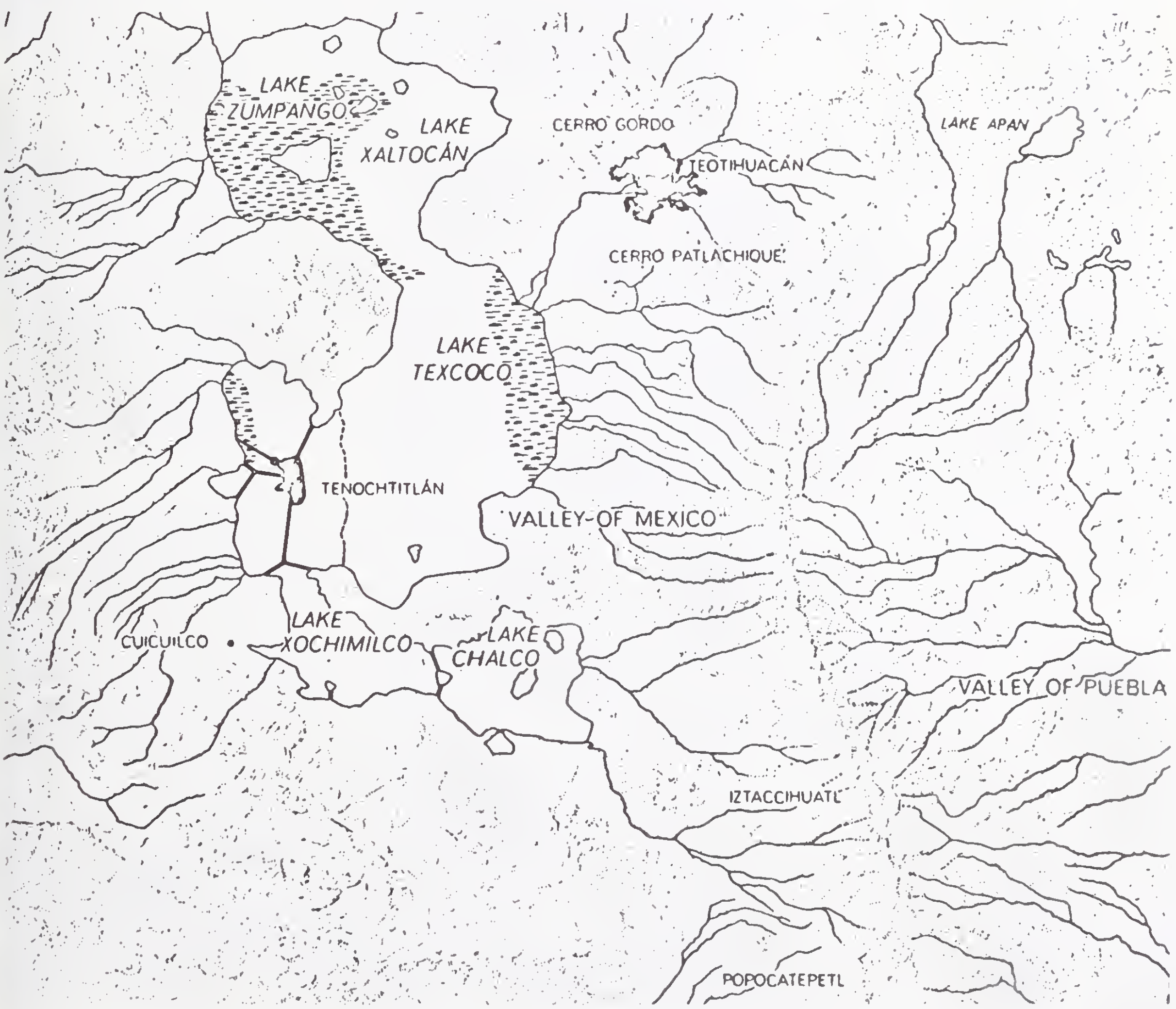
Until 1922 the only topographical map of the ceremonial center and heart of Teotihuacan had been the one prepared in 1865 by Maximilian's commission. In 1922 Gamio made a more detailed map of the same area, but did not even take it as far north as had Ramon Almaraz.

Millon decided that a proper map would have to show the full extent of the ancient urban zone so as to verify for density of construction and establish the way in which buildings had been disposed and related to each other.

To limit the area to be photographed, Millon and his colleagues first made a field survey to establish a neutral band, at least 300 meters wide, with no trace of a building in it. He first estimated that this would give him a city area of some 25 square kilometers. In the end he had to



Irregular boundary of Teotihuacan is shown as a solid line that approaches the edges of a grid, composed of 500-meter squares, surveyed by Millon's team. The grid drawn by Millon parallels the north-south direction of the Way of the Dead, the city's main avenue.



Teotihuacan was strategically located on the best route between the Valley of Mexico and the Valley of Puebla leading to the Gulf of Mexico.

cover 38 square kilometers, which caused a hiatus in his operations while more funds were sought to handle the enlarged project.

Once the funds were found, the job was to be carried out under the aegis of the Mexican Institute of Anthropology and History, whose new director was Ignacio Bernal.

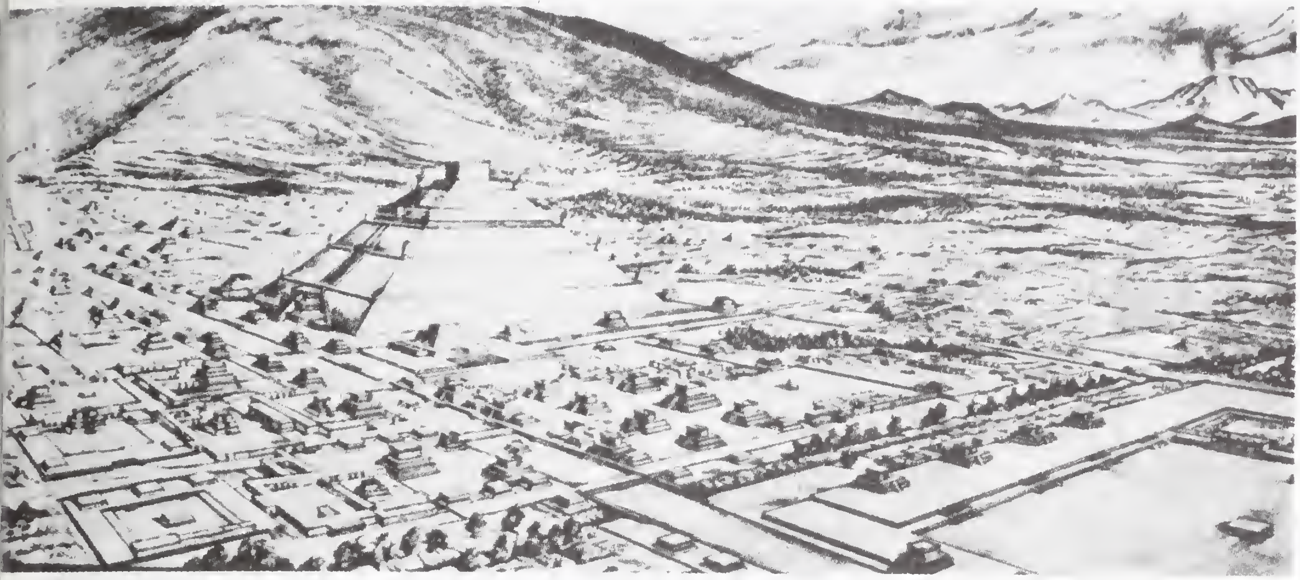
The map was to represent the most detailed surface study of so large a prehistoric urban area ever attempted. Photography took place in April of 1962, when the cloudless conditions prevailed that are essential for aerial shots from 4000 feet. Concurrently, a comprehensive archeological survey on the ground was undertaken to transform the raw photographic manuscript into a finished map containing all possible structural information of archeological interest. This was completed five years later, after various interruptions, in 1967. Overlay sheets would present a hypothetical reconstruction of what the city had looked like at the height of its development.

When the job was done, the results were staggering. From the jigsaw overlapping of photographs and the drawings made there appeared a fantastic view. At last it was clear to Millon that Teotihuacan had been an immense and well-planned city, laid out on a grandiose scale, teeming with life as early as 2000 years ago. There could no longer be any question about its having been only a ceremonial center. It appeared to be the first and most important urban center of the American continent, vaster than the area within the walls of imperial Rome of the Caesars, housing at the height of its development as many as 200,000 inhabitants organized into a most complexly stratified society. Teotihuacan had clearly been a religious, cultural, economic, and political capital, as well as the greatest known market center in Mesoamerica.

Millon realized that as a holy city, with thousands attached to its temples, Teotihuacan must also have been the seat of a religion with a wide appeal, possibly headed by a supreme pontiff, a city with the qualities of a Rome, Mecca, or Benares.

Economically it was clearly one of the largest pre-industrial cities in the world, with tens of thousands employed in crafts, and perhaps a hundred thousand involved in great markets at fixed intervals, a great attraction to visitors and traders, who had their own enclaves within the city.

Politically, Teotihuacan had evidently been the most influential center in Mesoamerica during the major part of the first millennium A.D., astride the major trade and access routes into and out of the Valley of Mexico, the seat of an increasingly powerful state that appeared to have extended its dominion over wider and wider areas.



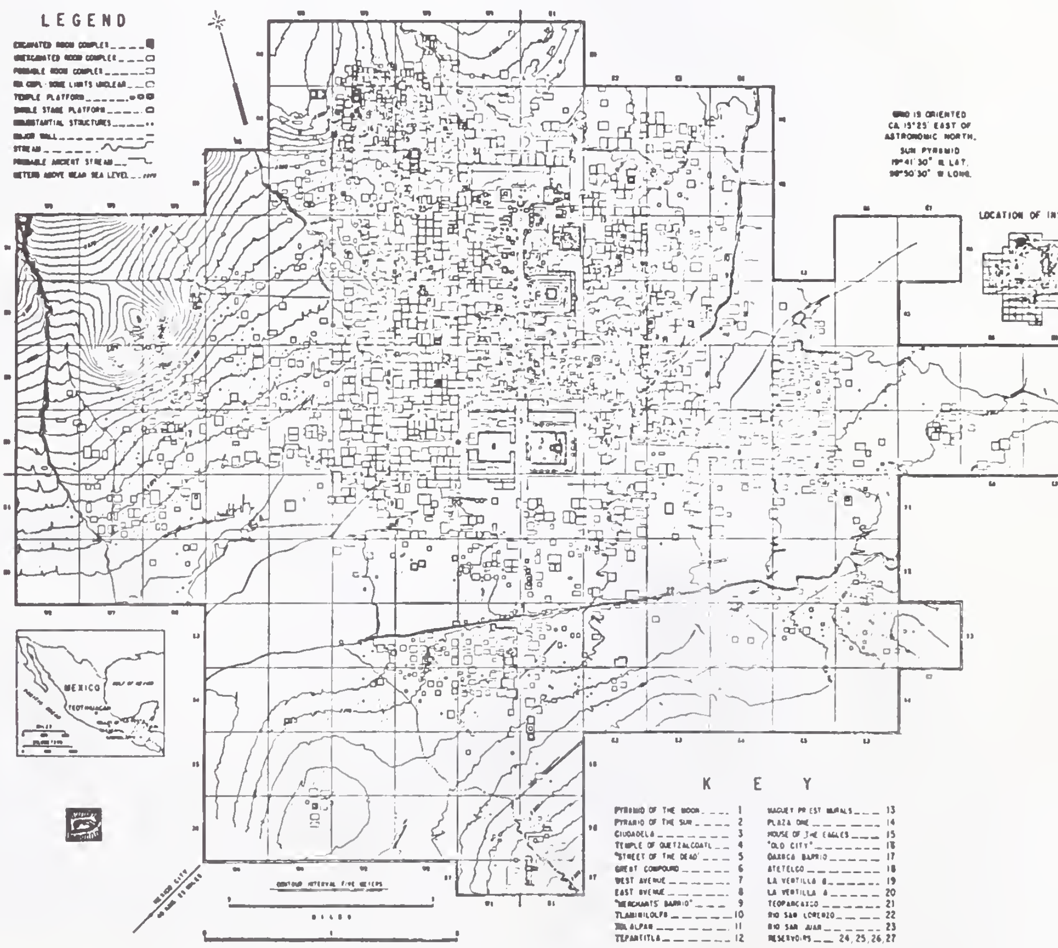
Reconstruction of the great city of Teotihuacan as imagined by Feliciano Peña of the National Museum of Anthropology.

Aerial photos revealed broad avenues to the east and west of the Citadel which had not been suspected, but which were quickly confirmed by surface reconnaissance. Other street patterns and clusterings of buildings into larger complexes, hypothesized through examination of the map, were also confirmed by field crews.

More than 2600 apartment compounds showed up, as well as other types of compounds, temples, platforms, and major structures. Of these larger stone-walled structures, more than 1200 manifested walls, floors, or other structural evidence *in situ*. In the course of surveying the city, more than 1800 floors and 1900 walls were recorded.

The outer walls of the apartment compounds turned out to be massive battered masonry or *taludes*, much thicker than interior walls, which made them easier to locate. High walls were on the exterior, without windows, giving onto narrow streets.

Millon estimated that sixty persons could have lived in one apartment compound of 3600 square meters, that thirty could live in a compound of 1600 square meters, and twelve in a compound of 600 square meters. Extrapolating from these figures, he obtained a possible population of 200,000.



Development of the great city of Teotihuacan from its inception in about 100 B.C. to its collapse in 800 A.D.

Between A.D. 450 and 650 the city, though it did not extend over twenty square kilometers, or twelve square miles, was, according to Millon's map, most densely populated, with more than 2000 apartment complexes. The city's peak of power and influence may have been reached about A.D. 500, and most of what is visible in Teotihuacan today is attributed by archeologists to this epoch.

By 650, some form of degeneration appears to have set in, and many inhabitants seem to have moved to the east side of the city. Yet the city still flourished, despite a slight drop in population.

The maps of Teotihuacan from 100 B.C. to A.D. 800 were prepared by Millon in 1967. Since 1966 additional data have significantly modified some of the areas shown. The maps are published with the permission of Professor René Millon, courtesy of the Sociedad Mexicana de Antropologia.

Ceremonial and/or administrative buildings along the Way of the Dead could now be clearly differentiated from residential areas on both sides of them. Surface survey and excavation indicated that Teotihuacan had been divided into neighborhoods or *barrios,* groups of buildings clearly set off from surrounding structures, forming easily definable units.

Inspection of the map showed the city to have been divided into quadrants. The north-south axis was formed by the Way of the Dead; the east-west axis, subordinate to it, was formed by two great avenues that determined the city's center, interrupted by the Citadel.

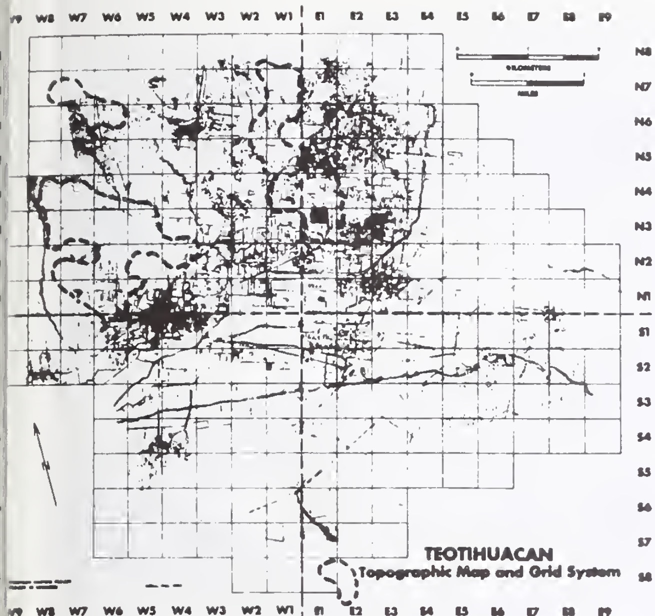
A striking feature of the northern and northwestern part of the city was its many walls and great precincts. Most of these massive long free-standing walls were identified in the field by locating ruined stretches of their two sides exposed on the surface, though excavation was often needed to reveal them.

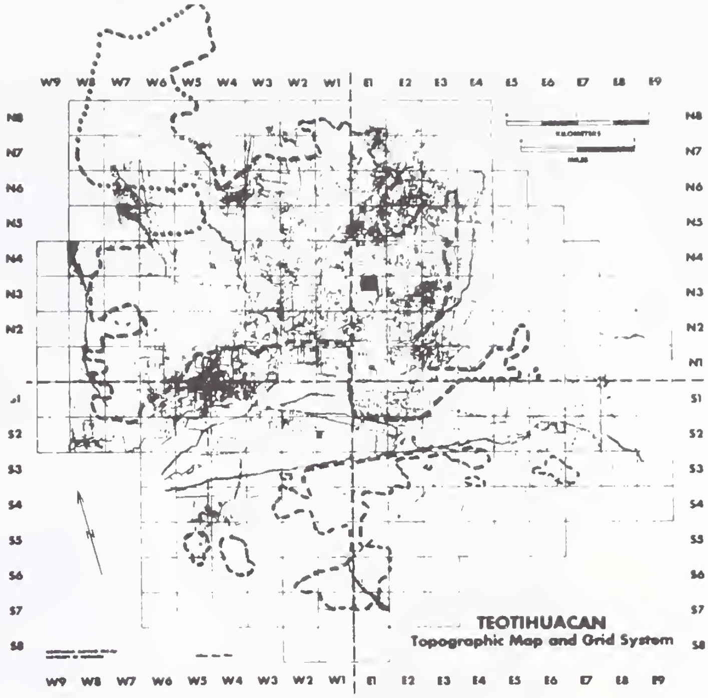
Though Millon estimated that most of the inhabitants probably lived from cultivating the land outside the city, it was clear that a very significant part of the population was engaged in craft activities within the city, the vast majority being obsidian workers in some five hundred workshops.

Millon and his principal colleagues, Bruce Drewitt of the University of Toronto and George L. Cowgill of Brandeis University, also found evidence of over a hundred other types of workshops—for ceramic, figurine, lapidary, shell, basalt, slate, and ground-stone work. They infer that different crafts lived in separate neighborhoods and believe that many were employed in the building crafts, such as masons, plasterers, and carpenters.

From aerial photos, examined stereoscopically, Millon made another surprising discovery: a part of an immense platform opposite the Citadel, with a counterpart to the south of equal size. These two great platforms formed an enormous compound around a plaza that appeared to be larger than the main plaza of the Citadel. It seemed extraordinary to Millon that so large a structure could have existed and never have been observed. The next day he and his associates went into the field and easily found outlines of the two enormous platforms with remains of apartment compounds on them, "though no prominent structures."

Millon put forward the hypothesis that this great compound had once been the city's principal market place, a bureaucratic center with compounds built on the immense platforms. With the Citadel, these compounds evidently formed the religious and commercial center of the ancient city, a megacomplex surrounded by broad avenues and plazas, with more open space than in any other part of the city, a sort of island in its center. Millon considered the plan


W9 W8 W7 W6 W5 W4 W3 W2 W1 E1 E2 E3 E4 E5 E6 E7 E8 E9
N8 N7 N6 N5 N4 N3 N2 N1 S1 S2 S3 S4 S5 S6 S7 S8
TEOTIHUACAN
Topographic Map and Grid System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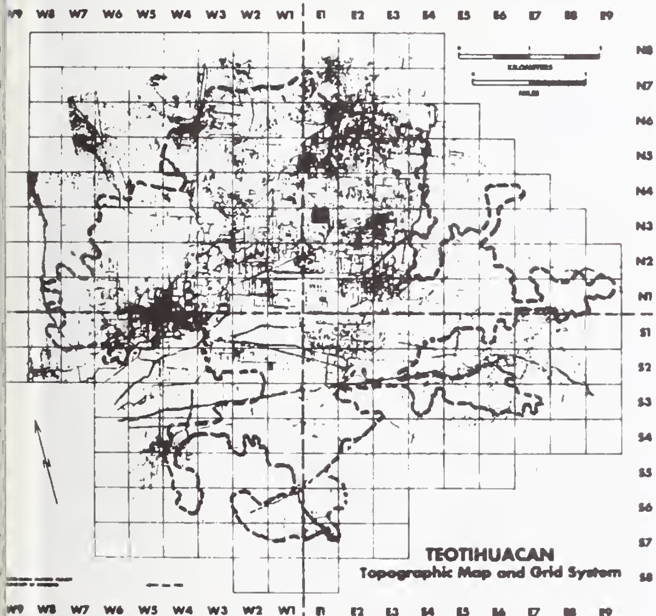
TEOTIHUACAN
Topographic Map and Grid System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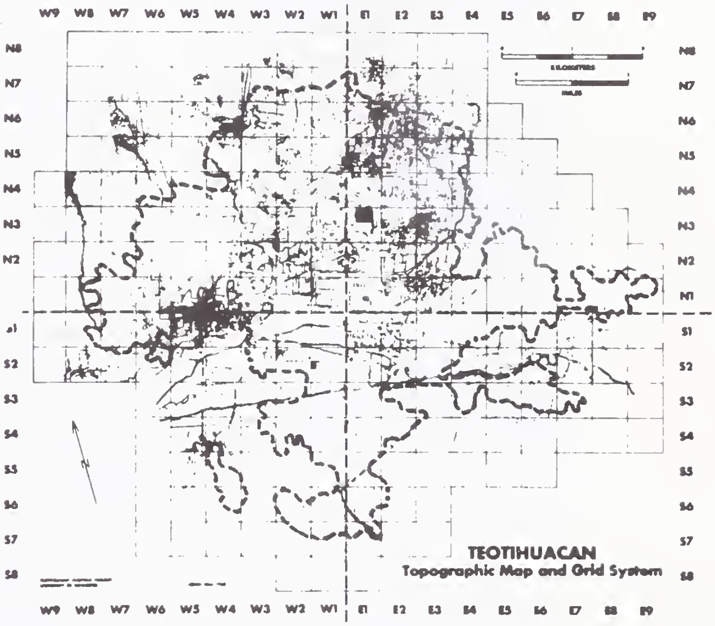
TEOTIHUACAN
Topographic Map and Grid System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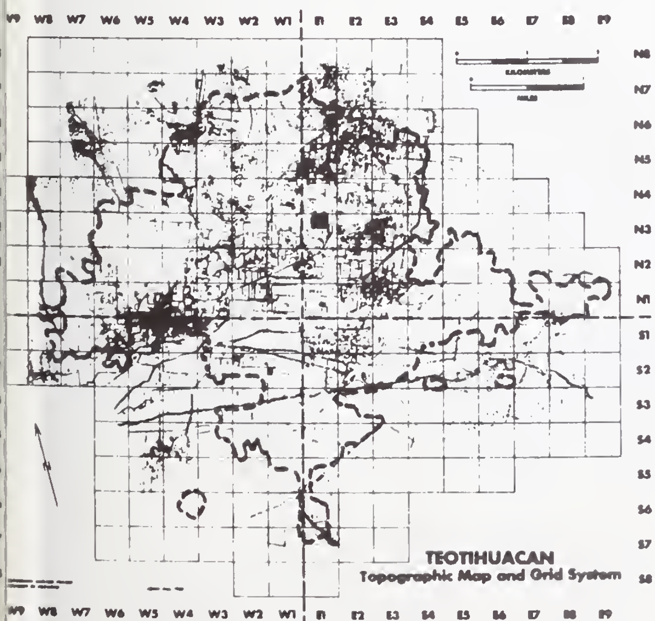
TEOTIHUACAN
Topographic Map and Grid System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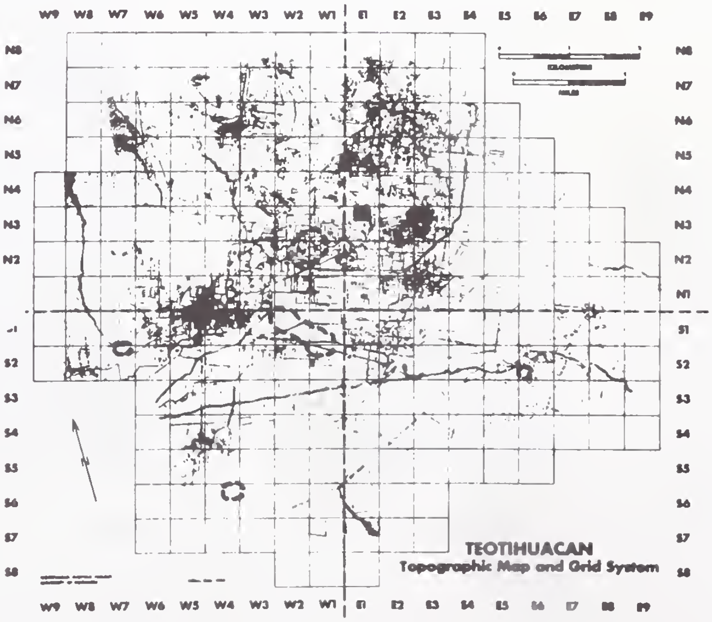
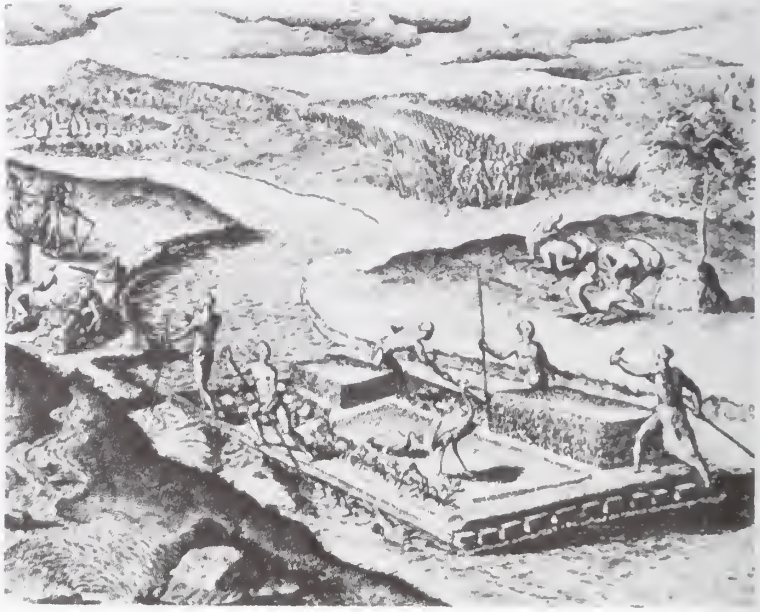
TEOTIHUACAN
Topographic Map and Grid System


W9 W8 W7 W6 W5 W4 W3 W2 W1 E1 E2 E3 E4 E5 E6 E7 E8 E9
N8 N7 N6 N5 N4 N3 N2 N1 S1 S2 S3 S4 S5 S6 S7 S8
TEOTIHUACAN
Topographic Map and Grid System

In the course of his explorations, Millon found that Teotihuacan had many carefully laid out canals and systems of branching waterways artificially dredged into straightened portions of a river fed by eighty permanent springs and its tributary streams, which altogether formed a network within the city and ran all the way to the lake, now ten miles away, but perhaps closer in antiquity. With these lakes and waterworks the ancient Teotihuacanos appear to have been able to feed a vast population with their system of chinampas, or so-called floating gardens, on which they could produce several crops a year.

Richard Ford of the University of Michigan analyzed plant remains of more than thirty superimposed kitchen floors and hearths in a "high status" apartment compound at Teotihuacan. He believes practically everything edible was consumed, including beans, squash, chili peppers, as well as an ample selection of wild plants such as sumac seeds. He found at least two varieties of goosefoot and portulaca leaves. He also found evidence of fish, deer, rabbits, and other game having been consumed.



one of the most majestic architectural achievements in the history of the pre-Columbian people of the New World.

Several more compounds revealed by the map, one west of the Moon Pyramid, and another immediately north of the Citadel, demonstrated that a great deal of planning had gone into the city. Millon concluded that the Way of the Dead must have been decided on very early in the history of the city, possibly before the construction of any permanent buildings other than the pyramids.

With the help of Millon's map it was now possible to recreate a tentative history of the development of Teotihuacan. Because the systems of scientific nomenclature devised by different archeologists to specify each historic period of Teotihuacan development are as confusing to the layman as they are unsatisfactory to scientists, the simplest way to date the development is by means of the Christian calendar.

From Millon's map and the shards that were excavated, it appeared that the Teotihuacan area had first been settled in the latter part of the first millennium B.C. when a handful of villages sprang up. The archeologists involved mostly agreed that it was during the period between 150 B.C. and the birth of Christ that Teotihuacan grew into a large settlement covering an area of more than six square kilometers, mostly in what was to become the northwest quadrant of the later city. In this area Millon found remnants of public buildings with stone walls and hard earth floors, the orientation of which was quite unlike that of the later city, an area that was to continue to be the most crowded throughout the city's later history.

The map survey revealed far more extensive residential areas covered with pottery fragments from the first century A.D. than previously believed. Since the same pottery was found on the Pyramid of the Sun, Millon concluded that the pyramids of the Sun and of the Moon probably were built in the earliest phase of the occupation of Teotihuacan, A.D. 1–150, rather than several centuries later, as had been assumed by Gamio and others. Early carbon dates were inconsistent, but later ones argued that the Sun Pyramid, or the greater part of it, had been built by A.D. 150.

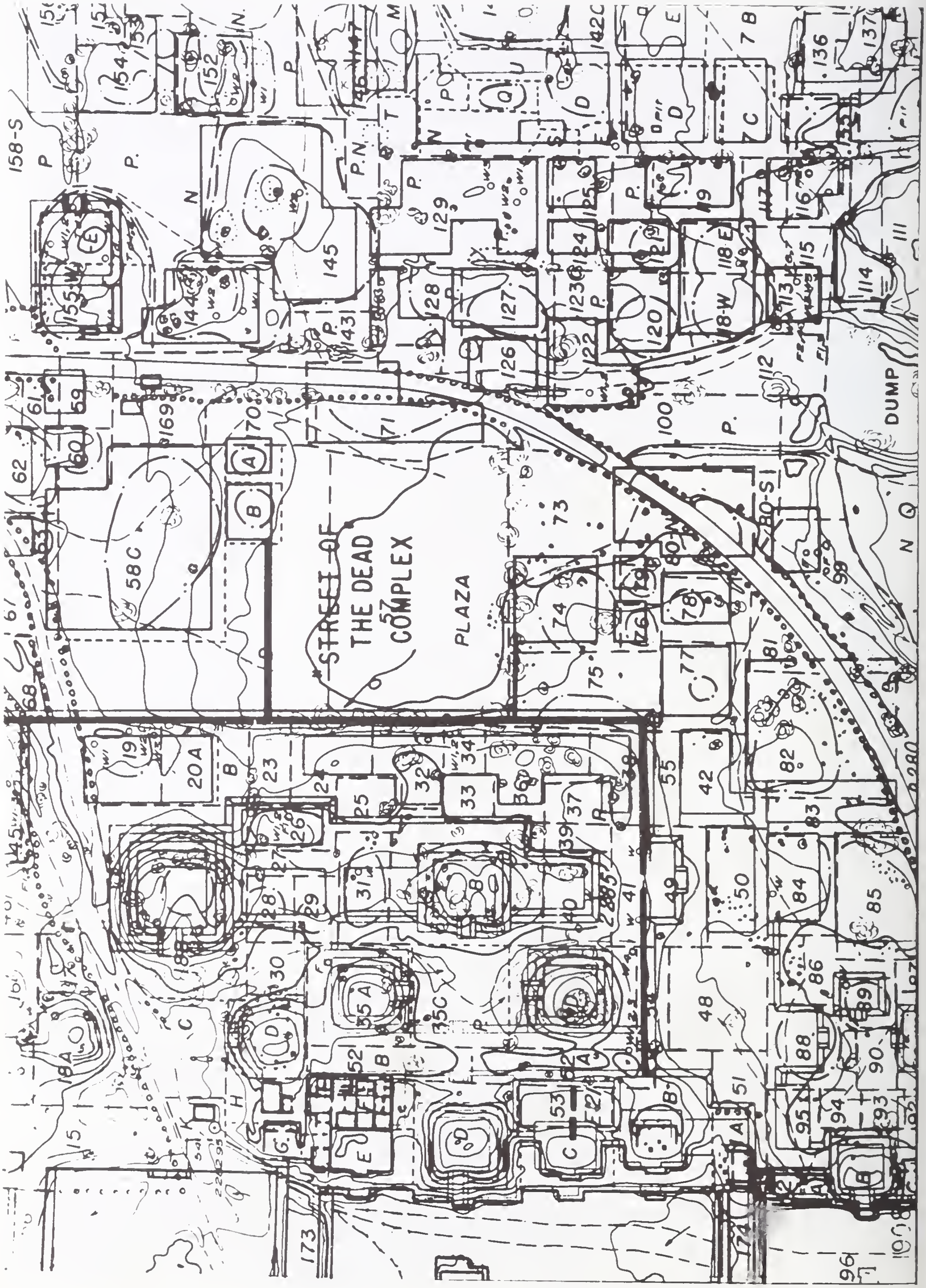
Other archeologists hold that the city was flourishing as early as 1500 B.C., and a small group maintains that the construction of Teotihuacan goes back to an era before the eruption of the volcano Xitli, perhaps 6000 years ago.

Historians and anthropologists maintain that the cooperation of vast numbers of people would have been needed to build the two pyramids, and that this indicates the preexistence of a great metropolis with a stable society and strongly centralized authority. These experts envisage Teotihuacan as a planned city laid out by priest-architects.

Between the first and second centuries A.D., Millon sees the city as growing rapidly to a predominant position in the Valley of Mexico, covering an area of more than twenty square kilometers. During this period Millon found evidence of the construction of more than twenty temple complexes, mostly on either side of the Way of the Dead, which had grown so long it made it impossible for travelers or traders to pass through the valley without passing through the city.

Between A.D. 150 and 200 there is evidence that the city shifted to the south and east, partially abandoning the northwest. From Millon's mapping, it is clear that by A.D. 200 the city had been split into four squares or quadrants centered on a point along the Way of the Dead opposite the entrance to the Citadel. Based on excavations carried out as part of the mapping project, Millon believes it was in this period that the Citadel was first built in its present form and that the uppermost part of the Sun Pyramid was completed. He believes that the Citadel, which was developed over the next two hundred years, along with the Great Compound, formed the symbolic as well as the geographic, political, and religious center of the city, and that nothing approaching them in scale of conception is known anywhere else in the prehistoric New World.

Between 200 and 450, the evidence shows an enormous amount of building activity, and a revolutionary change in the settlement pattern. Permanent stone-walled residential compounds, mostly consisting of a number of apartments, appear to have been built in all parts of the city, replacing most


STREET OF THE DEAD
57
COMPLEX
PLAZA
DUMP

René Millon's chart showing current views on the chronological placement of Teotihuacan, including periods prior to its known existence as a major center and periods between its fall and the arrival of the Spaniards.

VALLEY OF TEOTIHUACAN CHRONOLOGY

Table of Concordances

		Phase Names [1]			Phase Numbers [2]	
A.D. 1500		Teocolca			Aztec IV	
1400		Chimalpa			Aztec III	POS'
1300						
1200		Zacango			Aztec II	CLASSIC
1100		Mazapan			Mazapa	
1000						PERIOD
900		Xometla			Coyotlatelco	900 A.D.
800		Oxtoticpac			Proto-Coyotlatelco	
700	T	METEPEC			Teotihuacán IV	CLASSIC
600	E	XOLALPAN	Late		Teotihuacán IIIA	
500	O		Early		Teotihuacán III	
400	T I					PERIOD
300	H	TLAMIMILOLPA	Late Early		Teotihuacán IIA-III Teotihuacán IIA	300 A.D.
200	U	MICCAOTLI			Teotihuacán II	TERMINAL
100	A C	TZACUALLI	Late		Teotihuacán IA	PRE-CLASSIC
A.D. B.C.	A		Early		Teotihuacan I	
100	N	PATLACHIQUE		Chimalhuacán *		PERIOD
					Proto-Teotihuacán I	
200		Terminal Cuanalan; Tezoyuca		Cuicuilco *		LATE
300		Late Cuanalan		Ticoman III *		PRE-CLASSIC
400		Middle Cuanalan		Ticoman II *		PERIOD
500		Early Cuanalan		Ticoman I *		
600				Middle		MIDDLE
700		Chiconauhtla		Zacatenco *		PRE-CLASSIC
B.C. 800						PERIOD

[1] Phase names used by personnel of Teotihuacan Mapping Project (Millon and others) and by personnel of Valley of Teotihuacán Project (Sanders and others).

[2] Phase numbers used by personnel of the Proyecto Teotihuacán, of the Instituto Nacional de Antropologia e Historia (see Acosta 1964: 58-59).

* Pre-classic phases elsewhere in the Valley of Mexico.

NOTE: The absolute chronology shown is that used by the Teotihuacán Mapping Project. Terminology for the Teotihuacán phases is based on the Armillas classification (1950) with modifications.

RENE MILLON 9/64 REVISED 7/71

of the earlier structures built of relatively impermanent materials. High faceless walls and narrow streets, says Millon, became the rule in most of central and north central Teotihuacan, and the city assumed the form it was to hold till its fall. From this era date such beautiful temples as that of the Plumed Shells with its monumental deeply carved stone columns.

During the latter part of this period, or from around 350–400, the influence of Teotihuacan appears to have spread to all other parts of civilized Mesoamerica; for four hundred years, says Millon, its political and religious dominance went unchallenged. This period also saw the culmination of its architects' dreams: the city grew into a great religious center with palaces for the clergy and the aristocracy, and large apartment compounds with communal dwelling areas for farmers, craftsmen and specialists.

Between 450 and 650, the city, though it did not extend more than twenty square kilometers, or twelve square miles, was, according to Millon's map, most densely populated, with over two thousand apartment compounds. The city's peak of power and influence may have been reached about A.D. 500, and most of what is visible of Teotihuacan today is ascribed by archeologists to this epoch.

By 650, some form of degeneration appears to have set in and some inhabitants seem to have moved to the east side of the city. Yet the city still flourished, despite a slight drop in population. Sometime around 750, some great holocaust hit the city. Charred areas around all or most of the city's temples and public buildings suggest to Millon that they were deliberately burned. Millon and others found considerable evidence that the city's center, after burning and collapsing, was never thereafter rebuilt.

But whether the city was sacked by invaders or destroyed by a great fire of accidental origin remained the unanswered question. The only evidence on which all agreed was that the collapse was sudden and catastrophic.

After 750, Teotihuacan was a ghost town. As Millon reconstructs the evidence, only a few people lived in what amounted to a village one square kilometer in area. Some refugees, fleeing the traumatic experience, appear to have settled closer to Lake Texcoco and at nearby Azcapotzalco, but what happened to the rest of the population remains a deep mystery.

To account for the sudden end of Teotihuacan, other than through the agency of some unknown cataclysm, major earthquake, or violent invasion, several theories have been propounded, including a drastic change in climate, sudden soil exhaustion, massive crop failure, dreadful epidemics of malaria, yellow fever, or typhoid, or the rebellion of the agricultural populace against too demanding rulers. On the fringes of science fiction, it has been suggested that the inhabitants were removed by spacecraft from elsewhere in the universe, during which operation the city and its pyramids were discreetly covered with earth to hide their whereabouts from other travelers from space.

Climatologists maintain that a gradual decline in annual rainfall brought the city to a semi-arid climate in the latter half of the first millennium A.D., that deforestation of the hills caused erosion and a decrease in soil moisture for crops. Certainly the valley around Teotihuacan had once been humid, with vast forests in which game was abundant, with lakes teeming with fish and aquatic birds. One archeologist suggests that the destruction of the surrounding forests was caused by the burning lime that was used to carry out the great building programs in the city. Others suggest that there were repeated invasions of barbarous nomads from the north, one horde of which overwhelmed the city.

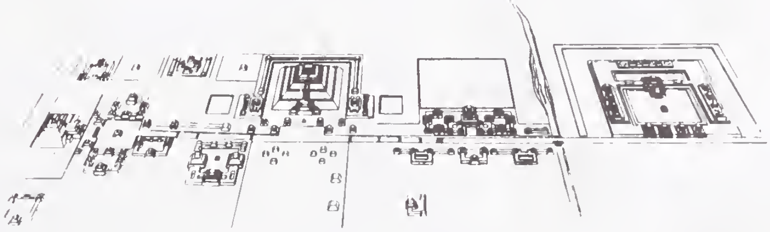
Whether or not Toltec tribes could have destroyed the great city, by A.D. 850 they were settling in the area. Millon says that, although at a relatively late date the Citadel underwent architectural modifications which could have been defensive, there is no evidence, except for the slaughtered inhabitants found by Batres in the House of the Priests, of attackers, foreign or otherwise.

Millon and others have wondered whether tensions, antagonisms, and conflicts within apartment compounds—or among people in different compounds, neighborhoods, states, classes, or sectors of the Teotihuacan society—could have posed insoluble problems for the hierarchy in the city and played a significant role in the dissolution of Teotihuacan society. He points out that great clusters of apartment compounds in an urban setting did not survive the fall of Teotihuacan and never again were the basis for a continuing tradition of urban living in central Mexico.

Was it coincidence, archeologists ask, that toward the end of the ninth century some mighty crisis appears to have overcome all the classic civilizations of Mesoamerica, at which time the many gigantic ceremonial centers that were scattered throughout the area, such as Tikal, Uaxactun, Copan, and Palenque, were suddenly abandoned for no known reason, to be devoured by the jungle?

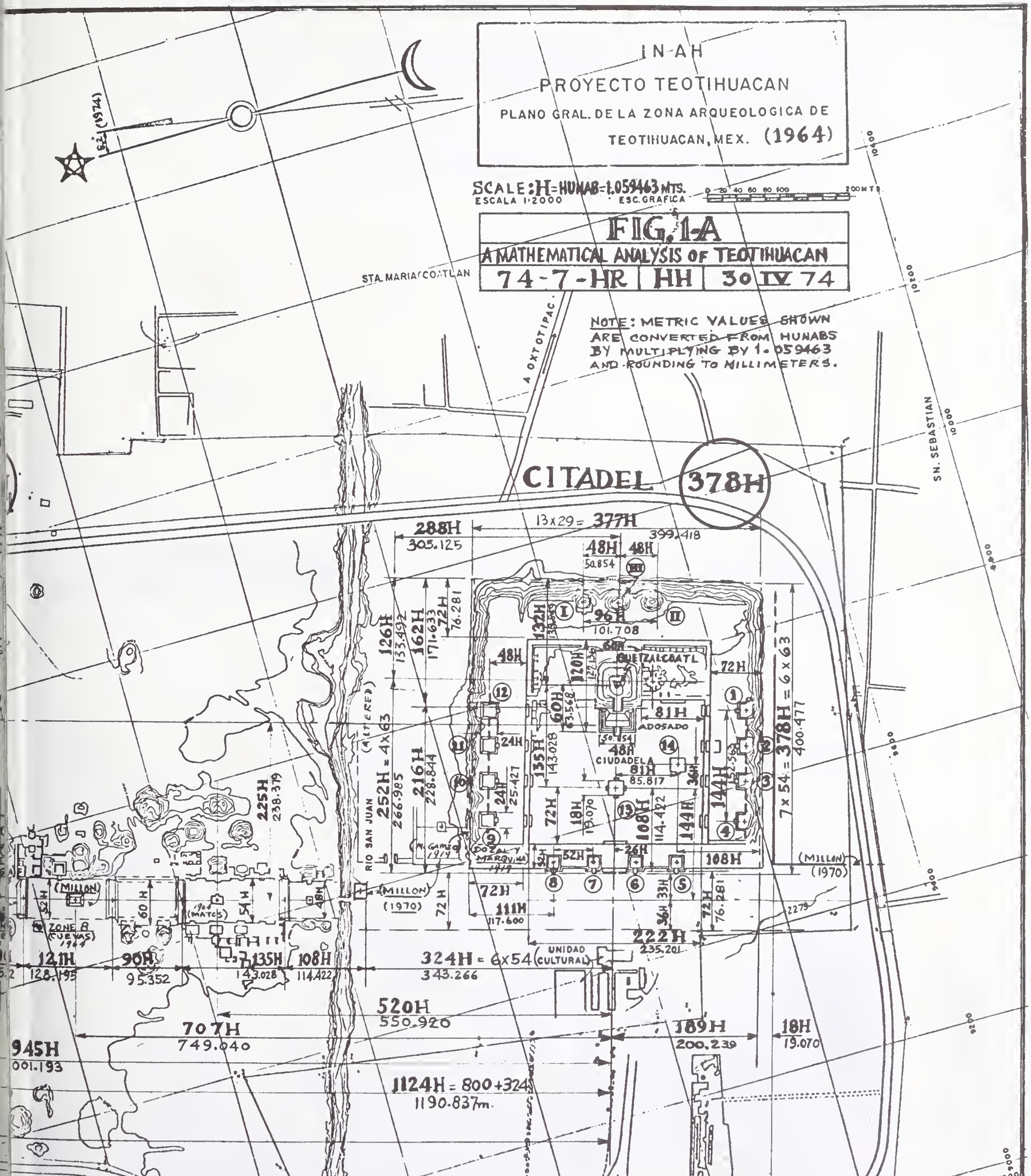
The ninth century has been described by historians as a period in Mesoamerica of degeneration, migrations, mass warfare, long and brutal invasions, followed by terrific confusion.

Toward the end of the century, Toltec tribes appeared in the Valley of Mexico to build on the remains of the Teotihuacan empire, only to vanish three centuries later and be replaced by the Aztecs, leaving the mystery of who the Teotihuacanos may have been and what may have become of them as shrouded today as when their great monuments were sighted by Cortes fleeing Tenochtitlan after the Night of Sorrows.

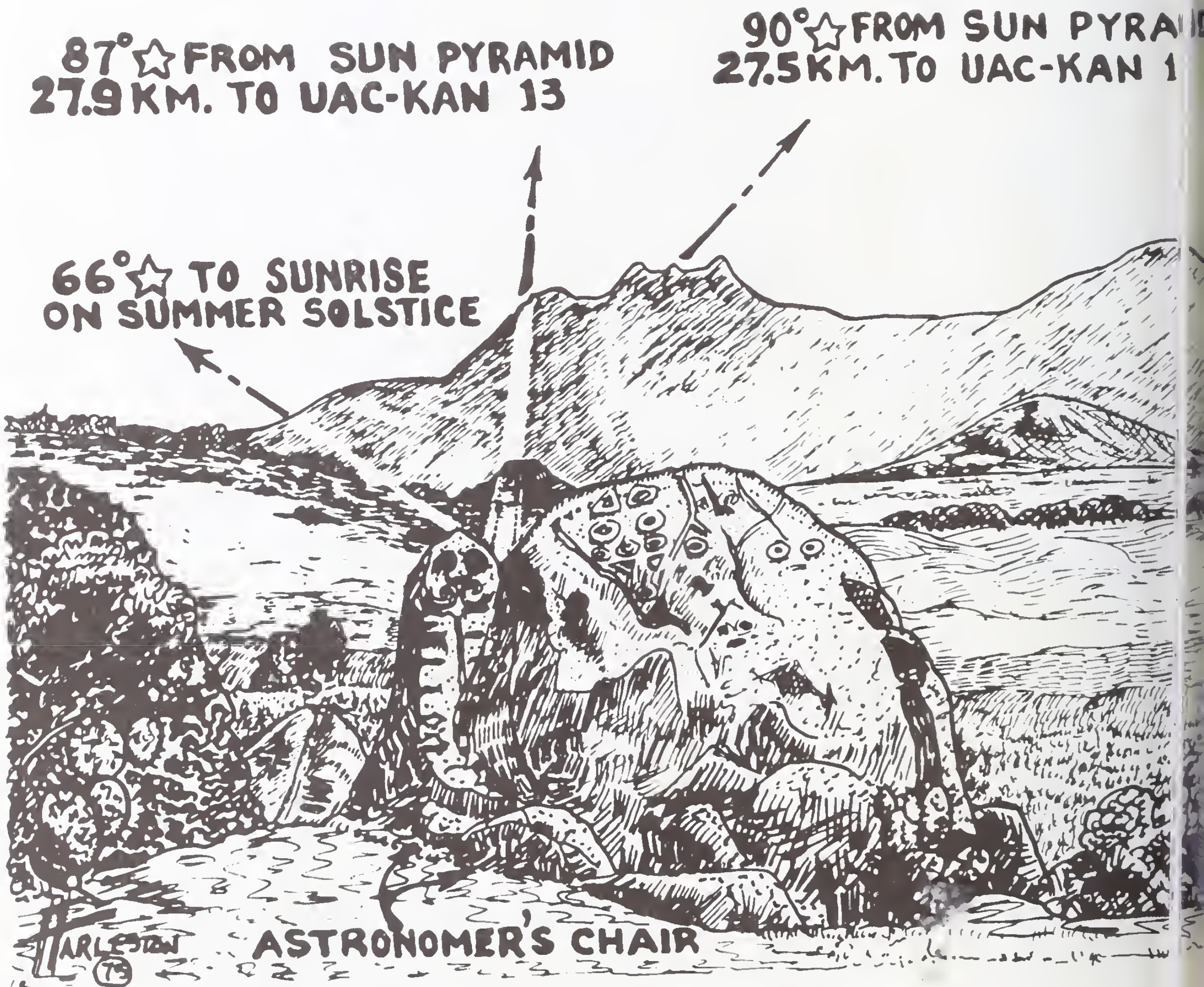



SN. MARTIN DE LAS PIRAMIDES
SN. FCO MAZAPAN
TEPANTITLA
SUN PYRAM
288H
305.125
4 x 54 = 216H
228.84
(MILLON - 1970)
444H
470.402
162H
162H = 3x54
171.633
96H
101.708
132H
139.849
48H
MOON PYRAMID
PIRAMIDE DE LA LUNA
144H
152.563
120H
127.136
2 x 96 = 192H
203.417
3 x 96 = 288H
305.125
378H
400.477
720H
762.813m.
720 + 1124 = 1844H
1953.649
333H
(DELGADO) 1964
(GALVEZ) 1964
(SALAZAR) 1964
(CUEVAS) 1974
ZONE 2
(BATRES) 1910
378H
400.477
351H
371.872
348H
368.693
(SEE MILLON - 1970)
(MILLON - 1970)

PART V



SCIENTIFIC ANALYSIS


87° ☆ FROM SUN PYRAMID
27.9 KM. TO UAC-KAN 13
90° ☆ FROM SUN PYRA
27.5 KM. TO UAC-KAN 1
66° ☆ TO SUNRISE
ON SUMMER SOLSTICE
HARLESTON 73
ASTRONOMER'S CHAIR

18. Mathematical Extrapolations

From Millon's map it was clear that the great city of Teotihuacan had been built by master builders according to a thought-out plan. The question remained as to whether such a vast complex with its massive temples might also have served a more special purpose, like Stonehenge, Cheops, or the Tower of Babel. Could Teotihuacan, like other great temples of antiquity, have served as a geodetic and astronomical marker to locate man in space and time, to fit him in the cosmos?

Unlike the Pyramid of Cheops, which has been measured to the millimeter, or the ziggurats of Babylon, for which cuneiform texts give the precise dimensions, no sound dimensional pattern had so far surfaced at Teotihuacan. Yet it was obvious that whoever laid out the city must have used some unit of measure as a yardstick, whether or not it was earth-commensurate as with the Pyramid of Cheops, whose base line of 500 cubits (or 750 Egyptian geographic feet) is exactly the distance traveled by the earth at the equator in half a second of time, there being precisely 86,400 seconds in one 24-hour day and 86,400,000 cubits in the circumference of the earth.

With the exception of Le Plongeon, none of the early diggers and reconstructors of Mexican antiquities since Almaraz—most of whom were intent on finding treasure and uncovering idols—appear to have been aware of the work of Edmé François Jomard, John Taylor, and Charles Piazzi Smyth, or of the controversy over the earth-commensurate dimensions of the Egyptian pyramids.

Unlike Cheops, with its chiseled corner sockets and trigonometrically reconstructable lines, the overgrown and dilapidated stone work at Teotihuacan made it difficult for archeologists to be sure exactly from what spot a piece of stone had been tumbled by vandals, crumbled by rain, bumped by an earthquake, or, indeed, replaced by some builder in remote antiquity.

Though the photogrammetric work of Millon's University of Rochester mapping project supplied a wealth of overall measurements, especially on a very large scale—distances of one to three kilometers—details were better shown in the drawings of Ignacio Marquina's *Prehispanic Architecture,* based on a careful survey of the Citadel area by Pedro Dozal, made with civil-engineering methods in the second and third decade of the century. Marquina considered this earlier data more reliable than the 1960 to 1964 information provided by maps in the files of the Mexican Institute of Anthropology, or even by the 1970 Rochester project.

Marquina, who had directed much of the rebuilding of the Citadel, pointed out that many of the dimensions, especially the longer ones of 150 to 200 meters, could only be considered accurate to within about 1 percent, which meant variations of over a meter.

With such margins of error, it seemed unlikely that a common unit of measure would emerge from Teotihuacan until in 1972 an American engineer, Hugh Harleston, Jr., who had lived a quarter of a century in Mexico and become obsessed with the beauty and challenge of Teotihuacan, hit upon a stratagem. Harleston decided to create a "mathematical model" to superimpose on the field measurement diagrams obtained by Millon and Marquina, on the theory that when and if a large percentage of points coincided with only a small margin of adjustment, a deliberate pattern of relationships might emerge.

To Harleston the key to resolving the problem lay in the *proportions of large measurements;* that is, if he divided the distance between the center of the Sun Pyramid and the center of the Moon Pyramid (almost 800 meters or over 2600 feet) by the overall length of the whole ceremonial zone from north to south (which is a little more than 2400 meters) the result, 2400/800, gives a ratio three to one, which changes very little if either of the distances is wrong by a few meters. Harleston reasoned that a comparison of *proportions* would show significant relationships despite any errors made in the reconstruction, especially if taken over large areas.

The first 3:1 relationship indicated to him to look for a system which might be organized in multiples of three. Taking as a supposition that errors of reconstruction or movements by earthquakes (though the geologists assured him that this had not happened) had shifted the centers between the two main pyramids by no more than 5 or 6 meters, which would make the distance between the top centers 806, instead of 800, and that if one side of the citadel were 402 meters instead of 400, the proportion of 806 to 402 would be 2.005 instead of 2.000, the result would be a proportion that varied by a mere 2/10 of 1 percent, a parameter within which Harleston could obtain valid results.

Already Millon had found what appeared to be a large recurring measure in both residential and semiresidential buildings with walled compounds which ran 57 meters to a side, twice that dimension, or a fraction of it. Longer streets also appeared to be measured off in multiples of 57 meters.

With a draftsman's compass, a pair of dividers, and all the maps he could find, Harleston set his dividers at 57 meters and began a search for further coincidences.

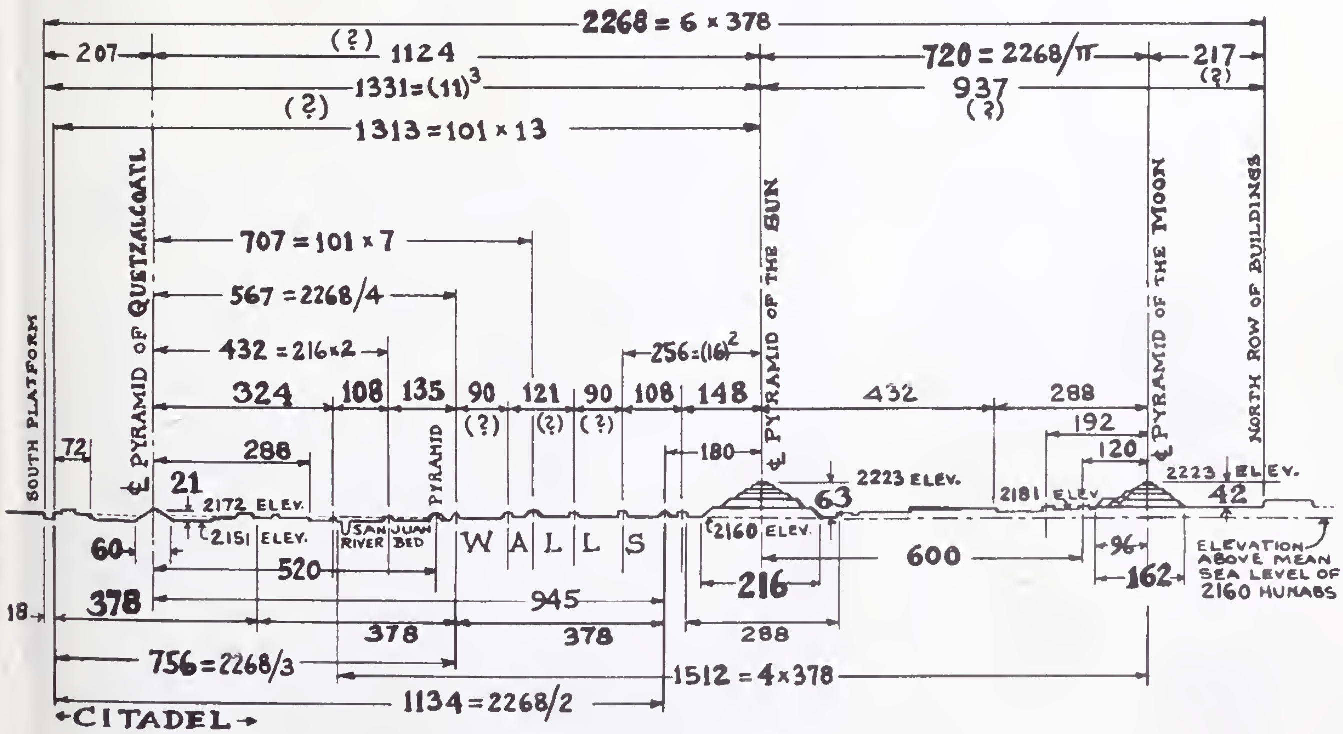
Almost immediately he saw that the north-south base line of the Moon Pyramid was 171 meters, or exactly 3 times 57. The base of the Sun Pyramid, marked on the map as 228 meters, was 4 times 57. The Citadel's wall of 399 meters was 7 times 57. Along the Way of the Dead, Harleston found markers at 114 and 342 meters, which is to say 2 and 6 times 57.

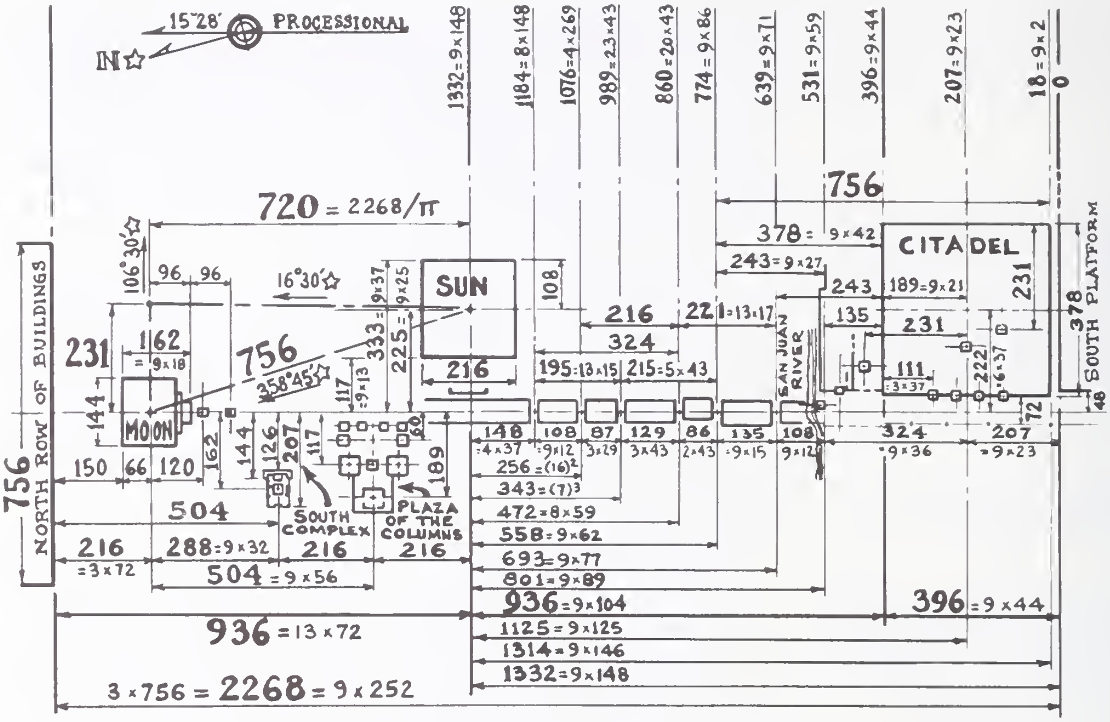
As 57 was clearly a recurrent measure, Harleston looked to see what fraction of it might give him a smaller proportionate measure. As 57 is only divisible by 3, he took the resulting 19 meters and searched with his dividers for any-

Harleston's view from the east of the Way of the Dead with the three major pyramids indicated in round-number distances marked by the center lines of the structures which produced such key numbers as:

162 for the Moon base
216 for the Sun Pyramid
378 for the Citadel.

The overall ceremonial zone of 2268, says Harleston, is equal to 6 Citadels, or 14 times the base of the Moon Pyramid. Individual walls along the way also show factors of 2268 including 2268/720 which is the direct line from the center of the Sun to the center of the Moon Pyramid or 3.15, evidently an easy figure for π, or the constant relation of diameter to circumference.





Sun Pyramid.

Harleston found that if he started at the Sun Pyramid and went south measuring walls, he got a significant set of numbers as far as the north face of the last big platform found and shown by Millon on his first map, which Harleston recognized as a clearly marked Ceremonial Avenue, 18 units beyond the Citadel wall. Measuring back from this point, Harleston was surprised to get a series of multiples of 9. This indicated to him some purposeful meaning which was only to become clear to him later. Meanwhile he noticed that most of the prime dimensional numbers in the Teotihuacan complex added up to 9: 162, 207, 216, 225, 369, 504, 531, 639, 720, 801, 936, 1125, 1314, 1332, etc.

thing that matched. In the Citadel and around the Moon Plaza he quickly found several platforms that were exactly 19 meters square. Assuming he might be on the right track, Harleston looked for a yet smaller measure. Dividing 19 by 3, the resulting 6.333 was at first sight unrewarding, until it struck him as being very close to the 6356-kilometer polar radius of the earth deduced by Sir John Herschel and Piazzi Smyth in their study of the geodetic values of the Great Pyramid of Cheops. Could the Teotihuacanos, Harleston wondered, have used as a basic unit of measure a fraction of the polar radius such as Herschel's and Newton's "sacred cubit" of .6356 meters, 10 million of which make a polar radius? The idea was intriguing, except for the fact that there seemed to be no other indication of a decimal system in the Teotihuacan figures: only 3s, 6s, and 9s.

Looking for a shorter unit, Harleston divided 6.356 meters by 6 and obtained a figure of 1.059, again a surprising result, for this was a very significant quantity in the realm of the mathematician, virtually the twelfth root of 2—a number which multiplied by itself 12 times gives a product of 2. Harleston wondered if the ancient builders of Teotihuacan might have arrived at such a basic unit by dividing the polar diameter of the earth not into 20 million parts as postulated by Herschel and Smyth for a unit of .6356 meters, but into 12 million parts for a unit of 1.059 meters. For neither one of these units was knowledge of the meter required; but Harleston had to use some conventional unit to work with

Moon Pyramid.

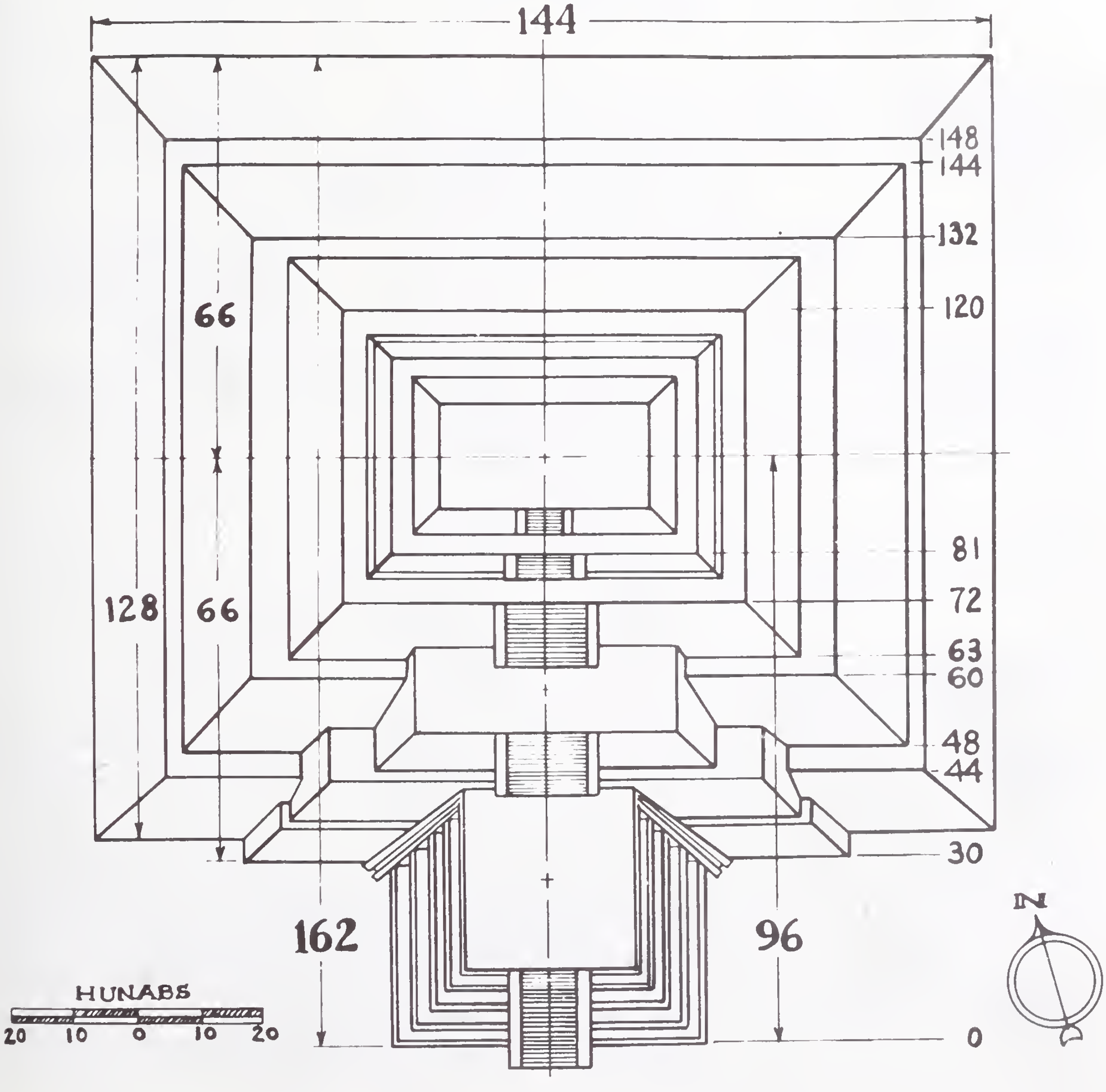
Harleston found that the edge lengths of the Moon Pyramid, from south to north, using the third *adosado*'s southern edge as a base zero point, repeated the same modules used at the Citadel and the Sun Pyramid: 30, 48, 60, 72, 81, 128, 132, and 162 STU. He found that the dimension 132 STU duplicates the distance from the center of the Quetzalcoatl Pyramid to the east edge of the Citadel, and can be factored into 11 × 12, 2 × 66, and 3 × 44.

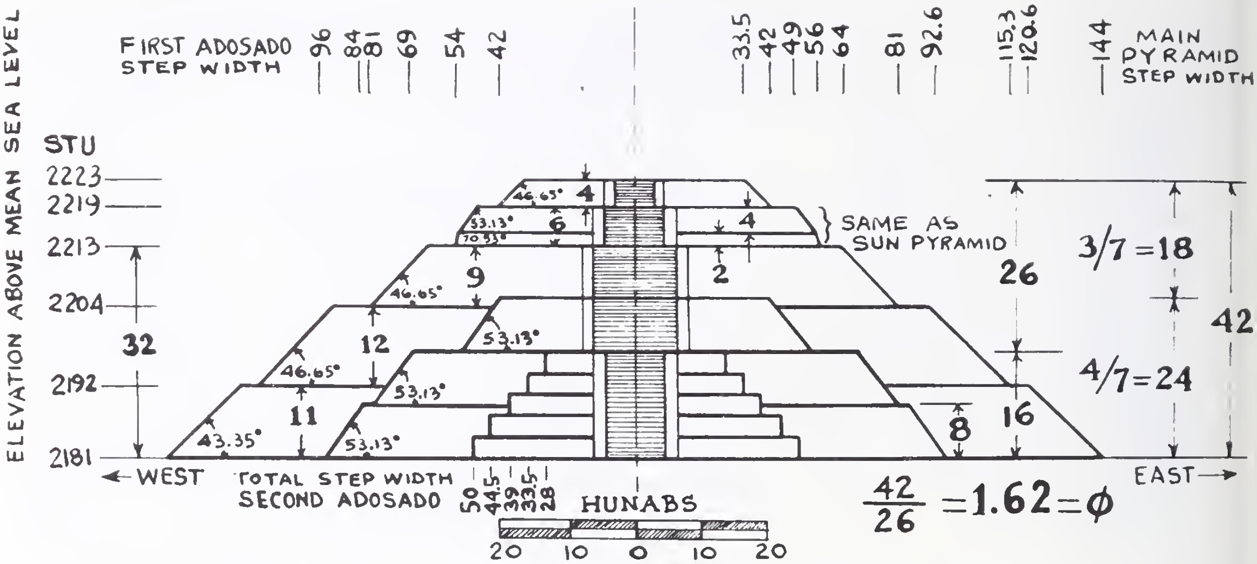
and choose to translate what he found in terms of the meter instead of the foot or the cubit, both of which are more inspired units, because the world has largely and unfortunately adopted the meter as its basic unit of measure.

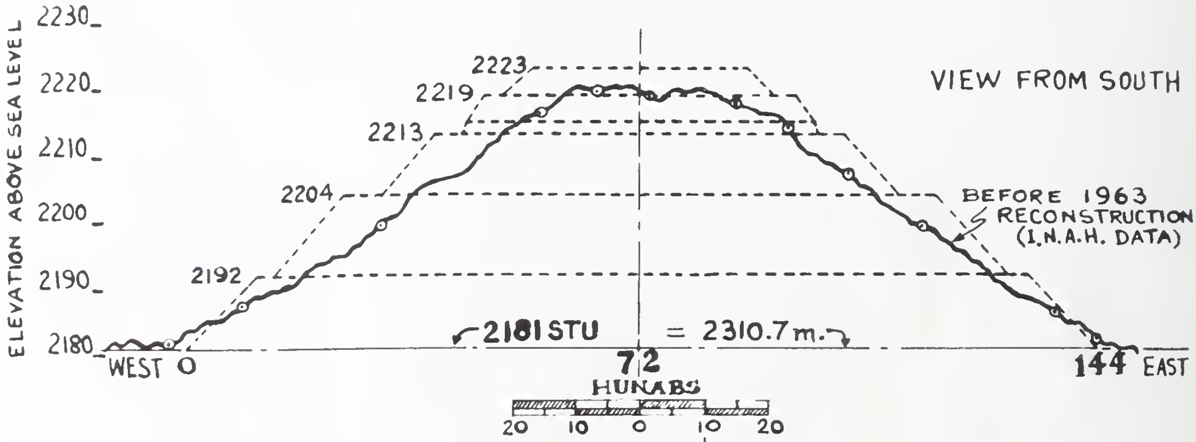
To check his theory that the Teotihuacanos had used a unit equivalent to 1.059 meters, Harleston set about measuring lengths of buildings, walls, and platforms on the basis of such a unit. Immediately he obtained modules of 18, 24, 54, 72, 108, 144, 162, 216, and 378, all in round numbers.

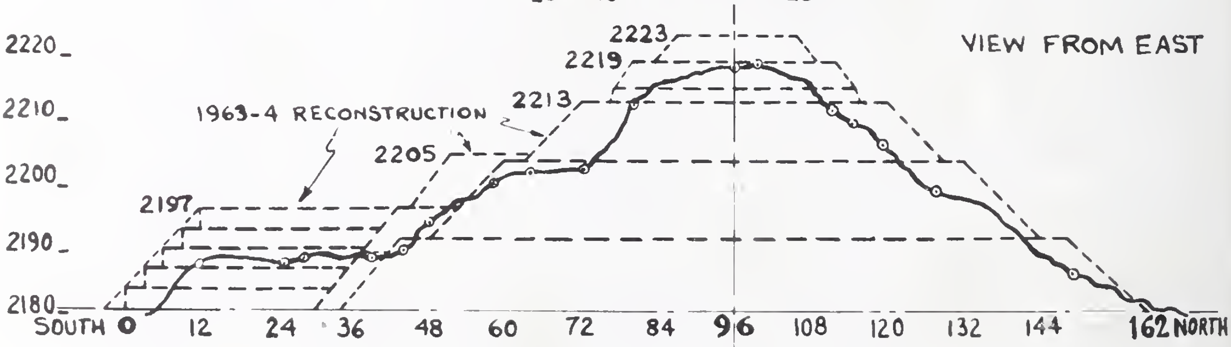
The Moon Pyramid, as carefully reconstructed by Salazar, gave Harleston lengths of 30, 48, 60, 63, 72, 81, 96, and 144 units, with a major north-south base of 162 units.

In the plaza at the foot of the Moon Pyramid, various temples each measured 18 by 18, for an area of 324 square units.









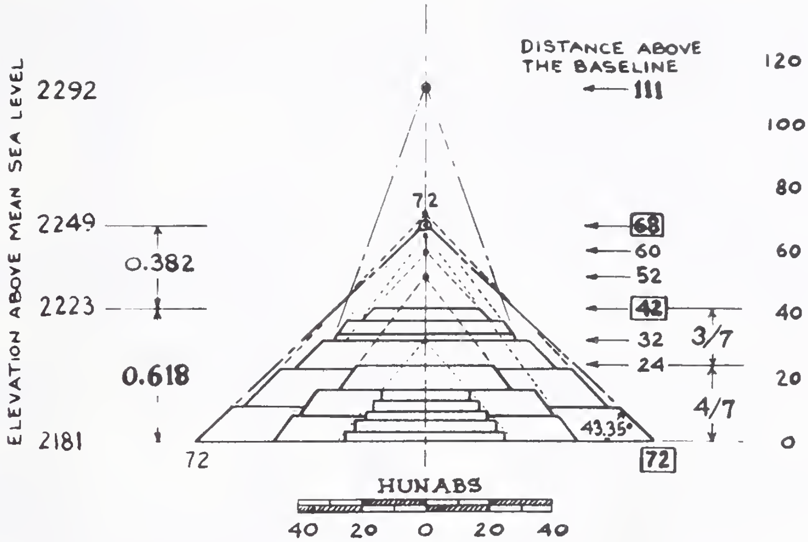
At the Sun Pyramid, measurements of the base and upper levels of each body duplicated measurements at the Citadel and the Moon Pyramid, indicating a logical series of 9, 12, 18, 27, 36, 54, 81 and 108, all multiples of 3. Lengths of 162 and 216 repeated lengths at the Moon Pyramid and the Citadel, adding up to 378, the overall length of the walls of the Citadel.

In his mathematical reconstruction of the Moon Pyramid, Harleston followed the basic principles of restoration outlined by Mexican archeologist Ponciano Salazar, who rebuilt the Moon Pyramid in 1964, maintaining the same lengths, heights, and original angles. But composite data yielded a more probable configuration with the top of the reconstructed Moon Pyramid at the same elevation above sea level as the Sun Pyramid, its base being higher than that of the Sun Pyramid. The Moon Pyramid is thus formed of thirteen basic components: the main pyramidal mass consisting of five bodies, the first *adosado* on the south side made up of three bodies, followed by a secondary *adosado* of five more bodies.

In Harleston's reconstruction, the first *adosado*'s height divides the Moon Pyramid vertically into 3/7 and 4/7, proportions shown horizontally by the west base line of the Quetzalcoatl Pyramid that cuts the Citadel into 162 STU to the east and 216 STU to the west. The north-to-south base of the Moon Pyramid, including the *adosados*, measures 162 STU and the base line of the Sun Pyramid is 216 STU, again giving the same proportions of 162/378 and 216/378 or 3/7 and 4/7.

The face angles of the Moon's first body are sloped at 43.35 degrees, the same as the Sun Pyramid. In Harleston's reconstruction, the projection of the sides to an overhead intersection point shows a triangular height of 68 STU. This means that the proportion of the 42-*hunab* truncated height becomes 68/42, again 1.62, the golden mean.

Combination of the heights of the Moon Pyramid's thirteen bodies gave Harleston values that cover a range of numbers from 2 to 42, reflecting major modules that appeared as significant factors throughout Teotihuacan matching other cosmic correlations.



$$\frac{72}{68} = 1.059 = \sqrt[12]{2} \qquad \frac{68}{42} = 1.62 = \phi$$

Along the Way of the Dead, boundary markers appeared at 378 and at twice 378, or 756 units. The overall length of the ceremonial zone was 6 times 378, or 36 times 63, the height of the Sun Pyramid.

The north-south length of the Moon Pyramid, the familiar 162, multiplied by 14 was also 2268, the length of the ceremonial area.

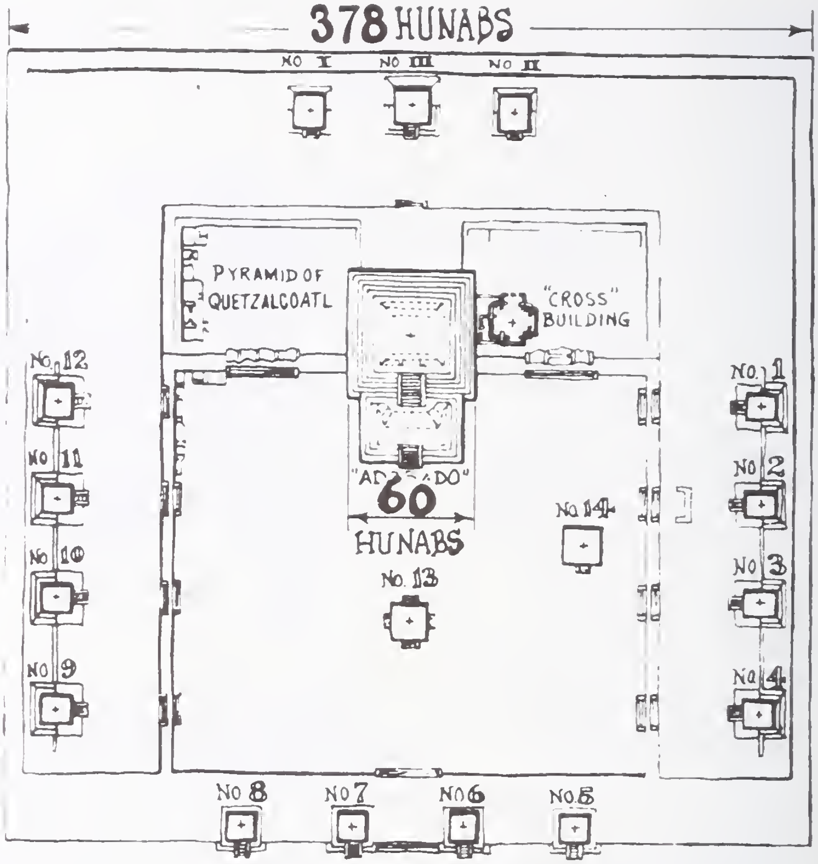
Behind the Moon Pyramid a row of buildings, almost perpendicular to the main north-south avenue, ran east and west. Harleston found that these boundary buildings ran 378 units both ways, totaling 756 units, twice the width of the Citadel, equal to the distance from the center of the Sun Pyramid to the center of the Moon Pyramid.

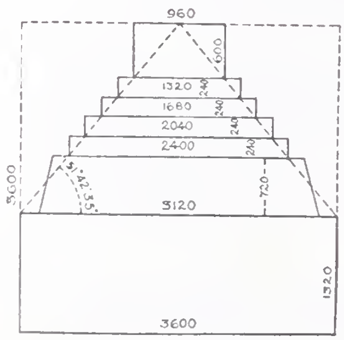
Convinced now that he had hit upon a possible Standard Unit of Measure or STU of the builders of Teotihuacan, Harleston named the unit a *hunab,* the Mayan word for "unified measure."

Studying the figures obtained from the Citadel, Harleston noticed that 378 times his basic unit multiplied by 100,000 gave a very accurate figure for the circumference of the planet, whose average spherical circumference is 40,049,589.35 meters. Harleston then found that the 60-unit base of the Quetzalcoatl Pyramid multiplied by 100,000 gave the polar radius of the earth. This led him to wonder whether the Pyramid of Quetzalcoatl, like the Pyramid of Cheops and the stepped ziggurats of Mesopotamia, could have been designed as a scale model of the earth, part of a citadel designed to incorporate mathematical, geodetic, astronomical, and possibly cosmic data.

Harleston decided the Citadel might include an earth-commensurate unit when he figured that the 378 *hunab* length of the Citadel divided by the 60 *hunabs* of the Quetzalcoatl Pyramid could represent the circumference of the earth divided by twice its radius, or 378 ÷ 120, which gives a value for π of 3.15.

But he overlooked the fact that the length of the Citadel wall is also 1296 Egyptian feet, or 864 cubits, lengths used by the Egyptians and Mesopotamians to compute the circumference of the earth.

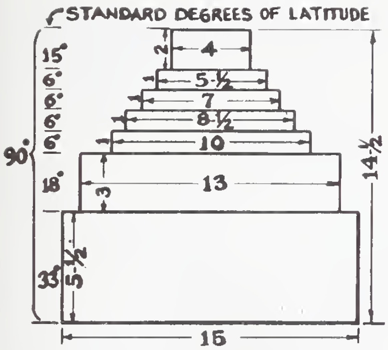




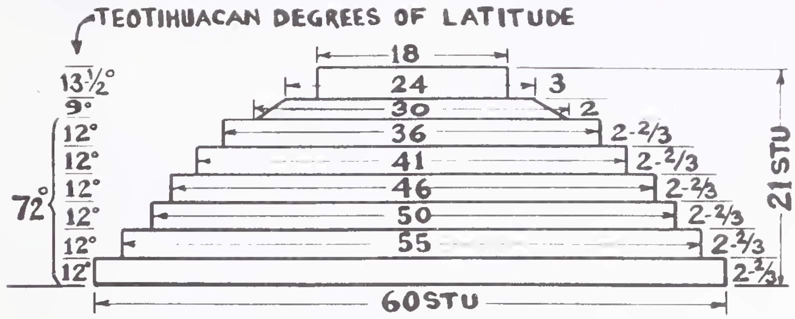
As with the ziggurats of Babylon, the square base of the Quetzalcoatl Pyramid covers exactly 3600 square units of Harleston's measure, equal to 43,482 square English feet, which is virtually an English acre. It also compares with the Mesopotamian land measure of 60 double cubits, as shown in the Babylonian ziggurats documented in the Smith cuneiform tablet.

As the Babylonians used each face of a stepped pyramid to represent a 90-degree quadrant or hemisphere of the earth, dividing the area between the equator and the North Pole into seven bands or zones, each diminishing in width to correspond to the shrinking degree of longitude, Harleston decided to check the reconstruction of the Quetzalcoatl Pyramid to see if the same system might apply.

The elevation plans of the Quetzalcoatl Pyramid made by the Mexican Institute of Anthropology show a structure rising in six tiers to 17 meters, on top of which rests a seventh structure of 5 meters, for a total of 22 meters, or 21 of Harleston's units. However, as the precise corners of the lower six levels have not been restored, it was necessary for Harleston to use the east-west values of the rebuilt horizontal face widths to arrive at a probable original length for each step.



BABYLONIAN ZIGGURAT
(RELATIVE PROPORTIONS)



PYRAMID OF QUETZALCOATL
(ACTUAL DIMENSIONS)

Temple of Jupiter Belus. The lengths of the seven stages of this Babylonian ziggurat were found inscribed on a palette by George Smith, F.R.G.S., according to which the area of the lowest section was 3600 × 3600 inches, or 12,960,000 inches.

The Quetzalcoatl Pyramid, as reconstructed by the Mexican architect and archeologist Ignacio Marquina in the 1920s, was also made in seven stages. The ziggurats at Ur, Uruk, and Babylon were as high as 300 feet (91 meters), equivalent to a 25-story building. This compares to Teotihuacan's Sun Pyramid at 18 stories. As Livio Stecchini has shown, the stepped pyramid, or ziggurat, transfers curved data to a flat surface in order to make a projection of an earth hemisphere with a minimum of distortion. Each main step face represents a 90-degree quadrant, and the levels can represent the zone between two parallels of latitude, in a series of mercator projections.

The Babylonians divided the area between the equator and the North Pole into seven bands, or zones, each diminishing in width to correspond to the shrinking degree of longitude. The base line corresponded to the equator, and the first step to the 30th parallel. The ziggurat in Mesopotamia raised the first step to a height corresponding to 33 degrees of latitude instead of 30 degrees, since 33 degrees was the location of Babylon. Thereafter each step rose in units of 6 degrees of latitude. By dividing the length of the step by 2/3, an easily remembered calculation of the cosine value of the latitude is obtained.

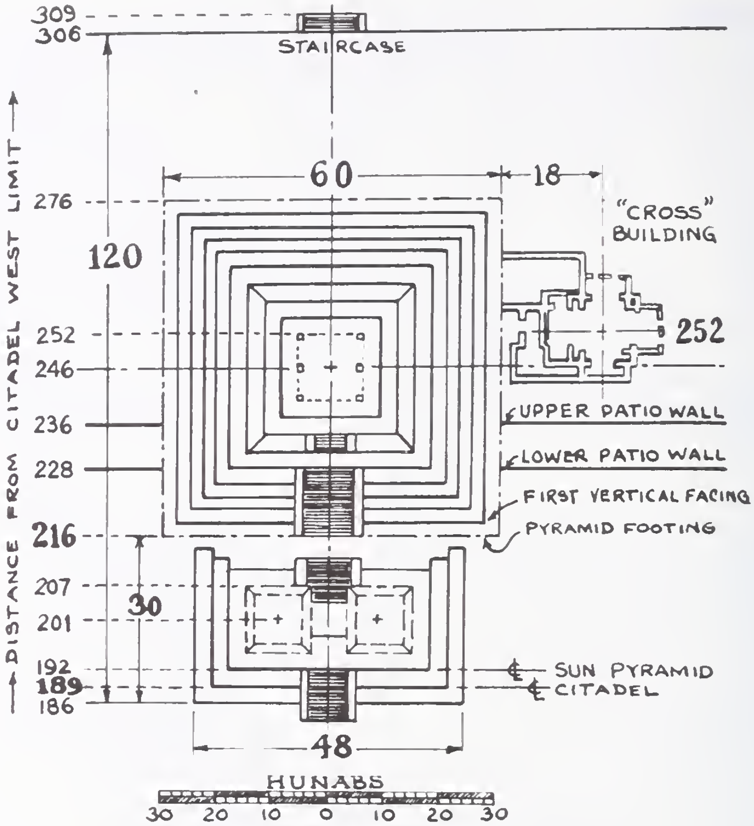
The Babylonian ziggurats incorporated a series of map projections several thousand years before modern cartography was refined in Europe during the eighteenth century. The Naba ziggurat at Barsipki was made in seven stages, and was said to have been painted with seven "planetary colors."

The Babylonians preferred counting in sixes, and their mathematical systems were hexagesimal and heptagesimal; that is sixes and sevens. This preference was apparently also characteristic of the Egyptians. Livio Stecchini shows how the degrees of latitude of a parallel represented by each ziggurat step can be obtained by multiplying the step height by 6. Thus 6 × 5 1/2 becomes 33 degrees of latitude for the first step.

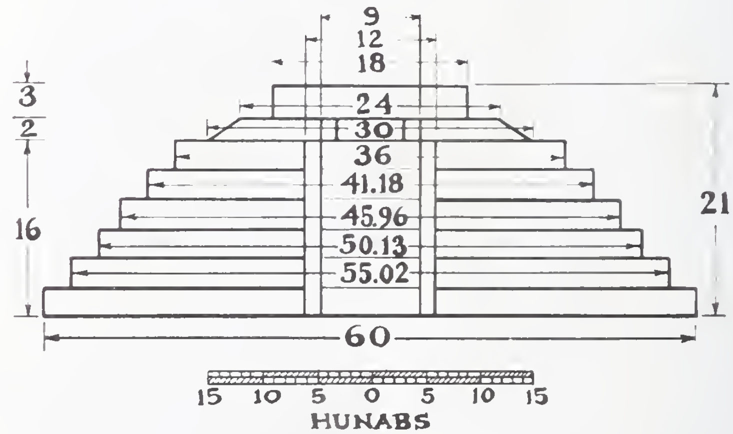
A similar system emerges at the Pyramid of Quetzalcoatl in Mexico. The elevation and plan views of the Mexican Institute of Anthropology allow converted measurements that show the height of the known steps in six tiers to total 17 meters, with a seventh structure of somewhat more than 5 meters on top. In Harleston's units each main vertical step becomes 2 2/3 *hunabs*, and the upper structure of 5 *hunabs* makes the pyramid 21 *hunabs* high, or 7 × 3. Since 21 *hunabs* represent 90 degrees of latitude, each step becomes 11 3/7 degrees of latitude.

Step No.	Step Length	Cosine	Latitude Angle, Std Degrees	Denotes
1	15	1.0000	00.00	Equator
2	13	0.8667	29.93	Thirtieth Parallel
3	10	0.6667	48.19	
4	8½	0.5667	55.48	°Lat. = °Long. (Equator)
5	7	0.4667	62.18	
6	5½	0.3667	68.49	
7	4	0.2667	74.53	Magnetic Pole

Harleston's reconstructed plan of the Pyramid of Quetzalcoatl with measurements in *hunabs*. However, when measured in Egyptian units, the width becomes a very interesting 204 feet, or 136 cubits, and its height 72 feet, or 48 cubits.

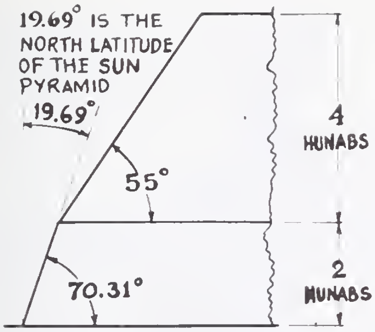


Harleston's reconstruction shows that the steps of the Quetzalcoatl Pyramid may have been designed to rise in lengths which indicated various important latitudes on the planet. When measured in *hunabs* the steps rise in increments of 2 1/3. But when measured in palms, they rise evenly in units of 24 from a base of 360 palms.



From the various figures given by the Mexican Institute, Harleston made several mathematical reconstructions until he arrived at one which seemed closest to what the original might have looked like.

To find the angle, or latitude, represented by the various steps, Harleston divided the length of each step by 60 to obtain the cosine of the angle of that latitude. The first step produced a result of 23.449 degrees, which corresponds to the latitude of the Tropic of Cancer. Other steps gave the latitude of the Arctic Circle, and the magnetic pole. The system appeared to be the same as that of the Babylonians.



Sun Pyramid's fourth body.

This still did not necessarily prove that Harleston's unit of 1.059 was the unit actually used by the builders of Teotihuacan; if the proportions were correct, the results would check out with whatever unit of measure had been used. But it did indicate that the Quetzalcoatl Pyramid had the measurements of an earth-commensurate model, like the ziggurats and pyramids of the Middle East.

To see what information might be keyed into the Sun and Moon pyramids, Harleston made composite reconstructions of them using minor deviations from the restorations made by the Mexican Institute of Anthropology. On the Sun Pyramid he replaced the amounts of missing material which the literature indicated had been removed by Batres from the first, second, and third levels.

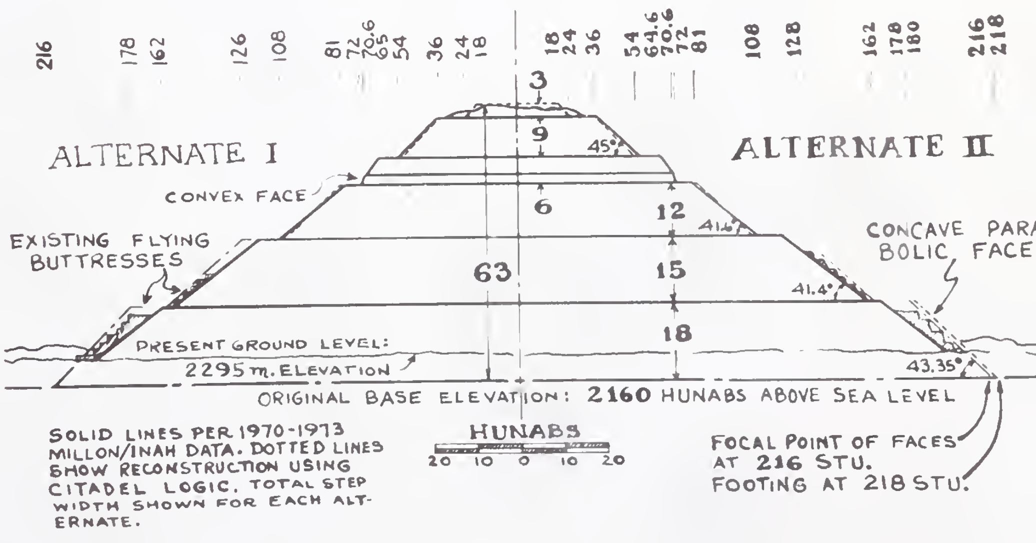
Immediately he noted a 1-2-3 relation between the Quetzalcoatl, Moon, and Sun pyramids, which turned out to be respectively 21, 42, and 63 units high, measured in his *hunabs*.

But it did not occur to Harleston that these same figures also gave 48, 96 and 144 of the ancient Egyptian cubit of .462 meters on which the great Pyramid of Cheops is built.

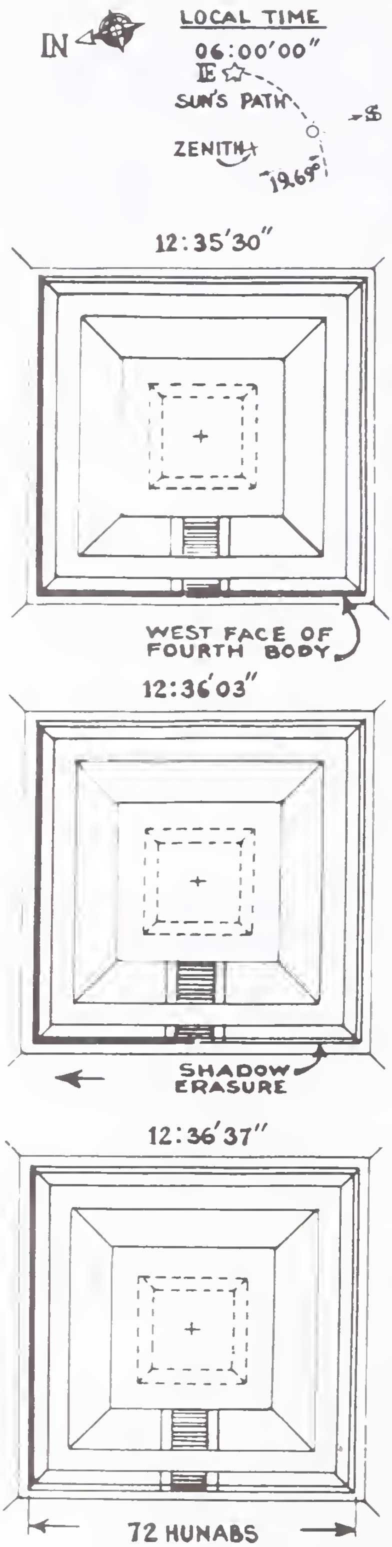
On the fourth body, Harleston felt that Batres had actually conserved practically the "original" positions of the stones (as he stoutly affirmed to his critics) and that the original design was close to what is seen today.

Noting that the lower portion of the fourth level was slightly convex and that it formed a triangle with an angle of almost 19.69 degrees to the vertical, it struck Harleston that this was also the latitude of Teotihuacan. This meant that when the sun crossed the pyramid at the equinox its rays would fall onto the north face of the fourth body at the same angle of 19.69 degrees to the vertical.

To observe what would actually happen at the equinox,



Conversion of the Sun Pyramid's metric measurements to *hunabs* is shown by Harleston's theoretical reconstruction. The solid lines indicate the restoration by Batres in 1906 to 1910, and by the Mexican Institute of Anthropology and History in 1963 to 1964. The dotted lines use the Citadel logic and are based on refilling almost exactly the parts left off. The flying buttresses formed retaining walls for the missing material that would have cost too much money and time to have restored in 1910. The mathematically sequenced lengths of the pyramidal bodies follow a series of increasing sums. The individual heights and also the elevations above sea level are factors of the number 3.



Manner in which the shadow on the lower part of the fourth body of the Sun Pyramid—a constant and boldly outlined feature of the structure—is eliminated at the equinox.

Hugh Harleston, Jr., showing lower fourth level in shadow. The only two shadows on the Sun Pyramid at midday on the equinoxes (March 21 and September 23) are on the western and northern faces, as seen in the above photograph of Hugh Harleston, Jr. The shadows appear only on the lower part of the fourth body. The shadow on the west face is removed by the advancing sunlight within a time lapse that suggested to Harleston that the designers divided a minute into 63 of their seconds (67 Newtonian seconds), the same number as the height of the Sun Pyramid itself in *hunabs*. The shadow on the north face is not removed until two days after the equinox, when it "flashes" on and off at midday, signaling the event and providing a calendar count correction twice a year, making of the Pyramid a living clock.

Harleston noted that the phenomenon in fact took place two days after the equinox. As the shadow did not wipe on the actual day, it meant the angle of the slope was 19.5 instead of 19.7, which could have been an error in reconstruction, or the angle was intended to convey some other meaning. However, observing the west face of the pyramid at the equinox, Harleston was able to witness a unique effect. As the sun crossed the zenith at 12:35′ 30″ (local noon at the longitude of Teotihuacan), the lower west part of the fourth face of the pyramid, which is in shadow during the morning, became illuminated as the sun's rays moved from south to north. The whole effect occurred in 66.6 seconds, a phenomenon which makes the Sun Pyramid a perennial clock, still transmitting its silent message, exactly as does the Great Pyramid of Cheops, or as does the south corner of the Castillo at Chichen Itza, each equinoctial day of the year. All these structures would have had to be designed by architects aware of the considerable astronomical and geodetic data required to achieve such effects—*before* the buildings were begun.

Harleston's analysis, interesting as it might be, remained

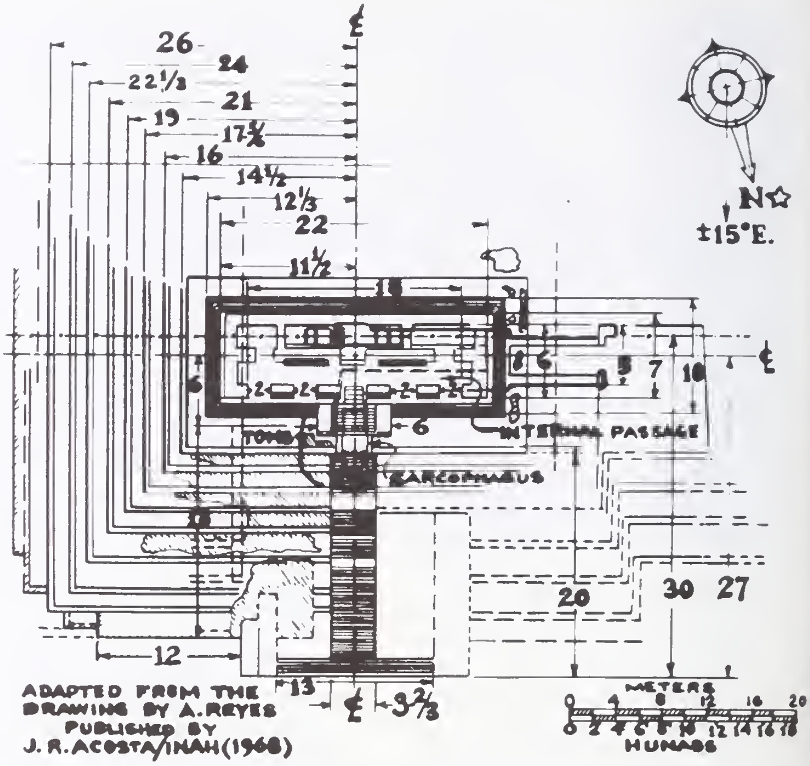
Harleston measuring Citadel.

circumstantial. There was no valid substantiation of his notion that the builders of Teotihuacan used the twelfth root of 2 as their constant, and it seemed hardly possible that they could have arrived at it as he had by means of the meter—or 1.059 thereof. Furthermore, as there appears to have been a great deal of intercourse between the Middle East and Mesoamerica, with a flow of technicians as well as religious and philosophical notions, it seemed reasonable to assume that any earth-commensurate unit used in Mesoamerica be related to the unit used in the building of the Great Pyramid of Cheops, or at least to have been derived from some common source. By applying to the Teotihuacan complex the ancient Egyptian geographic foot, of which there are 750 built into the base of the Pyramid of Cheops, the results were surprising. The most definite measure in the Teotihuacan complex is the width of the Citadel, given by Marquina as 399.48 meters (and by Harleston as 378 of his *hunabs*). Measured in the geographic feet of the Great Pyramid (or of the entire ancient world) 399.48 meters is 1296 feet or 864 cubits.

Here were the figures used by the ancients to define the circumference of the earth in both seconds of arc and seconds of time, the numbers from which they derived both their foot and their cubit. These two numbers, 1296 and 864, are basic to the entire ancient system of measures. Elsewhere in the Teotihuacan complex the foot and the cubit appear in easy and significant numbers. Harleston and Marquina's 800.6-meter distance between the Sun and the Moon Pyramids is 2600 ancient geographic feet.

The Quetzalcoatl Pyramid as measured by Harleston (on the basis of INAH's data) gives a width of 204 feet or 136 cubits. Its height comes to 72 feet or 48 cubits, figures that are every bit as significant as Harleston's. By his reconstructed measures, translated into geographic feet and cubits, the Moon Pyramid's height would be 144 feet or 96 cubits. Its reconstructed width, which is arbitrary, would be 558 feet or 372 cubits. The Sun Pyramid comes out to be 216 feet high or 144 cubits, all figures which Harleston considers significant. As there is still no known way of accurately measuring the base of the Sun Pyramid, of which only the northwest corner has so far been found, it may be idle to speculate on its length, but *if* it were to be the 218 *hunabs* postulated by Harleston, it would be almost to the millimeter the length of the Great Pyramid of Cheops: 750 feet or 500 cubits.

Even more startling is a transfer to feet and cubits of Harleston's reconstruction of the Palenque Temple of the Inscriptions. Whereas his measurements in *hunabs* come out to a mostly uneven 26, 21, 17 5/6, 14 1/2, 12 1/3, 11 1/2, Temple of the Inscriptions at Palenque showing measurements made by Harleston in *hunabs* of 1.059 meters, which come out in random fractions. Computed in Egyptian feet and cubits the same measures give an extraordinary progression of even numbers from 12 to 90.



3 2/3, when measured in the geographic feet of the Egyptians, these same numbers come out to a round 90, 72, 60, 50, 42, 40, and 12.

As the ancient foot and cubit were divided into palms and fingers and the Aztecs also had palms and fingers, the same divisions may have been used by the Teotihuacanos: if measured in palms all Teotihuacan measurement numbers would simply be increased by a factor of six, or by a factor of 24 if measured in fingers. The ancient Middle Eastern finger of .01925 of a meter is one of the most indelible measures: 96 fingers equal their fathom, 9600 fingers their stadium, and 96,000 fingers their mile; 21,600 of these miles, or 60 × 360, will take you around the world. The Arabs also divided their finger into 6 grains of barley or 36 hairs of a camel; thus their cubit was equal to 864 hairs of a camel, whereas the circumference of the earth was 86,400,000 cubits, or 100,000 times the Teotihuacan width of the Citadel in cubits.

Evidence for the use of finger, palm, foot, cubit, and fathom in Mesoamerica is solid as a pyramid.

Dr. Daniel G. Brinton, head of the Archeology Department of the University of Pennsylvania, in his *Essays of an Americanist,* published in 1890, is unequivocal about the unit of the Aztecs: "the foot measure was adopted as the official and obligatory standard both in commerce and architecture." To which he adds that there is ample evidence that it was "widely recognised, very exact, and officially defined and protected." Quoting Herrera, he shows that, just as in the Hebraic world, anyone in the Aztec world who falsified units of measure was considered a public thief, an enemy of the community, and severely punished.

After a long and careful study of the subject, Brinton concluded that the foot and the cubit (of a foot-and-a-half) had been the basic units of measure not only of the Aztecs but of the Maya and the Cakchiquels (among whom he includes the Quiche and the Tzutahil). To this he added that "the Aztec terms for lineal standard being apparently of Maya origin, suggests that their standard was derived from that nation."

The Mayan foot was the *oc*. Their cubit was the *cuc* or *noch cuc,* which Brinton describes as being about 18 inches, or a foot-and-a-half. Their fathom of six feet was a *zap* or *zapoul;* half a fathom or *betan* was their three-foot yard.

A *kaan* was 36 fathoms square, and 20 *kaan* made a *vinic,* the area of land needed by a man to support one family in corn. According to Brinton, the smallest Maya units of lineal measure were the finger breadth or *u nü kab,* and the thumb breadth *u na kab,* our inch or French *pouce.* The Maya also had three different spans of which the most used was the *nab,* from tip of thumb to tip of index; but they also had the *chi nab,* from thumb tip to little finger tip, and the *kok:* closed finger palm with extended thumb.

Father Thomas Coto expressly states that the cubit or *chumay* was the customary building measure among the Cakchiquels. "When they build their houses they use this cubit to measure the length of the logs. They also measure ropes in the same manner." Cakchiquel fields were marked off in fathoms of four cubits, and a three-fathom unit was a circle around a man with outstretched arms. The Aztecs also had the finger, span, and foot, as well as the cubit which they called *cemmolicipitl,* from *ce* = one and *molicipitl* = elbow. Their fathom was the *cemmatl,* and a half-fathom or yard the *cenyollatli.* For measuring longer lengths they used the *octacatl,* and though the unit has not been identified, Brinton believed that because *oc* is the Mayan for foot, it may have been a ten-foot length, a unit of which he found considerable evidence in the Americas.

Father Duran reports that along the Aztec highways, there were posts or stones erected with marks upon them showing how many of these stops there were to the next market town, a system employed throughout the Middle East. Unfortunately Duran did not measure or find out the distance between two such markers.

If it seems astounding that no one quickly established just what the Aztec unit of measure might have been, as related to European or any other measure, it must be remembered that it is a perennial and fundamental rule among conquerors to obliterate their victim's system of measures and place on the ruins of their sacred temples new structures built with an imposed system of measures.

It would have been pleasant to leave the matter there, but a possible complication may eventually lead to even further clarity. The Egyptians, or Middle Easterners, had a unit of 40 fingers called a *bema* whose length was .77 of a meter, 300 of which fit exactly into the base of the Great Pyramid; it was widely employed as a measure equal to ten palms.

If Harleston's *hunab* is divided into 60 fingers, a unit of .01765 meters is obtained, which is virtually the Aztec finger, as reported by V. M. Castillo in his *Unidades Nohuas de Medida,* ten of which make an Aztec *bema* of .706 meter. When applied to both the Teotihuacan and Palenque complexes, Aztec fingers, palms and *bemas* give even more significant results than Harleston's *hunab.*

The Quetzalcoatl Pyramid base, instead of being 60 *hunabs* becomes a more rational 90 *bemas* or 360 palms, and its steps rise in increments of 4 *bemas* instead of 2 1/3 *hunabs*. The perimeter of the Sun Pyramid becomes 12,960 *bemas* and its base length 1296 fingers. As the numbers 1296 and 864 were the key to unraveling the astronomical and geodetic secrets of the Great Pyramid, they may in due course resolve the mysteries of the Mesoamerican Pyramids.

Is it a coincidence that a circle of 1,296,000 units has a radius of 2,06,265 units and that 20.6264 is the length of both an English and Egyptian cubit, that the Hebrew shekel weighs 129.6 grams, and the English guinea 129.6 grains, and the measure of the Most Holy in Solomon's Temple is 1296 inches?

Not only was the number 129600 the numeric basis for astronomical measurements as far back as the records are traceable, it was also the favorite number in Plato's mystic symbolism. W. H. Wood, in his *Ideal Metrology,* says the multiples and submultiples of 12960, which are easily memorized—1728, 864, 720, 432, 360, 216, 180, 90, 40, 36, 20, 16, 10, 8, 5, 4, 2—were everywhere used as sacred numbers in the building of temples. The Babylonian tablet Igi-Gal-Bi contains all of them, plus 144, 162, and 810, which appear at Teotihuacan in both *hunabs* and cubits.

Wood points out that in the law of the Yoga, all periodic actions developed under the inspiration of the Invisible are measured by ideal cycles, expressed in geometric form by the number 1296 in thousands or thousands of thousands. The third stage of Yoga is represented by the third of 1296 or 432, which is considered the symbol of consecration, or standing in harmony with nature's beauty and order. The exalted life of a disciple of Buddha called for a cycle of 4320 million years.

Alan Watts in his *The Book* points to the Hindu myth which says that as time goes on, life in the world gets worse and worse, until at last the destructive aspect of the Self, the god Shiva, dances a terrible dance which consumes everything in fire—shades of Tezcatlipoca! There follows, says the myth, 4,320,000 years of total peace during which the Self is just itself and does not play or hide. And then the game begins again, starting off as a universe of perfect splendor which begins to deteriorate only after 1,728,000 years, and every round of the game is so designed that the forces of darkness present themselves for only one third of the time, enjoying at the end a brief but quite illusory triumph.

Charles Muses, writing on the origin of certain Babylonian numbers in a note in *Ancient Cultural Anthropology,* says the Chaldean priesthood of the ancient Sumero-Babylonian civilization was convinced, as were the later Pythagoreans, and indeed many physicists and cosmologists today, that embedded in cosmic structures lies a comparatively small "alphabet" of deeply fundamental numbers. As Muses put it, rephrasing Plato, "God not only geometricizes, but profoundly arithmetricizes."

Among those numbers still in great use today, Muses lists 360 degrees for a circle, 60 minutes for an hour, 60 seconds for a minute, and 24 hours for a day. He also notes our 7 days of the week, 12 months of the year. Taking the 4 states of matter, plus a quintessence, and adding to them unity and trinity, Muses makes a list of 1, 3, 4, 5, 7, 12, 24, 60, and 360; he proceeds to show how all of these numbers are simply and uniquely related to patterns of *circular arrangement.*

Using as an example a hostess with a round table of guests to be seated, Muses shows how the number of arrangements she can choose from jumps from 12 for 5 guests to 60 for 6 guests and to 360 for 7 guests. The seven guests, says Muses, represent the heavenly bodies of Babylon. Babylonian astronomy, which existed overwhelmingly for astrological purposes, was developed upon the 5 visible planets plus the Sun and the Moon.

These all appeared to revolve against the background of the stars in a comparatively narrow belt, changing the pattern of their place arrangement about what Muses calls "the great round table of the sky," overtaking each other because of their observably varying speeds. With 7 bodies, the number of arrangements was just 360. With 6 bodies, obtained by placing the sun in the center—the system standardly used for the interpretation of horoscopes—the number becomes 60. With 5 bodies, setting aside both sun and moon, the number is reduced to 12, or a division of the sky into the 12 zodiacal signs, or the twelve months of the year.

According to Muses, a twofold twelveness, or 24, comes from uniting the 12 signs of the zodiac with 12 hours of the day. Thus from 360, 60, and 24 came a circle for time of $24 \times 60 \times 60$, or 86,400 seconds; and a circle for space of $360 \times 60 \times 60$, or 1,296,000 seconds.

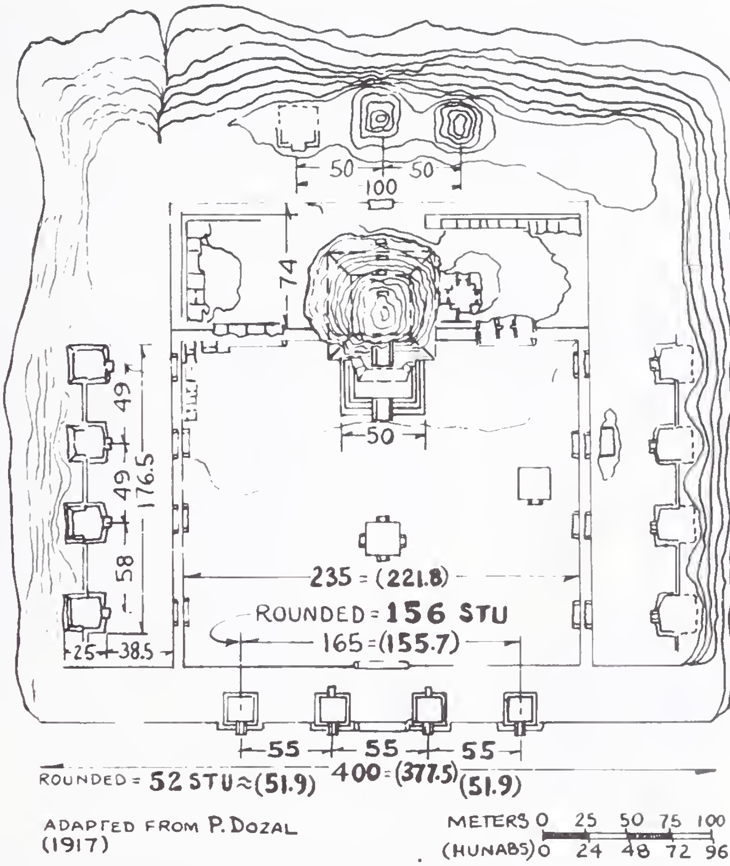
When a fellow engineer from Louisiana, Alfred E. Schlemmer, suggested to Harleston that he scan the Citadel for indications that it might have been used as a vast calendrical complex built around the numbers 13 and 52, Harleston realized that the four temples on the north, south, and west platforms of the Citadel, all the same size, plus one more, oddly placed within the patio, added to thirteen; all of them had thirteen steps on each of four sides for a total of fifty-two—the length of the Aztec century. Harleston noted that the distance between the centers of the western temples when measured in his units was 3 times 52, or 156.

This led him to conjecture that the builders of Teotihuacan could have celebrated ceremonies on various temples specially designed and arranged to incorporate the mathematics of their calendars.

He figured that if the Teotihuacanos had added one day to their calendar every 4 years, repeating the exercise thirteen times for a cycle of 52 years (perhaps using the four faces of their thirteen temples for a yearly ceremony), and then added another day at the end of three 52-year cycles (perhaps using the three larger temples on the east side of the Citadel for this 156-year cycle), they could have spread their calendrical ceremonies over a span of five human generations to obtain a calendar far more accurate than the Gregorian, correct to within 9/10 of a second per year, which would have needed no further correction for another 97,500 years.

For this the Teotihuacanos would, of course, have had to use a sidereal year, observing when a star reappeared in the same position in the sky at the end of 365.2564 days. With such a fraction of a day, just over the quarter, or .25, they would eventually have had to add another whole day over and above the leap years in order to keep their calendar correct; once every 156 years, to be exact.

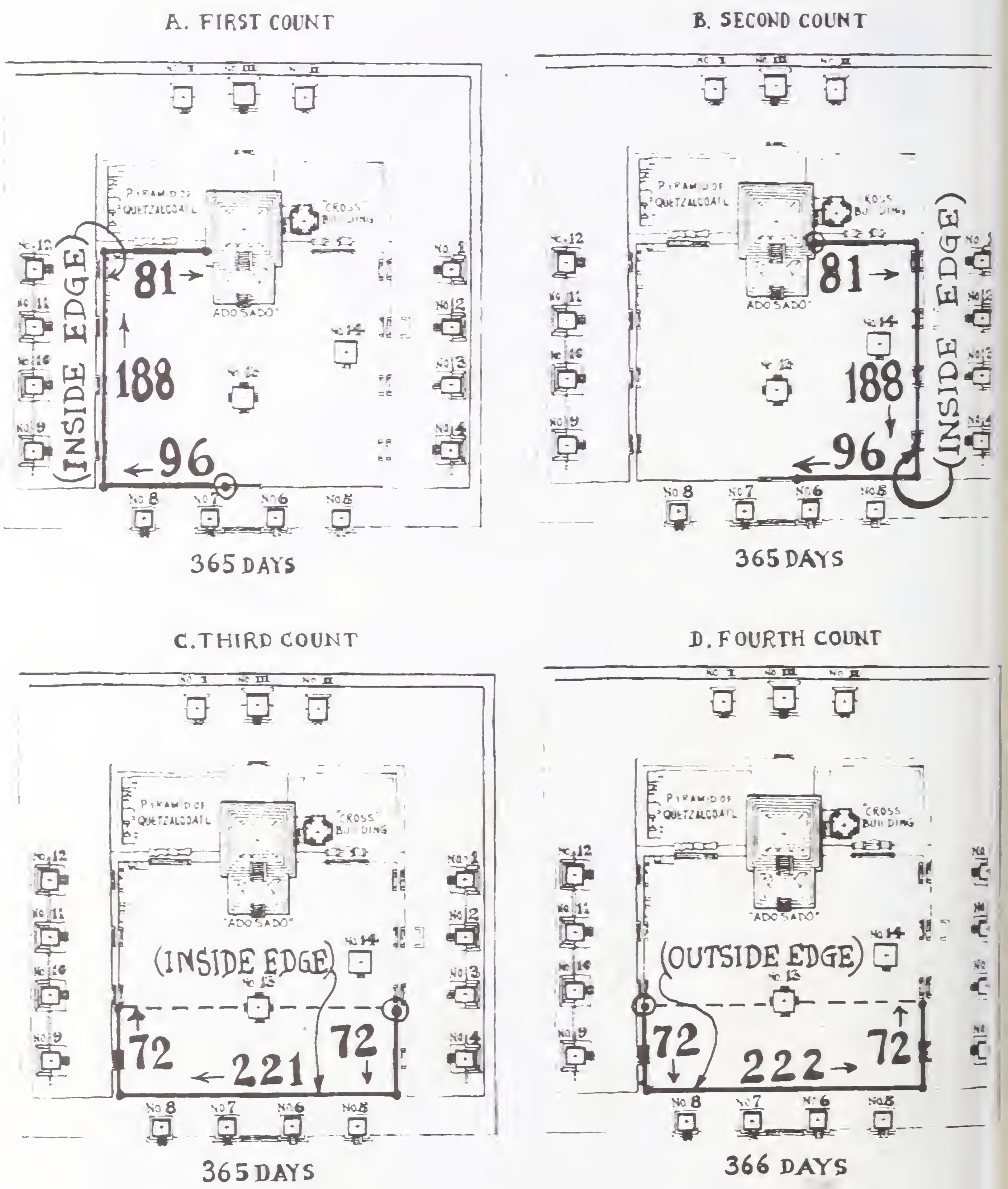
The four western platforms of the Citadel mark 156 *hunabs,* a distance that could represent a tricentennial time period of three 52-year "centuries."



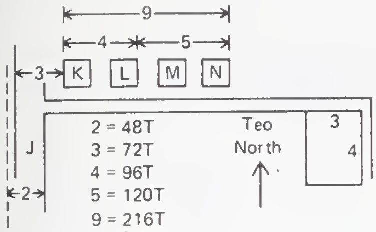
Spurred by the results of his hypothetical reconstruction, Harleston looked to see if there were other measurements in the Citadel to indicate a calendrical system. Starting at the entrance and moving clockwise around the perimeter of the patio, Harleston was surprised to obtain three counts of 365 and one of 366 units—clear indications of a yearly cycle—for a total of 1461 days, or units, identical with the Sothic cycle of the Egyptians.

Already in 1962 a similar notion had been advanced by George Kubler, author of *The Art and Architecture of Ancient America,* who suggested that the Citadel was "probably used for rituals of a calendrical nature." It struck Kubler that the three groups of four platforms round the Citadel plaza added to the Quetzalcoatl pyramid made thirteen ritual locations which could have been used for ceremonies dividing the calendrical cycle of fifty-two years into four parts of thirteen years each.

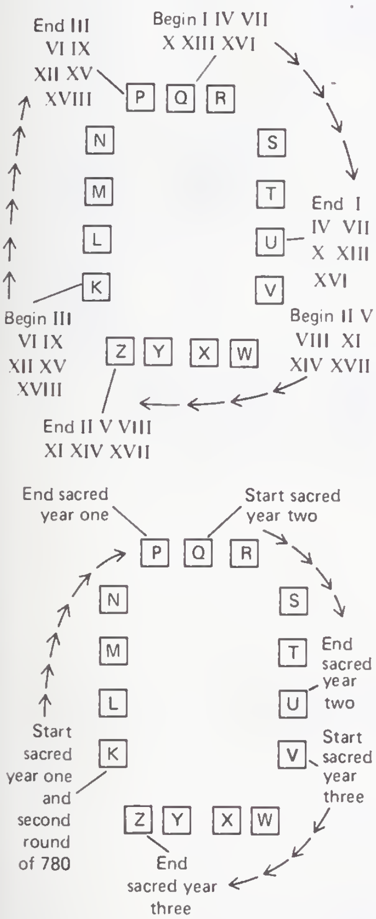
Kubler's idea was sustained and elaborated by David R. Drucker in a doctoral thesis for the University of Rochester. Drucker, who had worked on the Citadel as an assistant to Millon, suggested that the Teotihuacanos, fully conversant with the Maya technique of day counts in intermeshed calendars of 260, 360, and 365 days, could have used succeeding platforms in the Citadel to celebrate a constantly



Harleston's four-year calendar count.



Relationships among square platforms on F J and the Palace area expressed as simple whole numbers.



Drucker's calendar count in the Citadel.

Drucker took Platform Q as his starting point because it was the largest, and proceeded clockwise counting by twenties. He suggests there was a ceremony every 52 years on the Temple of Quetzalcoatl, and that each mound may have been surmounted by a temple with a flag or insignia on its roof to signify its role. Drucker says the system would have been perfect for recording a *tun,* or 360 days, as the last day would end on the main pyramid and start again.

unfolding day count for each of these rounds, plus the 584-day synodic return of Venus.

If, says Drucker, each Venus year were celebrated counterclockwise on the next platform immediately to the right, after 104 calendar years of 365 days (equal to 146 sacred years) a conjunction of the vague and Venus years would occur on the Quetzalcoatl platform where the ritual could be witnessed from the plaza.

Drucker furthermore believes that the Teotihuacanos laid out their whole city on the basis of a calendrical system that was most likely a heritage of the Olmecs (though it now appears that the Maya may have preceded the Olmecs). Drucker points out that the bearing of sunset at the beginning and end of the 105-days interval after the day of zenith was perpendicular to the Way of the Dead at the latitude of Teotihuacan, or 19° 42′.

Harleston concluded it might be worth investigating whether other geodetic, astronomic, or physical data could have been displayed in the actual geometry of the Citadel's buildings; if, for instance, there were triangles whose sides contained information deliberately encoded by the builders.

To eliminate the possibility of irrational or chance occurrences obtained from using any desired dimension to force answers, he put some elementary restrictions on his search. Any lines used had to fall on integral numbers defined by marker limits in the Citadel, such as walls, edges of platforms, centers of platforms, centers of pyramids, edges of staircases, and so on. Triangles had to be right-angled, and had to run north-south and east-west.

Within these parameters, Harleston soon found a score of Pythagorean right-angle triangles, and it was clear to him that the designers had a knowledge with exceptional accuracy not only of π, but of ϕ and ϕ^2—numbers which have a mathematically abstract relationship, and which appear to be basic to the construction of this universe.

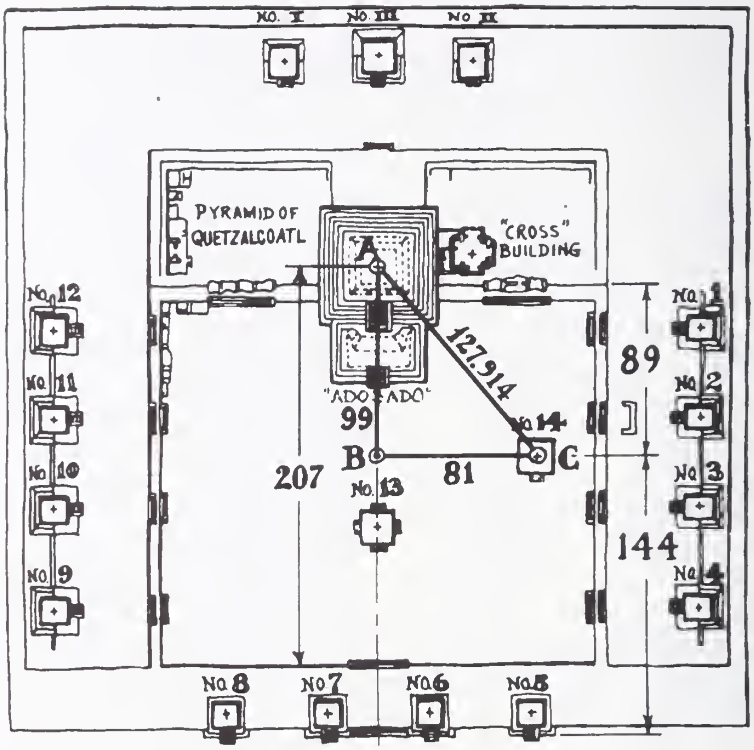
In the case of π, Harleston found nine integral triangles, all of whose sides included principal Citadelic dimensions such as 189, 222, 246, 147, 165, and 216 units.

Surprisingly, the triangle with the sides 216 and 165 units produced a hypotenuse of 271.810596, extremely close to the constant *e,* the natural logarithmic base 2.718281828 for Napierian logarithms. Twelve more triangles gave *e* with exceptional accuracy.

Harleston found that the probability of multiple reiterations of such numbers being strictly chance approached zero as the number of repetitive displays increased.

When Harleston saw that the Citadel's message might contain such "modern concepts" as the value for a logarith-

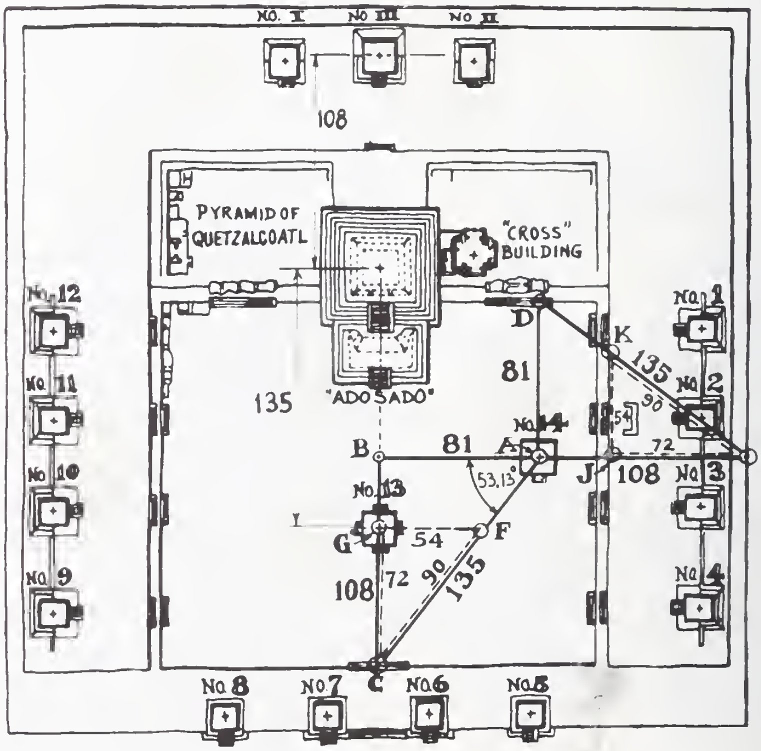
Harleston found the ϕ proportion in the Citadel, starting from the center of the Quetzalcoatl Pyramid. $207/127.9 = 1.618 = \phi$, and $144/89 = 1.618$. As with many classic and Renaissance structures, these ϕ relationships are aesthetically satisfying and account for the Citadel's extraordinary air of elegance.



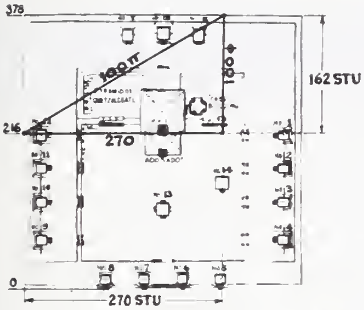
The constant, known to the ancients and designated by the Greek letter ϕ, is the proportion called "the golden mean." It has been found to be related in nature to the spiral growth in sea shells and other organisms. Mathematically the number is obtained in two ways: as the limit of a series of numerical divisions called the Fibonacci series (after the Italian mathematician), or simply taking the square root of 5, adding 1, and dividing the sum by 2:

$$\phi = \frac{\sqrt{5}+1}{2} = \frac{2.236068+1}{2} = \frac{3.236068}{2} = 1.6180339885\ldots$$

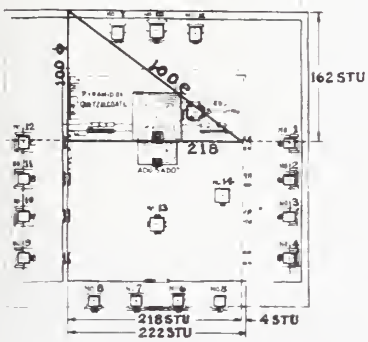
The number is usually shortened to 1.618, or further to simply *1.62*.



In the Citadel Harleston found several 3:4:5 Pythagorean triangles.



π and ϕ triangle in the Citadel.



e and ϕ triangle in the Citadel.

mic hyperbolic function, he wondered if there might not also be triangles which would give values for the other basic Einsteinian constant, the speed of light, which would have to be expressed as one-millionth of its value, namely 299.7925.

Harleston found that a triangle with sides 144 and 262 (which are 12^2 and $100\phi^2$) gave the speed of light within —1.0028, and another, with sides 162 and 252, gave a diagonal within 99.93 percent.

To Harleston, the correlative triangular information defined by the design of the Citadel's walls, platforms, and other delimiting structures was of such a complexity and interwoven exactness that he could only compare it to that of a computer program readout.

Here, said Harleston, was a design whose dimensional configurations provided accurately universal mathematical and other constants with a minimum of shared points. It was as if punch cards had been supplied for a four-dimensional advanced computer with the request to display an ideal architectural design that would incorporate major universal constants, geodetic, atomic, astrophysical, and other cosmic information in the minimum number of structures, all of which had to conform to right-angle Cartesian coordinates on an optimum scale model of the earth.

As the chances of the designers and builders of Teotihuacan having deliberately laid out such triangles to incorporate the values of π, ϕ, e, and the speed of light seemed remote, the more acceptable conclusion appeared to be that the designers could have been operating from some higher state of consciousness with the benefit of more cosmic and therefore simpler mathematics by means of which they could intuitively sense valid relations which would automatically include the basic constants of our three-dimensional math, which we, like blind men touching the elephant, can only describe with the squaredom of Cartesian coordinates.

Perhaps the pyramid complex was an intended hint to latecomers to expand their consciousness for a clearer view of the cosmos and of man's relation to the whole.

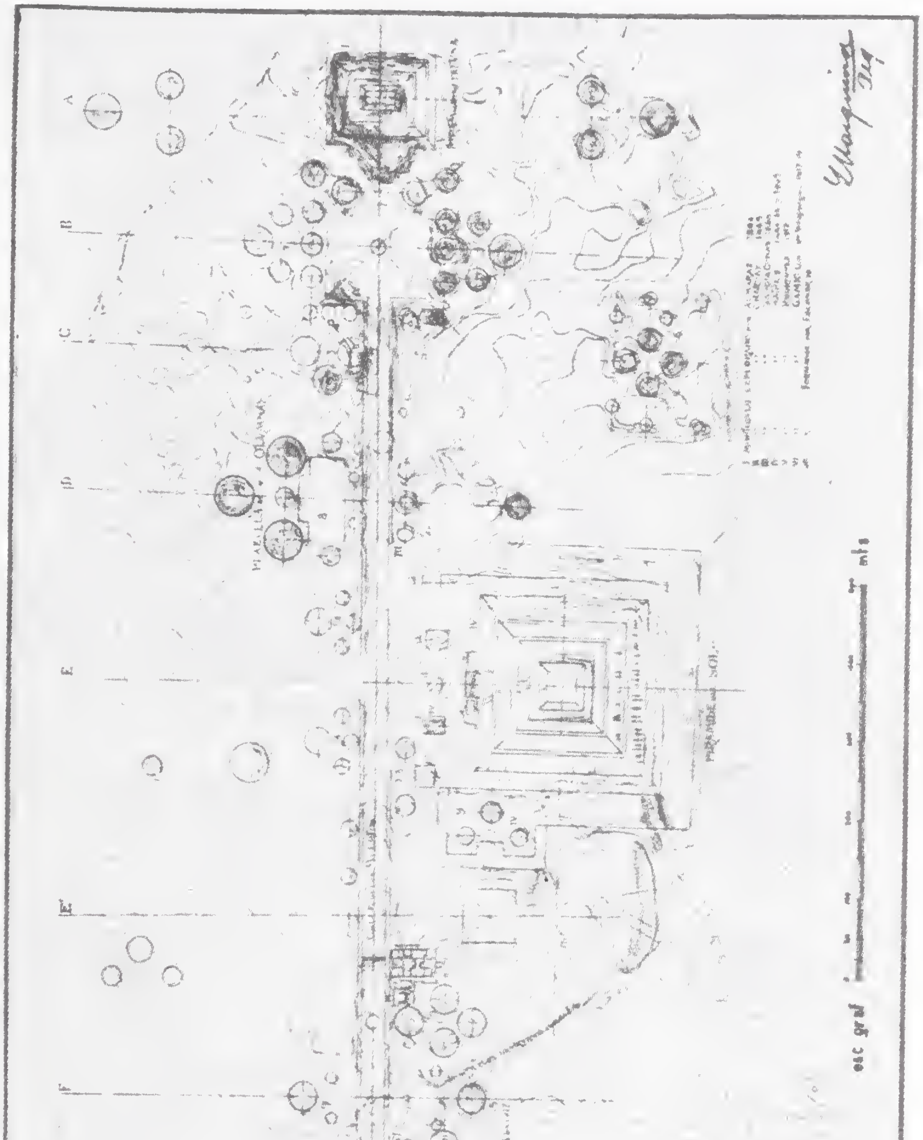
19. Cosmic University

Like a dog with a bone, Harleston continued to worry his *hunab* length and growl at any scoffers. If the Sun Pyramid had served its designers as a geodetic clock, and the Citadel as a gigantic calendar and repository of triangular data, what, Harleston wondered, was the function of the great north-south axis of Teotihuacan, misnamed the Way of the Dead? As he pursued his research, he began to get indications that it might have served as an enormous planetarium, a scale model of our solar system.

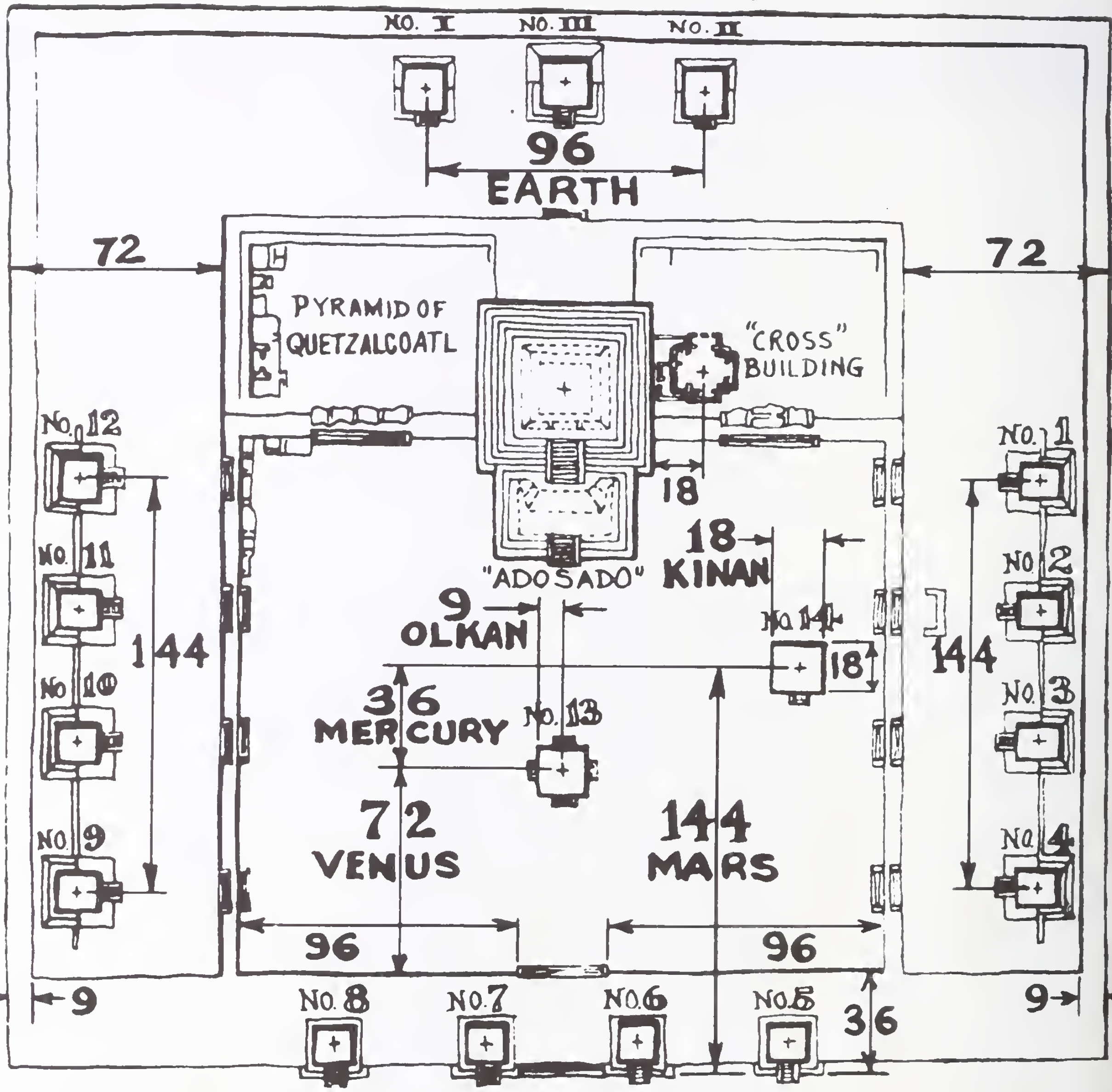
If one side of the base of the Pyramid of Quetzalcoatl of 60 units had been used by the Teotihuacanos to represent the radius of the earth, the radius of the sun would have been proportionately 6500 units, with a diameter of 13,000 units. Searching for such a demarcation, Harleston saw that this was roughly the distance across the Valley of Teotihuacan.

Rolled up and gathering dust in the vertical bins of the third-floor map and record room of the Mexican Institute of Anthropology, Harleston came across some old material considered to be strictly obsolete and only of academic interest, some of it still in the form of pencil drafts on squared graph paper, depicting the Way of the Dead.

Analyzing this material, Harleston saw that lengths between the walls with respect to the Sun Pyramid's center line provided integral proportions similar to the magnitudes already displayed by the Citadel and the Sun and Moon pyramids: lengths of 108, 144, 135, and 324 units. Already Millon had found a regular spacing of north-south streets, with definitely placed structures at fixed intervals not only along the Way of the Dead but along its prolongation north of the Moon Pyramid, and had suggested as a zero point for the ceremonial



Ignacio Marquina's early aerial map of the ceremonial area of Teotihuacan done while working with Gamio shows the areas explored by Almaraz in 1864, Charnay in 1885, Garcia Cubas in 1895, Batres in 1885–1905, Rodrigues in 1912, and Gamio in 1917–1919.



Orbits of the inner planets.

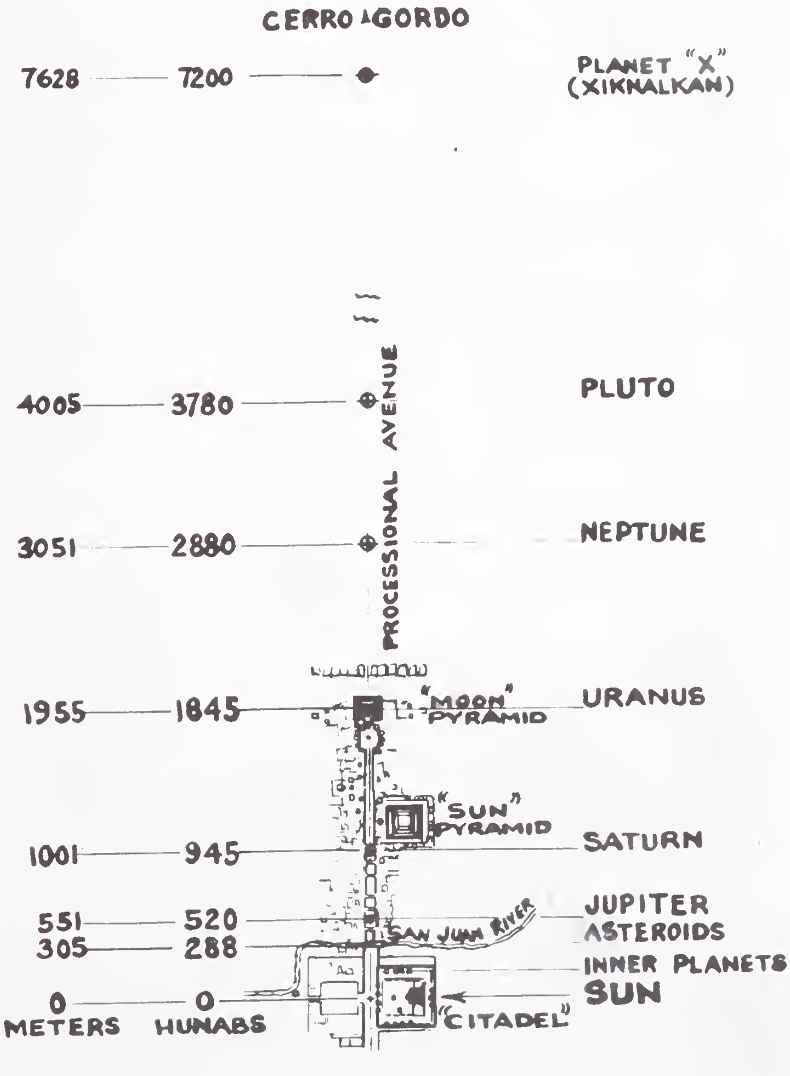
Harleston measured from the center of the Citadel to the edge of Platform 13 for a total of 9 units. He then realized that the values of the distances of the inner planets from the sun were displayed by the various walls and platform centers giving 9, 18, 36, 72, 96, and 144, which correspond to the orbits of Mercury, Venus, Earth, Mars, plus two additional possibilities closer to the sun than Mercury. These Harleston named Olkan and Kinan meaning "Sun Consciousness" and "Sun Spirit."

zone and approximate geographical center of the ancient city the intersection of the Citadel's center line with the axis of the Processional.

Taking this point as the center for a scale model of the solar system, Harleston was able to find markers along the Processional which to him gave values for the orbits of the various planets. Starting from the exact center line of the Pyramid of Quetzalcoatl in the Citadel, and arbitrarily assigning to the earth's orbit a value of 96 *hunabs,* the inner planets of Mercury, Venus, and Mars fell on their correct orbital values of 36, 72, and 144 units.

From the same starting point and traveling northward up the Way of the Dead, Harleston found that the canal of the San Juan River, apparently diverted from its original course by the ancient Teotihuacanos and made to flow under the Processional parallel to the Citadel, gave the average maximum orbital distance of the asteroids at 288 *hunabs,* or twice the orbit of Mars. This was only a vague indication. But still further, at 520 units, the remains of a pyramid corresponded to the average proportional distance of the orbit of Jupiter, as found by our astronomers, some 3 percent out of line from an ideally stable orbital shell.

Excited, but still doubtful, Harleston paced his way on up the Way of the Dead with a steel tape measure. At 1000 meters, or 945 *hunabs,* north of the Citadel's center line there is a spot where there had once been a platform, now obliterated. During the work of reconstruction carried out between 1962 and 1964 this section of the Way of the Dead had been paved over with asphalt to allow rubber-wheeled tourist trains to transit through the zone. By Harleston's calculations the spot could have been the demarcation for the average orbital distance of Saturn, which is now 9.55 astronomical units, about 2 percent further out than the ideal symmetrical orbital shell.



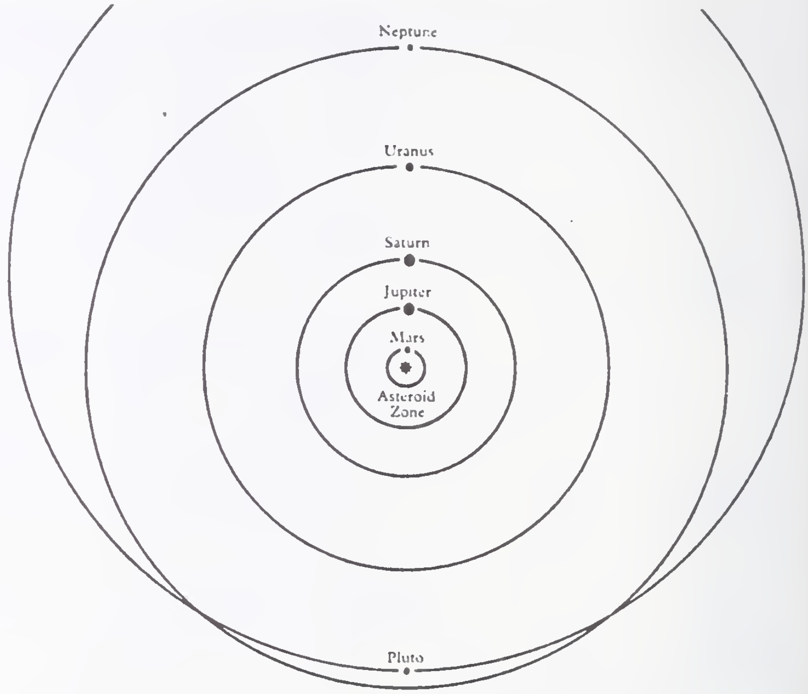
Outer planetary orbital distances

Starting with the center of the Quetzalcoatl Pyramid as a mark for the sun, and measuring northward up the Processional, Harleston found that all the known planets, plus another potential one, fell on definite markers which were symmetrically spaced in what appeared to be a binary progression beginning with the number 9: i.e., 9, 18, 36, 72, 144, 288. This is illustrated by the actual distances of Mercury, Venus, Mars, and the asteroids (9×4, 9×8, 9×16 and 9×32 units when the earth's orbit is assigned a value of 96, a number which is clearly displayed in the Citadel). It was here that Harleston concluded that the earlier indications of multiples of 9 appearing throughout the ceremonial area could have been intentional.

Starting from the premise that the law of angular momentum is valid for all the known universe, a Soviet named Schmidt, for whom the Institute of Geophysics in Moscow was named, formulated a theory of the harmony of the distances between planets by which the square root of the distance of planets from the sun increases from planet to planet by a constant amount. Schmidt's theory has now been verified not only for the planets of our solar system but also for the satellites of the larger planets.

In 1963 Lloyd Motz, then associate professor of astronomy at Columbia University, stated the view that planetary systems must appear and develop around stars of a given type as uniformly as the formation of salt crystals, which are always the same, whether they are formed on earth, Mars, or a planet millions of light-years away.

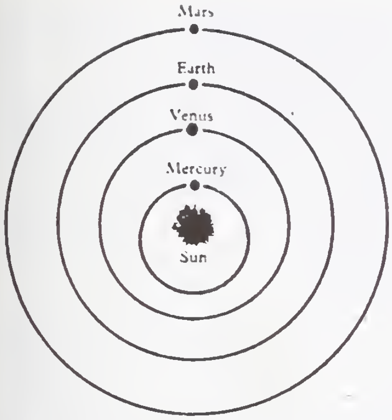
Until late in the eighteenth century, only five planets were known: Mercury, Mars, Venus, Jupiter, and Saturn. However, at the beginning of the seventeenth century when Johannes Kepler discovered that the orbits of the planets were slightly elliptical rather than truly circular, and that even these ellipses were irregular, the aberrations were attributed to some other as yet undiscovered planet or planets.



Next came the center point of the Moon Pyramid, corresponding to 19.2 astronomical units, or the precise orbital distance of the planet Uranus.

Encouraged by what he considered the extraordinary consonance of these processional markers, Harleston took off behind the Moon Pyramid and climbed the flank of Cerro Gordo to see what more he could find. At 2880 and 3780 *hunabs* from the Citadel, he came upon two typical temple mounds not yet reconstructed by the Mexican Institute of Anthropology and History. The first mound marked the correct orbital distance of Neptune at 30 astronomical units from the sun. Neptune was discovered in 1846. The second mound marked the distance of Pluto at 39 astronomical units. Pluto was discovered in 1930. Further up Cerro Gordo, at 7200 *hunabs* north of the Moon Pyramid's center line, Harleston came across the remains of an ancient temple known to the native residents as the Temple of Xochitl (or "Flower"), remains that were barely visible because treasure hunters had thrown most of the structure over the side of the ravine to cover up the traces of their pilfering.

Extrapolating from the previous Teotihuacan data, Harleston theorized characteristics at this location for an unknown planet "X," almost twice as far from the sun as Pluto. Naming it Xiknalkan (Mayan for "Flying Serpent"), Harleston attributed to it a mean orbit of 11,212,800 kilometers, or 75 astronomical units from the sun, a diameter approximately three times that of the earth, or 37,000 kilometers, and an inclination to the plane of the ecliptic of 4.74 degrees, compared with Pluto's 17 degrees.



In 1787 Sir William Herschel, Astronomer Royal at the Greenwich Observatory, realized that what was thought to be a star was actually a planet. First named for him, it was later called Uranus.

In 1845 a bright young Englishman, John Couch Adams, figured out where to look for a second new planet, but the local observatory paid him no no heed until a local Frenchman, Urbain Leverrier, reached the same conclusion by independent calculation and the planet Neptune was discovered during the night of the autumn equinox of 1846.

In 1930, at the observatory built in Flagstaff, Arizona, by wealthy Bostonian Percival Lowell, a young man, Clyde Tombaugh, got a picture of a new planet which turned out to be Pluto, a planet so eccentric in its orbit that in 1976 it moved in closer to the sun than Neptune.

Because such evidence indicates an overall system operating from the macrocosmic to the microcosmic, occultists have based their number systems on the time periods of the planets which are a direct function of their distance from the sun. To occultists the fact that twelve earth years is equal to one year of Saturn, leads them to conclude that 12 times 30, or 260, must be a significant number in the system.

There is, of course, considerable mention in occult literature of undiscovered planets in the icy regions of space beyond Pluto, and the Russian philosopher Georges Ivanovitch Gurdjieff maintained that we experience the influence from two such undiscovered planets beyond Pluto.

Physicists, philosophers, and psychics have all adduced data on the possibility of intra-Mercurial and extra-Plutonic planets as yet unofficially discovered. Several leading astronomers, including J. J. See, W. Peck, T. Gugril, and G. Forbes, have predicted planets with varying periods of orbit. But the weight of academic thought on their putative postions does not correspond with Harleston's locations. Dr. William H. Pickering, working out of his private observatory in Jamaica in the 1930s, postulated, on the basis of an exhaustive study of the perturbations of both Uranus and Neptune and of the period comets, the existence of two more planets beyond Pluto and predicted that the first of these, which he called "S," would have a sidereal period of 333 to 336 years, at a mean distance from the sun of 48.04 astronomical units, or half of Harleston's distance.

Pickering's figures agree remarkably well with those obtained by Dr. Charles Muses, a mathematician, physicist and cyberneticist who placed such a planet—which he suggested calling Pan—at 48.4 astronomical units from the sun with a period of 342 years. Dr. Muses obtained his data from two different approaches: by a refinement of the Bode-Titius law into a threefold law whose parts are related and mutually overlapping at their successive limits of application, and by a theory of cylindrical wave formation whereby the planetary orbits appear as rings formed by the comparatively dense matter of the planets in contrast with the light-filled bands of interorbital space in the solar system, as explained in his paper published by the National Research Council of Italy in 1965, and in a more popular version as "Why Do Celestial Bodies Rotate and Revolve?" in the *Journal for the Study of Consciousness*.

One other mathematician, Joseph L. Brady of Livermore, California, in an effort to explain the major irregularities in the orbit of Halley's Comet, has proposed a planet closer to Harleston's location, one that would orbit retrogradely in a period of 512 years, with a mass 300 times that of the earth, and tilt of 60 degrees to the ecliptic.

Within the Citadel's boundaries, where he believes the dimensions may indicate the orbits of the inner planets Mercury, Mars, and Venus, Harleston thinks that the dimensional system may indicate two more planets closer to the sun than Mercury, to which he has given the names of Olkan and Kinan, "Sun Consciousness" and "Sun Spirit."

Harleston's drawing represents his and Alfred Schlemmer's "far-out" notion derived from Aztec mythology of a flayed planet—the twin to Mars—called Quetzalcoatl or "Sumer," whose outer surface is conceived to have been deliberately "peeled off like an orange" by space people and deposited into the oceans of Terra in the form of the present continents, leaving the moon as a sterile core.

According to this reading, the damaged twin companion, Xipe Xolotl, the flayed Red God of the East, or Mars, retreated to a new position at a distance of 228,000,000 kilometers from the sun, its face cratered with the evidence of celestial bombardment confirmed by the Ranger space probes of 1976.

In this Velikovskian heavenly drama, Venus, the former twin companion of Earth, would have plunged into a nearly circular orbit at a symmetrical position of 108,000,000 kilometers from the sun, three-quarters the distance to her sister Earth. According to Harleston, the "arrow," that the Aztec said Venus launched, returned to her as a gravitational field, and she bounced sunward, stopped her clockwise spinning, and began to revolve backwards in retrograde rotation. Thereafter a dead planet, her incandescent atmosphere slowly cooled enough to have a temperature of boiling oil.

In this legend, Terra, the planet with the iron heart, was not light-headed like Quetzalcoatl, the hollow moon that arrived from the *west* (an orbit farther away from the sun), so she now deviated in her orbital circling only six percent. As Schlemmer reconstructs the tale, rotational rates may have varied, along with polar inclination, as the differences caused climatic changes, worldwide macroearthquakes, rains of meteorites, floods, and general havoc that remained engraved in the subconscious memories of the survivors.

Geoffrey Hodson, the psychic Theosophist, using what he calls "etheric vision," was able to spot an intra-Mercurial planet postulated under the name of Vulcan by astronomer Urbain Leverrier, who successfully predicted the discovery of Neptune. Using Hodson's and Leverrier's data, another astronomer, George Sutcliffe, was able to determine an orbital period for Vulcan. According to Sutcliffe, Vulcan can only be seen on very rare occasions of its transit as a small black disk over the sun's face because it radiates and reflects only deep infrared radiation.

In Dr. Muses' analysis there is room for just one such planet orbiting between Mercury and the sun, with a period of 42.9 days, but there has been little systematic search for Vulcan because of observational difficulties due to its proximity to the sun.

Surprisingly corroborative evidence for Harleston's figures then came from his friend Alfred Schlemmer, who for years had been analyzing the recurrence of large-scale earthquakes around the globe, keeping records of where they occurred and how big they were. From this accumulated data Schlemmer established to his own satisfaction that tornadoes and earthquakes repeat in cycles in a broad band around the world, cycles which he says are conditioned by the effect on the earth of the several motions of the other bodies in our solar system, motions called torsional because of the twisting effect they have on the earth as it rotates on its axis and revolves around the sun. When the moon, for instance, is at perigee (closest to the earth) every 27 1/3 days, its pull on the earth increases by 6 percent. The constantly differing patterns of planetary movements cause great torsional pull on the earth's crust, as does the sun's varying gravitational field, all of which cause earthquakes.

Curious to see if the periodicity of the earthquakes had anything to do with the length of the earth's rotation on its axis, measured in either tropical or sidereal years, Schlemmer came up with a list of thirty-eight numbers which appeared to be constants. By using a tropical year of 365.242189 days and dividing it by 1440, the number of minutes in a day, Schlemmer obtained the number 0.2536404097, by means of which he was able accurately to extrapolate orbital distances for the planets; he was also able to conjecture the theoretical existence of six additional planetary shells between Mercury and the sun, which may or may not be occupied by condensations called "planets" or merely by rotating fields, with the first three either non-condensed or burned out.

To Harleston and Schlemmer's surprise, nineteen of Schlemmer's constants coincided with numbers obtained by Harleston along the Processional at Teotihuacan. They found this so remarkable, as might any reader of Arthur Koestler's *The Roots of Coincidence,* that they concluded that if anything they had underestimated the scientific capacity of the Teotihuacanos and the reach of their overall mathematical display. It looked to them as if their Teotihuacan constant of 1.059 might provide an index of orbital distance, while ϕ, or 1.618, might be an index of time, both incorporated into the laws of celestial mechanics.

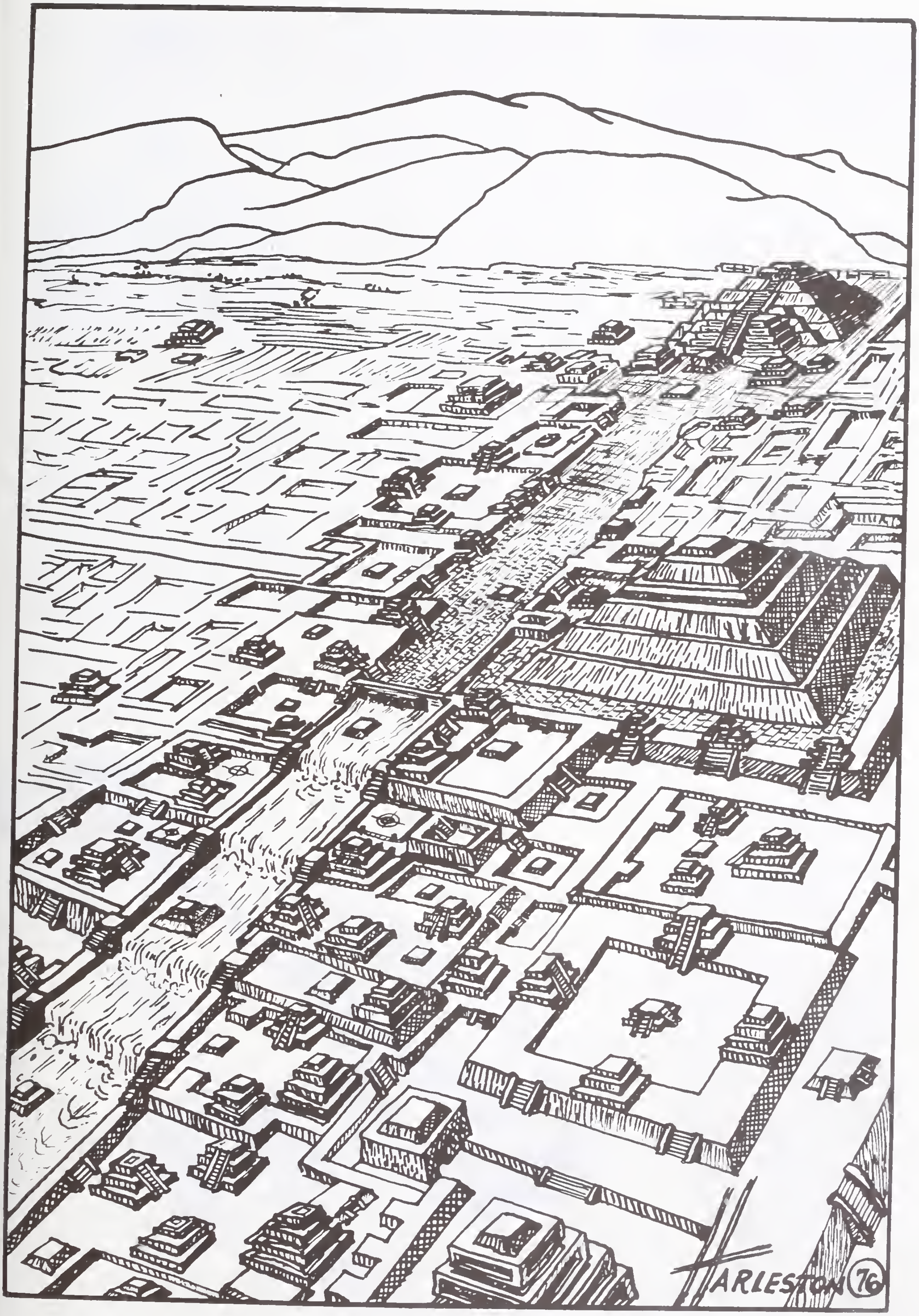
If repeating shell data could be validated by further outer space probes, Harleston figured there might be not one but two more planets beyond Planet "X," the first, Planet "Y," at 100 astronomical units, orbiting at an inclination of 2.09 degrees to the ecliptic, and Planet "Z" at 150 astronomical units, or 22 1/2 billion kilometers from the sun, at an inclination of 0.44 degrees.

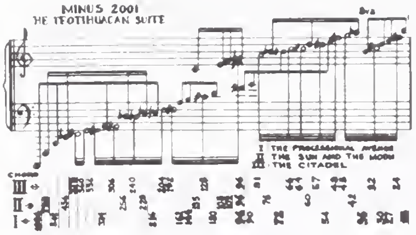
A further clue to the possible layout of the Way of the Dead came to Schlemmer from watching a pan of oil on a tractor in which standing waves of a very particular shape were being engendered by the simultaneous spinning and vibrating motion of the tractor.

Schlemmer figured that if an earthquake in one part of our spinning globe can cause standing waves to form on a liquid surface right across the planet, then the several walled-off levels of the Processional, whose lengths coincided with his torsional constants, could have been used as a series of reflecting pools, falling down from the foot of the Moon Pyramid to the area in front of the Citadel, like the pools at the Royal Palace of Caserta, near Naples, harmoniously designed to enable Teotihuacanos to read from the standing waves formed on them the location and strength of earthquakes around the globe, enabling them to predict such an occurrence in their own area. Harleston then figured that at a time when earthquakes appear to have been more frequent and more devastating, knowledge of the characteristics of resonant vibration could have permitted the Teotihuacanos to use the several pools as long-range seismic monitors. It could also be an indication that the modern penchant for laying out reflecting pools, like the raising of obelisks, may be just a hangover from an ancient science no longer understood. Certainly a series of reflecting pools with the Moon Pyramid in the background would have been as impressive a sight as the Taj Mahal; and in support of Schlemmer's theory, one can still see sluices at the foot of each of the partitioning walls along the Processional.

Spurred by this conceit Harleston could no longer be restrained. He suddenly saw the Teotihuacan layout as possibly containing clues not only to the planetary orbits and telluric convulsions, but to much more hermetic data. It occurred to

Harleston's romantic reconstruction of how pools of water could have cascaded from one to another down the Way of the Dead, fed by springs from Cerro Gordo. When sluiced from below and used as reflecting pools, Harleston and Schlemmer believe that standing waves generated in the variously sized pools by distant earthquakes could have served the Teotihuacanos as a form of seismograph.


HARLESTON 76

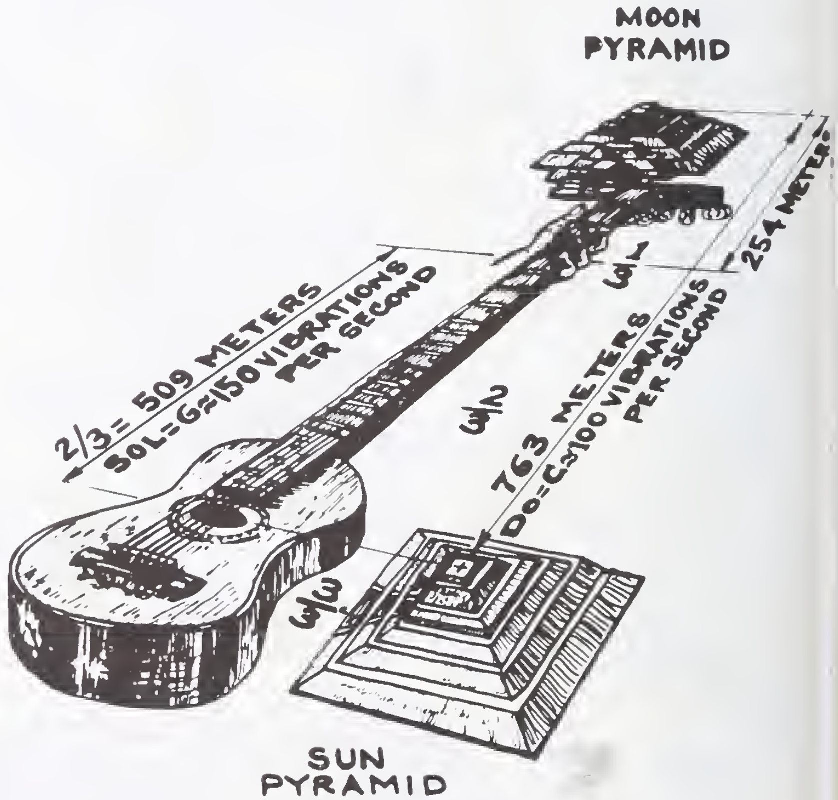


Harleston says the modular lengths of Teotihuacan can be compared with musical octaves. If the distance from north to south between the Sun and Moon pyramids were a huge guitar string 763 meters long, it can be imagined to sound a fundamental vibration, like a bass violin or the lowest note on the piano. He arbitrarily calls this tone C (or do). To sound the tone G (or sol) the guitarist would place a finger one-third of the way up the string 254 meters from the Moon Pyramid, and leave two-thirds free to vibrate. The string will oscillate one and a half times as fast as before.

Harleston found that the three chords overlap at one wavelength: 96 units, which he calls the relative orbital distance of the earth on the Teotihuacan planetarium. The orbital proportion of Mercury would then become what he calls the note B (or si) and one octave below it is Venus, while two octaves below represents Mars. To Harleston these are three base chords that might form the structure of a Teotihuacan suite.

When the proportional "notes" which corresponded to steps, walls, and buildings of the Processional, Citadel, and the Sun and Moon pyramids were converted to "chords" and diagrammed on paper, three great chords appeared, which, to Harleston's surprise, were just like the opening bars of Richard Strauss's *Thus Spake Zarathustra,* used by Stanley Kubrick as background for the opening of his motion picture *2001.*

Harleston that the Way of the Dead, as seen from the bird's-eye view of Acosta's mapping, might give the appearance of an enormous guitar whose frets were the walls of Schlemmer's reflecting pools. Could the Teotihuacanos, Harleston asked himself, have incorporated in their design of the great Processional an eight-note musical scale? Looking for "musical relationships" in the distance between the wall "frets," Harleston arbitrarily took as his note B (or *si*) the marker he had found for the relative orbital distance of Mercury. In this way an octave below it came Venus, and two octaves lower, Mars. But the distance of the markers did not quite work out, at least so long as he went by the frequencies of our "well-tempered clavichord," a scale worked out by Johann Sebastian Bach in which the mathematical frequencies are slightly corrected for the pleasure of Western ears and the convenience of orchestral scoring. Some of the notes were as much as four cycles lower than the mathematical frequencies displayed in the Teotihuacan measures. Then Harleston remembered that when he had first arrived in Mexico in the late 1940s he had been taken to the house of the Mexican composer Julian Carillo, who composed music in a different scale, one which he called "sound 13" because it divided an octave mathematically by means of the twelfth root of two, or what



Mexico's composer Julian Carillo.

Harleston says that as Teotihuacan yielded its secrets, one by one, he began to sense the sweep of its creator's vision. "At the lower level of the vibration, three major chordal sequences merge at a common note that symbolizes our planet's orbit: 96. At the intermediate range of the visible spectrum six balanced colors of light point toward the invisible vibrations beyond the range of our normal optical capabilities. And beyond this the sounds of our spiral universe are heard, as the evolution of an open-ended wave that becomes four-dimensional radial space and three-dimensional radial space and three-dimensional expanding time, the tetrahedron, and the sphere."

Harleston considered was the Teotihuacan constant, into thirteen equally spaced notes (or twelve intervals) with seven white keys and five black keys. In this system, each frequency multiplied by 1.059 gave the next half note, which, multiplied by itself, gave the next whole note.

Harleston found that Carillo's musical proportions, which produced a weird and exotic effect on the listener, turned out to be the closest approximations to the relationships of the measurements at the area of the Teotihuacan monuments.

Creation is certainly mathematical and harmonic, with physical relations such as the orbit of a planet, the pentagonal divisions of a fruit, the spiral growth of a vine, or the shape of a honey bee's cell, all expressible in mathematical terms: even the structure of bones, nerves, muscles, cells, molecules, and atoms, all appear to be governed by mathematical law.

Light, music, color, and even the table of chemical elements appear to be harmonically linked. Were the human ear capable of discerning sounds produced by chemical action, we might perceive a musical harmony, or better a symphony, in all forms of living. In the past, certain members of society may have had just such abilities.

According to Michael Heleus, an astrologer from St. Petersburg, Florida, who has developed a theory called "astrosonics," the actual motion of the planets as they orbit the sun makes sounds, or creates wavelengths, which affect a human being in different ways, more especially as they harmonize, or not, with the person's own birth chart.

By reproducing the various wavelengths of orbiting planets and raising these sounds sufficient octaves to be audible, Heleus claims to be able to produce in people astrological effects at will.

Like Orpheus, who was supposed to be able to charm any creature with his lyre tuned to the motions of the planets, Heleus says he can produce painful or pleasant sensations in humans. Gurdjieff also describes a broad gamut of musical effects, including the raising of boils on bodies with a tune.

Citing the stock example of a glass shattered by a singer's voice because it can only absorb so much energy on that wavelength, Heleus suggests that objects and especially buildings on this planet absorb and retransmit only if their proportions are earth-commensurate or harmonize with wavelengths from the cosmos. He believes the yard, the foot, and the inch are more in tune with telluric and cosmic forces than the inadequate meter.

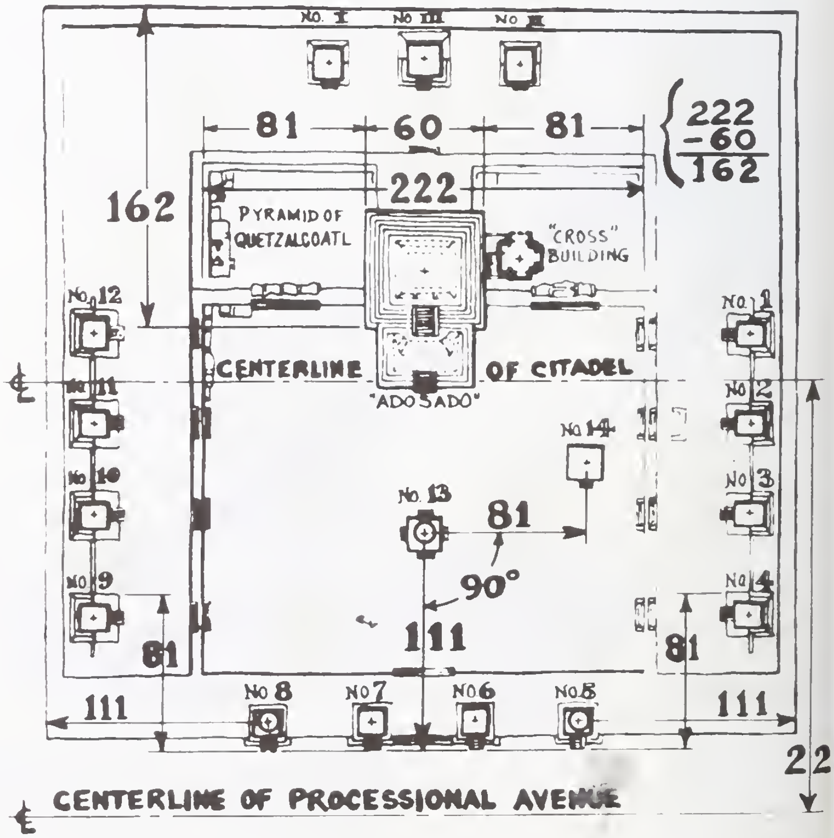
There may even be wavelengths and receptive shapes which together generate natural growth and reproduction—effects attributed to the ϕ proportion—as opposed to other wavelengths and shapes which restrict or enchain.

Harleston next saw the Teotihuacan layout as possibly giving clues not only to wavelengths of the structure of the immediate world of sound, heat, color, smell, and touch in which we live, but also to the wavelengths of light, the micro-universe of atoms, and the macrouniverse of galaxies.

Whether it was known or not to the designers of Teotihuacan, Harleston realized that the constant of 1.059 controls not only the frequencies of sound but those of light. If visible light is divided into six basic colors from ultraviolet to infrared, omitting the arbitrary indigo, the frequency of each succeeding color is obtained by multiplying by 1.059 or its square. The seventh frequency at either end of the band of light remains invisible. Harleston found other phenomena such as the fact that when the color orange is multiplied by 1.059 it gives the wavelength of the helium-neon laser.

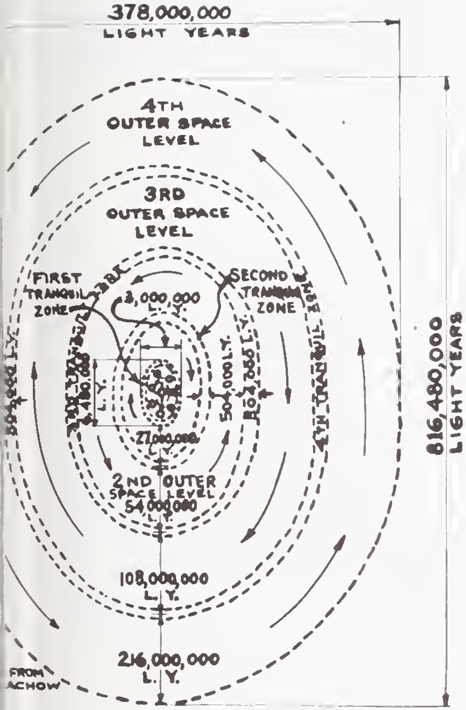
Schlemmer's symmetrical series for the orbiting distances of planets, says Harleston, can be reduced proportionately all the way down through the interior of the sun and finally to atomic configurations, indicating that Teotihuacan may also have been a display of cosmic data.

Of the whole numbers which Harleston considers to be deliberately displayed along the Processional, he was puzzled by 148 till he divided it by 4 for 37. Closer inspection of the



The Hydrogen Constant.

When a physicist tries to calculate the optical properties of a material or the way an object will behave in the presence of light, the hydrogen constant, or 1.37037037, enables him to make his experimental results fit theories which may be largely based on incorrect assumption. The constant, says Harleston, should be particularly useful when humans will have to cope with very large amounts of energy.



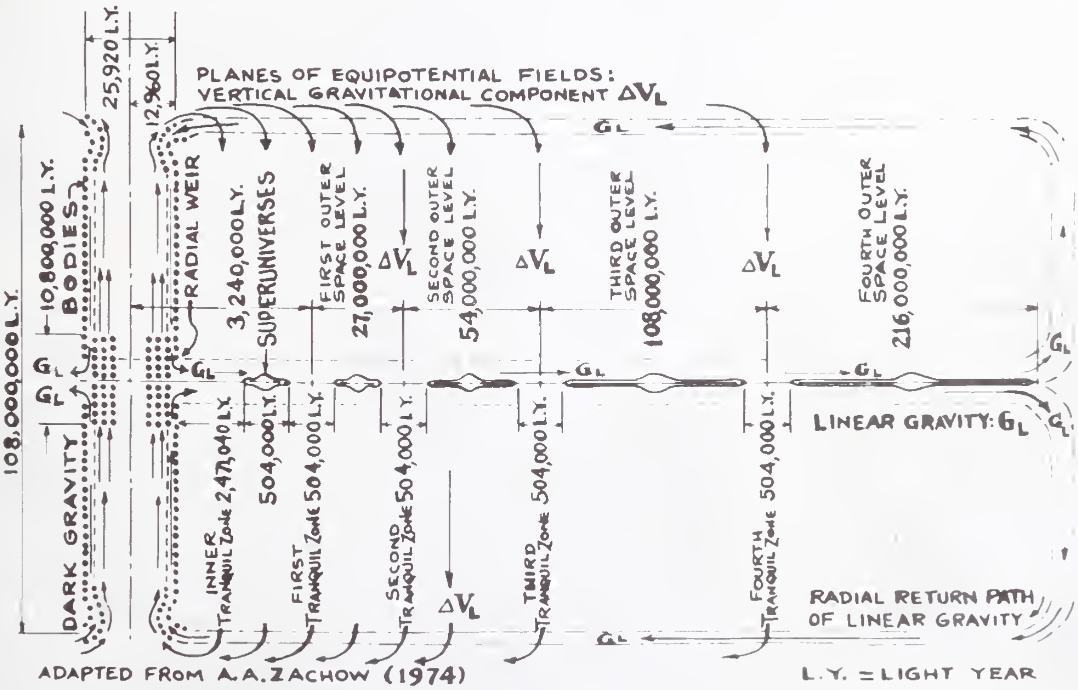
Harleston's adaptation of A. A. Zachow's logarithmic plan of the Grand Universe.

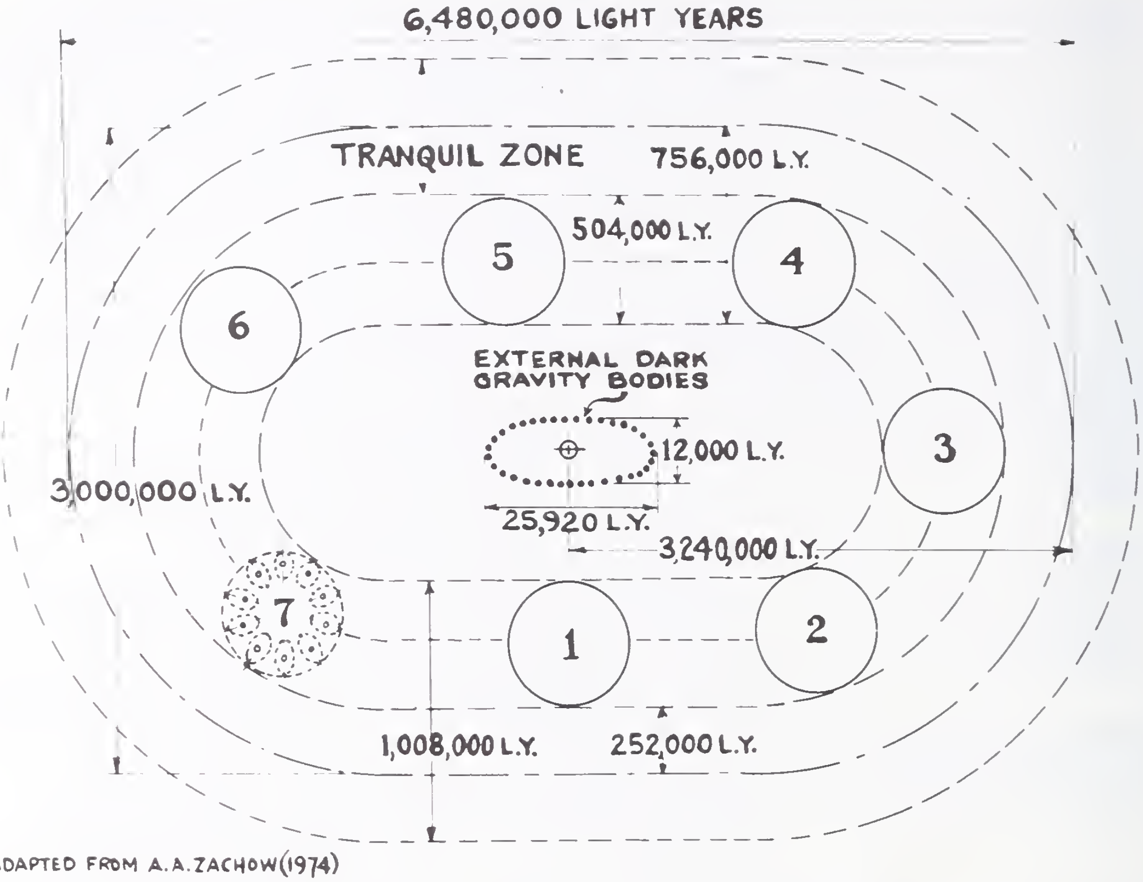
Citadel showed Harleston that the west platforms were located 111 *hunabs* from the north-south ends—that is 3 × 37—and the Citadel's central patio was 222 units or 6 × 37. Searching for some meaning to this apparently intentional indication, it was some time before the relationship of 37 to 27 came to him. In twentieth-century physics, 37/27 or 1.370370370, with the 037 continuing indefinitely, is the physical constant which forms the connection to the level of the atom. Multiplied by 100, this number is the average fine constant for hydrogen and deuterium, published in 1972 by the Bureau of Standards in Washington, D.C., a basic datum, says Harleston, for eventual macroenergy management.

Such a built-in datum appeared to him to be another indication that seen from another dimensional point of view the Teotihuacan complex contained vital physical data about the energetic and geometric makeup of the cosmos.

Harleston quotes the cosmology of A. A. Zachow, who postulates seven superuniverses that follow an elliptical path around dark gravity bodies, known as "black holes" by today's astronomers, to show that the Teotihuacan parameters could also relate to the structure of the *macro* universe. The cosmology of Zachow implies that the proper motions of nearby suns seem to indicate centroid positions that are "intelligently directed," and that this would suggest that stars, as well as star groups and galaxies, may be found to be located on symmetrically repeating orbital shells when future analyses permit the comparisons to be made. As each of Zachow's superuniverses contains seventy-two galaxies,

Zachow's transverse section of the Grand Universe.



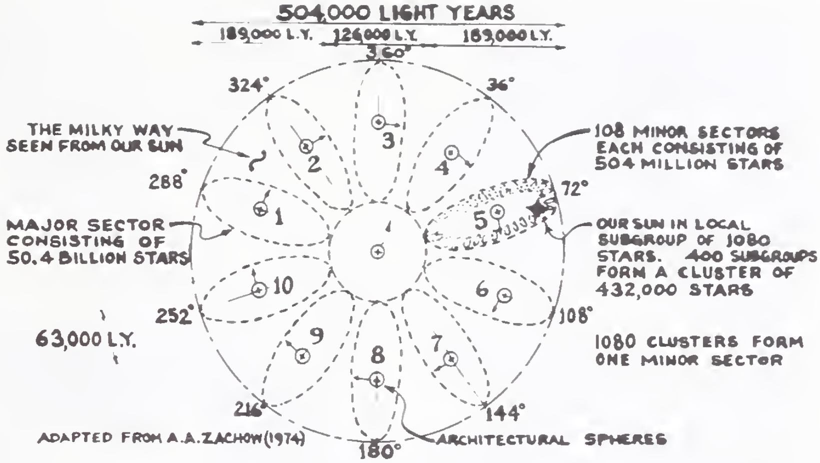


Zachow's plan of the Super Universes.

which cause our sun to experience seven distinct directions of motion through the superuniverse, Harleston surmises that the Teotihuacan standard unit of measure, or *hunab,* may be a natural unit of space-time. The selection of a measure that unifies space and time taken from a stable planetary dimension (such as its polar diameter), says Harleston, gives the advantage of enabling one to see cosmic relationships such as orbital symmetry in a simplified manner. He believes it most likely that the same proportion would exist on all planets, and suggests that the $\sqrt[12]{2}$ of the diameter would give a unit of measure appropriate for that orbit, correctly relating it to the unit and diameter of all other planets.

The angles and perspectives in the Teotihuacan layout appear to Harleston to show the framework of an integrated earth and heaven—along with the megaspace of the heavens above—as being the work of a master mathematician. To Harleston the messages of Teotihuacan point to a new way of looking at time and space, and to some new source of energy from the cosmos, some new field fabric that our science has not yet isolated. He believes that if Teotihuacan could express knowledge of cosmic relationships erected in the form of a ceremonial center, the whole complex could have served as a university. The ceremonial center, whose architecture exhibits

Zachow's view of our Super Universe.



information such as the rotational distance moved at the equator in a given time, plus positional latitudes and longitudinal distances of rotation, could have been used as an educational center for geodesy and navigation.

To Harleston the Teotihuacan messages are timeless concepts which could teach the student to reach beyond himself to a larger vision of the relationship of man to the cosmos and of man to himself as knower and perceiver. He says the overall information of Teotihuacan presents logical relationships so simple that the basic principles can be learned in a day; from these principles cosmic information can be deduced. "It is as if the Teotihuacanos," says Harleston, "had wanted to provide a method of teaching cosmic truths so simple that, once learned, the survivors of some unforeseen cataclysm could rebuild the knowledge from memory."

Harleston says that once the student at Teotihuacan learned the important values of thirds, sevenths, and ninths, and that squares and square roots were basic mathematical tools, the next step was to understand the relationship in space of two simple geometric solids: the sphere and the tetrahedron.

It was some time before Harleston found the clue to a tetrahedral geometry incorporated into the Teotihuacan complex, but he finally found it in the dimensions of the Pyramid of the Sun. Unlike the Pyramid of Cheops, which is a very exact scale model of the Northern Hemisphere (with the apex as the North Pole, the base as the equator, and its perimeter equal to one-half minute of arc), the Sun Pyramid does not fit such a system; it does, however, very accurately give the entire surface of the earth.

Harleston divided this surface into four great circles, making four great spherical triangles, each of which corresponded to the area of one face of the Sun Pyramid. This solution brought with it the question of how and why the Teotihuacanos should have chosen such an apparently complex system. That is where the tetrahedron came in.

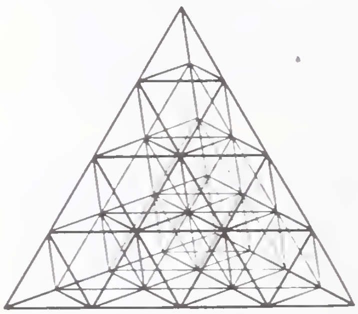
Harleston finds it significant that if you stand a tetrahedron on its nose at the South Pole it will form three triangles above the equator splitting the world into four equilateral great-circle triangles which will exactly divide into areas of 1/3 above and 2/3 below the equator.

A Teotihuacan sphere whose diameter is 12 will give an area of 144 π, a quarter of which is an easily reckoned 36 π, and so forth. Again all the numbers run in a 3, 6, 9, 12, 24 series, unique with a sphere of diameter 12.

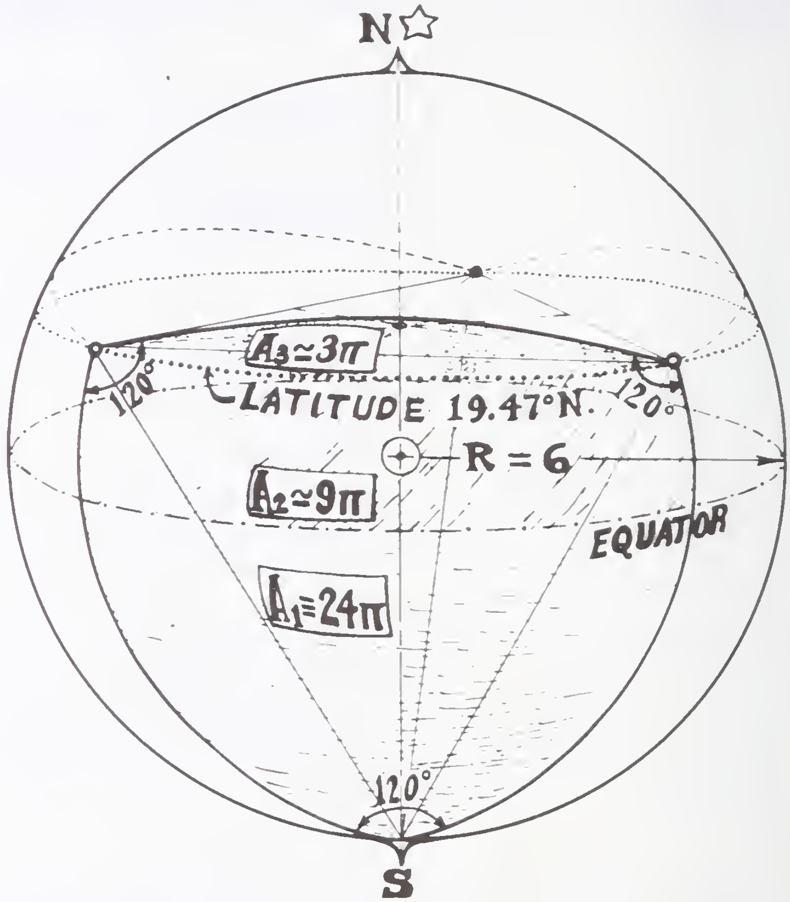
The tetrahedron, simplest of the five Platonic solids, is a perfect pyramid, a geometrical figure that represents the smallest number of points that will form a solid in three-dimensional space. It is constructed by uniting four identical equilateral triangles at their edges to form a body with four nodes, four faces, and six edges.

Harleston points out that the abstract properties of such a six-edged tetrahedron involve functions of 3, 6, thirds, square roots, and the number 1.06, all emphasized by the Teotihuacan displays.

When he inserts the tetrahedron into a sphere of diameter 12 some extraordinary relations develop. When the diameter of the circle is 12 (and therefore its radius 6), the ratio of the area of the sphere to the tetrahedron is 2 to 1. This is the only case in which this significant correlation occurs.



R. Buckminster Fuller's isotropic vector matrix.



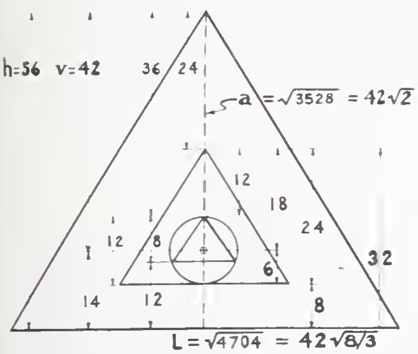
The four points at which the great circles meet form the nodes of a tetrahedron inscribed in a sphere. This apparently casual relation showed on closer inspection that an extraordinary and unique relation exists between a tetrahedron and a sphere whose diameter is twelve, one from which cosmic data ensues.

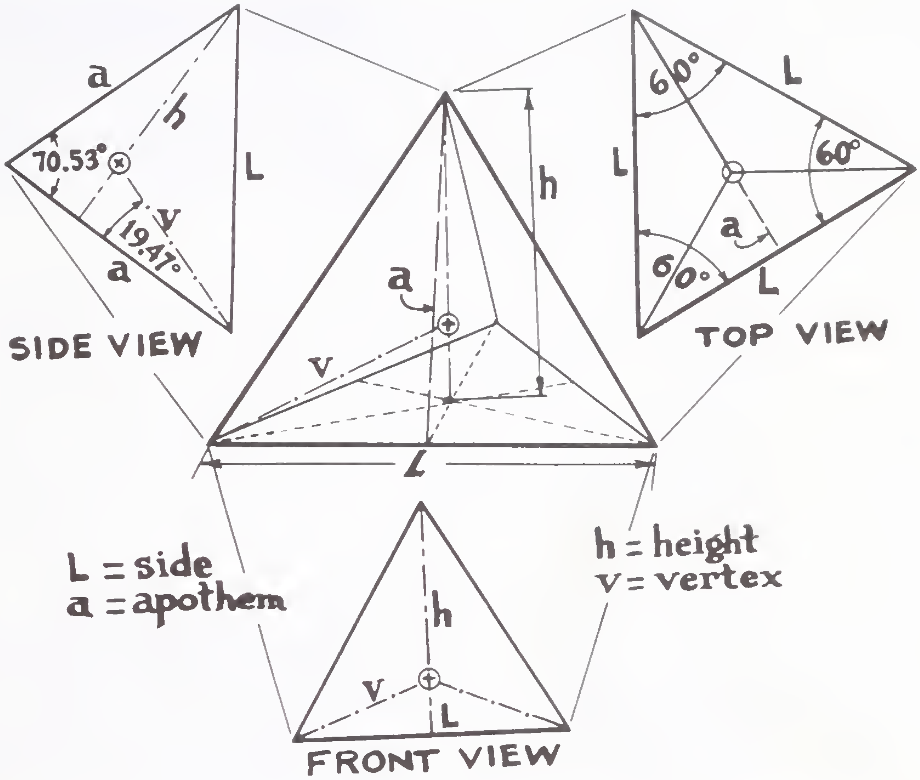
Oddly, or coincidentally, the relation between a tetrahedron and a sphere constitutes the thrust of the work of Buckminster Fuller, who, in his book *Synergetics,* maintains that the tetrahedron gives the basic mathematical blueprint for the universe.

From what he calls his "isotropic vector matrix" Fuller obtains a constant of $\sqrt{9/8}$, which comes to 1.06066, so close to Harleston's 1.059 constant that it fits the Teotihuacan complex virtually as well.

The difference between them—a mere one part in a thousand—produces a difference in length of less than 1 meter in the 800-meter overall distance between the Sun and the Moon pyramids, and less than 10 meters on the overall length of the entire Valley of Teotihuacan, differences easily absorbed by Harleston's own postulated margins of error.

The regular tetrahedron.





A tetrahedron whose height is 12 is demonstrated by Harleston to have a side that equals the square root of 216, the length of the base of the Sun Pyramid, which is 6 × 6 ×6 or 6 cubed.

The height of an equilateral triangle of 216 base will be the square root of 3 × 6 × 9, or 162, the length of the Moon Pyramid.

If a larger tetrahedron is selected so that the sphere exactly fits inside it with the surfaces of the sphere touching the centers of the four faces of the tetrahedron, then the characteristics of the superscribed tetrahedron will be exactly three times the values for the one inscribed within the sphere, and its height twice the diameter of the sphere.

Harleston is impressed by the fact that the side of the tetrahedron's apothem, or slant height, as well as its area and its volume, are all multiples of 216—the side of the Sun Pyramid in *hunabs.* The ratio of the volume to area of this tetrahedron equals 2 to 1, the same as for the sphere of radius 6 it encloses. All the above numbers are major Teotihuacan dimensions. Harleston considers the tetrahedron to be fundamental to the message of Teotihuacan. A tetrahedron inside a sphere will have linear properties that are 1/3 of the tetrahedron surrounding the sphere.

Pointing out that the carbon atom—which is the basic building block from which the material bodies of all living organisms are made—is a regular tetrahedron, and that the water molecule has characteristics that conform to the tetrahedral structure, Harleston concludes that the fundamental message conveyed by the Teotihuacanos is that the physical universe is tetrahedral from the microscopic level of the atom all the way up to the macroscopic level of the galaxies on a scale of vibrations in which man stands about the center. Man would thus have built into him, as suggested by Pythagoras and Plato, the tool for unlocking the geometry of the cosmos and recovering the knowledge of his role in the scheme.

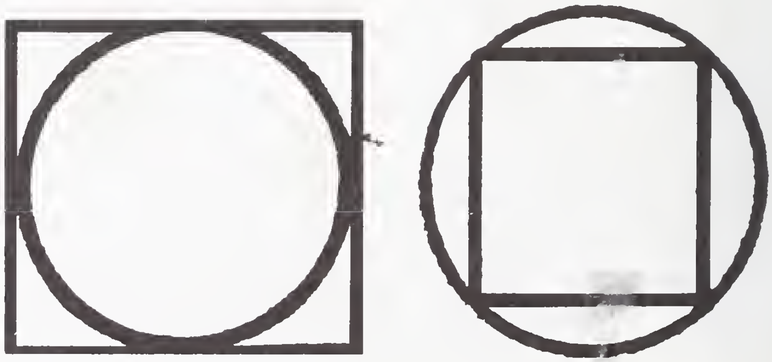
What evidence is there that the ancient inhabitants of Mesoamerica had sufficient physics, mathematics, and knowledge of the cosmos to leave such a message?

20. Wisdom of the Ancients

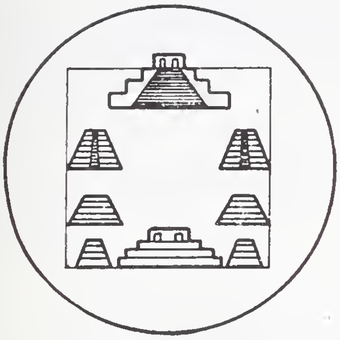
The most explicit Mesoamerican text on the origin and mechanics of their universe is the Quiche manuscript of Chichicastenango, better known as the *Popol Vuh,* which slips gently from a description of the physical world of men to a description of the spiritual entities and elementals which produced it.

In a carefully reasoned analysis of its text (which translates from the Spanish as *The Popol Vuh Is Right!*) the distinguished Maya linguist and philologist Domingo Martinez Paredes concludes that a very old and very highly developed culture existed on the American continents whose cosmogony agrees very closely with modern hypotheses about the origin of the universe and of its evolution.

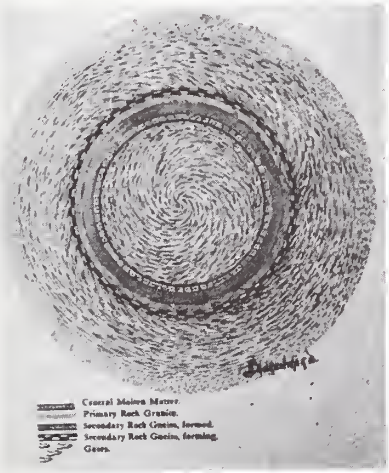
According to Martinez the Maya came to the mathematical certainty of the existence of a cosmic consciousness which they named "Hunab Ku," sole dispenser of measurement and movement, to whom they attributed the mathematical structuring of the universe. This divinity they represented by a circle in which was inscribed a square, just as did Pythagoras.



Hunab Ku, sole source of movement and measure, symbolized the universe for the Maya in the form of a circle with an inscribed square. The circle was the symbol of the infinite, the spiritual; the square of the material. Hunab Ku was thus a universal dynamism or that which motivates and stimulates life in its total manifestation as spirit and matter, the all in one. Martinez points out the similarity between the Mayan Hunab Ku symbol of a square in a circle and the Masonic symbol of the Great Architect of the Universe: the compass and the square. Martinez says *Hun* means sole or single in Mayan, *Naab* means measure, and *Ku* means giver.



According to Martinez, the central ceremonial area of a Mesoamerican pyramid complex was made in the form of a square circumscribed by a circle, symbol of Hunab Ku.



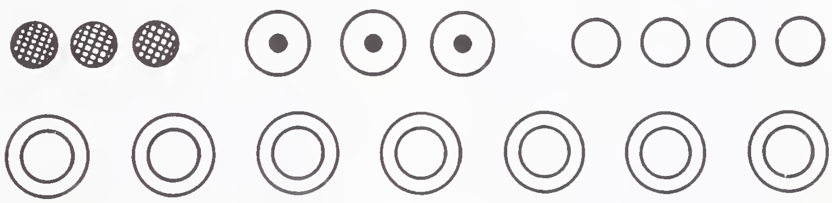
The Maya believed the world had been formed from a condensing nebula, here seen in Churchward's rendering.

The Maya believed that their supreme divinity functioned through a principle of dynamic dualism, or polarity, active and passive, positive and negative, masculine and feminine, by which, through the agency of four prime elements, air, fire, water, and earth (symbolizing space, energy, time, and matter) the whole material world was engendered.

The Maya conceived of the earth as having been formed from a nebula through the combination of fire, water, and gases which produced "solid" matter. Their name for the lesser deity of creative energy was Can or Kan; and Huracan was the rotary vortex which made possible the condensation of primordial elements by incorporating them into a nucleus, thus reintegrating elements disintegrated by Chaos. Gucumatz was water, Tepeu was fire, and the four elements symbolized by a square also represented matter in its four states: plasmic, gaseous, liquid, and solid.

The Maya considered every element in nature to be a cooperator in cosmic harmony, bound by its own vibrations into geometric form, a form which changed in type and quality as the vibrations changed. Modern science, Martinez points out, has found that no cell, no molecule, whether animal, vegetable, or mineral, escapes geometric form.

To the Maya the earth was not a corpse, it was neither dead nor inert, but a living entity intimately tied to the existence of man both physically and psychically; they knew that by laying their naked bodies on the earth they could revitalize their forces. They saw that trees and water constantly purified and revitalized man, as part of the cosmic order.

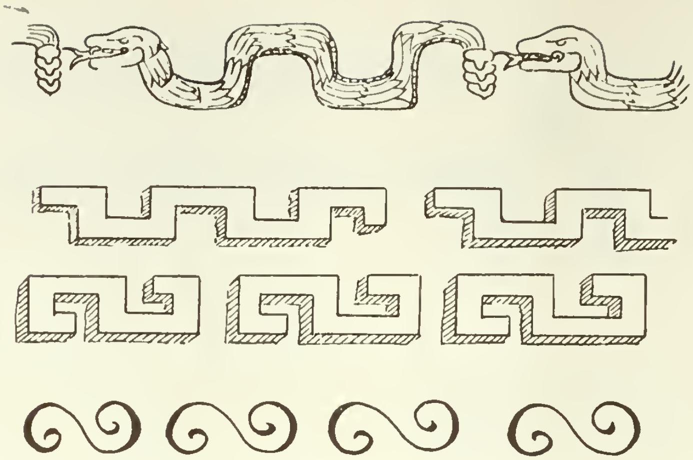


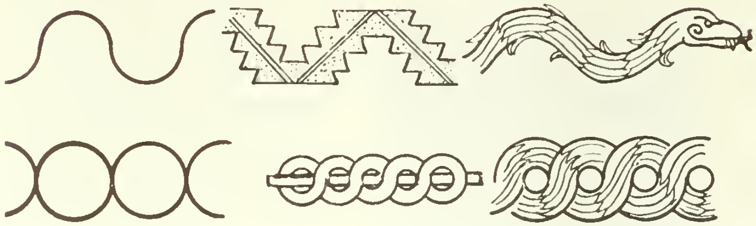
The Mexican mathematician Hector M. Calderon says that a people as sophisticated mathematically as the Maya would have had to incorporate its theogonic concepts into actual numbers, using the latter to express their ideas about the universe. He gives as examples Tzacol, the creator, as 1; Kukulcan as 2; Bitol, the fashioner, as 3; Alom, the female cosmic progenitor, as 4; Cajalon, the male progenitor, as 5; and Tepeu, the governor, as 6. All, were considered part of Hunab Ku, the primordial source of movement and measure.

Tzacol as 1, the creator, was considered a supernatural originator of energy, time, space, and matter. Creation, says Calderon, was considered foreign to the law of the conservation of energy, and nothing could be created or destroyed, only changed.

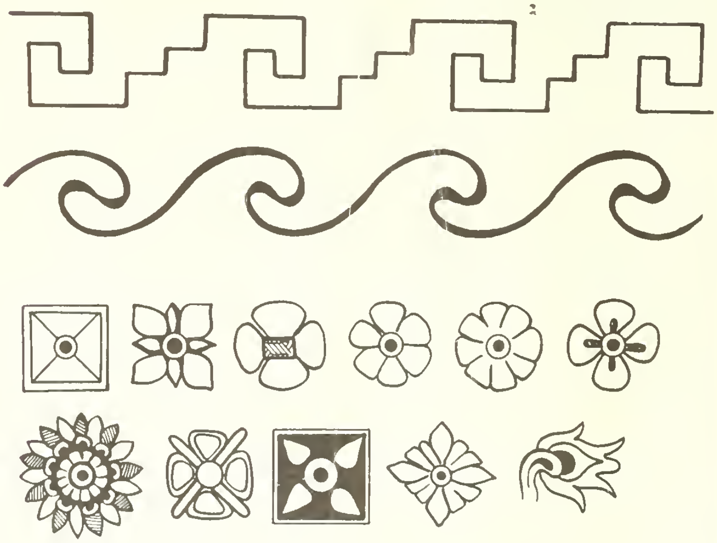
The Maya symbolized 1 by a point which, depending on its position, could increase in value to the infinite.

Number 2 was Gucumatz or Kukulcan or Quetzalcoatl, the airy plumed serpent symbol, the feathered part of which represented the spiritual and abstract, whereas the snake was the earthly and palpable. It represented the spirit-matter duality of the universe.





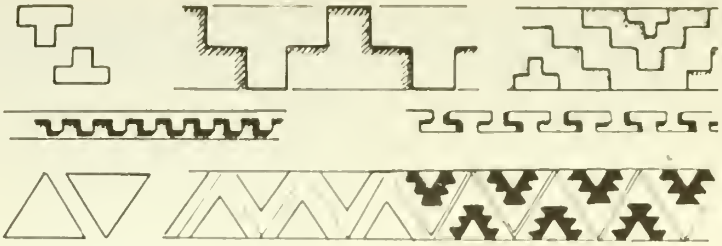
In all of nature the Maya saw countless combinations and manifestations of primordial forces which they incorporated into their architecture as geometric designs and represented by a host of nature spirits; yet they did not violate the basic notion of a single creative principle, a ubiquitous supreme dual god who created itself and all that exists.



Number 3 was Bitol, the Maya formulator, modeler of the clay of creation into countless evolutionary patterns of ever greater complexity. Its symbol was the wave, the basic giver of shape to the universe, a wave half evolution and half involution as it was represented by the Maya in their architectural designs. It symbolized the polarity or motor principle of the cosmos, which, from atom to star, is positive-negative—the latter not necessarily worse, just opposite, as gravity is to levity. Numerically, the 3 was derived from 1 plus 2.

Number 4 was Alom, mother of life, whose symbol was the flower, which receives the fecundating pollen; it is mother earth, which receives the grain of corn and the fertilizing rays of the sun. Its symbol is fourfold or a square. Cajalom, 5, is the father of life, or ⁚·⁚ the sun at its zenith, bathing the earth with fecundating energy. Its symbol is the celestial cosmic cross, four points with a central sun, which becomes ⁝·⁝, or 7, with the addition of East and West and the enlivening rain. For the Maya, 13 was the sun amidst the 12 constellations of the zodiac.

Calderon shows how Tepeu, the governor, who puts order into the furthest reaches of creation, was represented by the Maya as the number 6 or 3 and 3, a series of interlocked Taus, "as above so below," "synthesis and antithesis."



To the Mesoamerican everything was possessed by a "respected spirit." Not only the mineral, plant, bird, animal, and human kingdoms, but the mountains, clouds, and stars—all were possessed by invisible forces of life, the spiritual components of outer physical forms. These forces, or primordial images, were represented by men wearing strange anthropomorphic masks.

Itzamna, head of the Maya pantheon.

Kukulcan, the wind god.

Chac, the rain god.

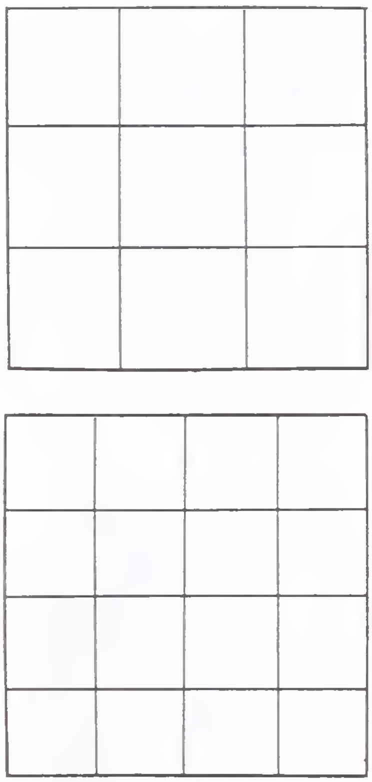
The god of sacrifice.

Like the Hindus, the Maya postulated rhythmic astronomical cycles as a result of which great civilizations appeared and disappeared, cycles that the priests maintained they were aware of and could understand through their mathematics, astronomy, and astrology.

The basic Mesoamerican chronology envisaged four great eras or world periods before the present or fifth world in which they lived. They believed that each of the previous worlds had been destroyed—the first by jaguars representing earth, the second by air, the third by fire, the fourth by a great flood. The fifth, they prophesied, would be destroyed by a cataclysm of earthquakes.

Ixtlilxochitl, writing in the sixteenth century, concluded from his study of Nahuatl sources that the creation of the Fifth Sun occurred in 3245 B.C. But the preponderance of modern experts on Maya chronology, following Herbert Joseph Spinden's correlation, project the beginning of the Great Maya Cycle back to August 12, 3113 B.C.; they interpret the Maya prophecies to indicate the end of this fifth world will come on December 24, 2011 A.D., when the earth is supposed to be destroyed by catastrophic earthquakes.

At the end of his remarkably erudite and sensitive book *Mexico Mystique, or The Coming of the Sixth World Consciousness,* Frank Waters has attached an appendix by an astrologer, Mrs. Roberta S. Sklower, who has computed the probability of the particular arrangement of the planets which occurred in 3113 B.C. taking place only every 4500 years. As for the arrangement in A.D. 2011, she estimates it can occur once in 45,200 years, which led Waters to remark, "From this extraordinary pattern we might well expect an extraordinary effect."



Calderon shows how the Mayans used a checkerboard or mat, lined in nine or sixteen squares, to perform the mathematical operations of addition, subtraction, multiplication, division, and the finding of square roots with a minimum of effort and without having to memorize a complex multiplication table.

The notion that the earth is periodically destroyed was not restricted to Mesoamerica. Heraclitus and Aristarchus both concurred, as did Hesiod, who recounted the destruction of previous worlds; Hindus, Tibetan Buddhists, and Persian Zoroastrians all shared the notion.

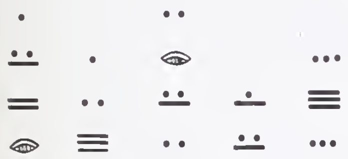
Convinced that nature was governed by cyclical laws, the Maya believed that everything could be foreseen—providing you understood the numbers which lay beneath the manifestations.

Nor were they mean mathematicians. Thanks to a checkerboard system, the Maya were able to handle very high numbers with little effort. Their system was so simple a child of four could multiply, divide, and obtain square roots without having to memorize a multiplication table; yet so versatile was the system that a housewife could manage her budget, and an astronomer could plot the centennial motion of the stars so as to calculate the arrival of a new eclipse.

The Maya knew our $+$, $-$, $=$, $\div$, and $\times$, but their zero was not a symbol for nothing: it represented completion and the seed from which all could be derived.

In his *La Ciencia Matematica de los Mayas,* Hector M. Calderon, a Mexican engineer who carefully analyzed the

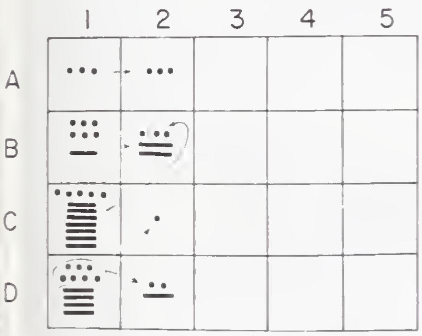
To add the following Maya columns of numbers:



11,000 455 16,142 127 1,503

add = 29,227

The Maya moved them all together by adding each column from the left, properly adding each square and moving upward any excess over 20.



The result

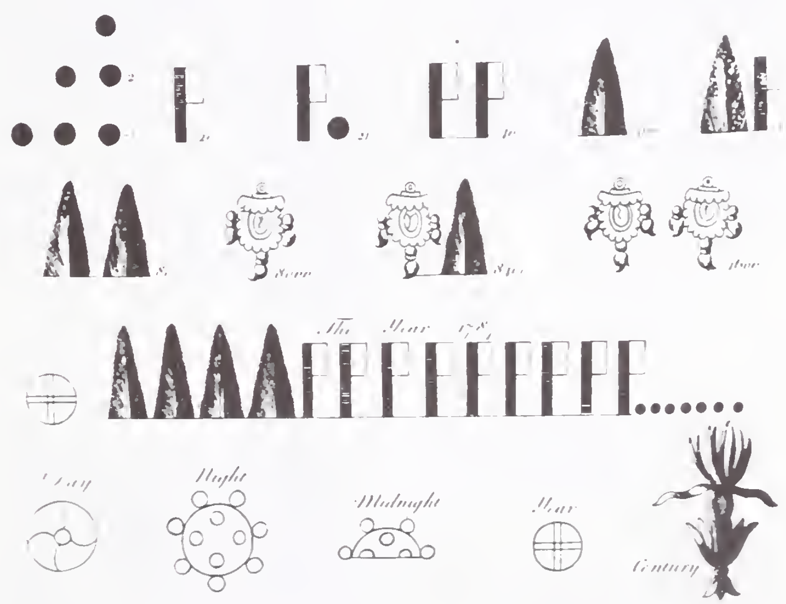
= 3 × 8000 = 24,000
= 13 × 400 = 5,200
= 1 × 20 = 20
= 7 × 1 = 7

29,227

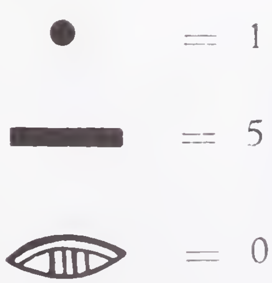
Mayan system of mathematics, says the Maya were able to resolve complex mathematical problems, perhaps several millennia before Christ, by means of a very simple system of grains of two colors to represent the numbers 1 and 5, placed in various positions on a checkerboard which they could draw on any flat surface. By means of these boards—represented on their monuments, paintings, clothes, and mats—the Maya were able to handle their chronology, astronomy, engineering, and architecture.

Calderon points out that what the Maya were using was a technique of metrical calculation only redeveloped in the middle of the past century, a system which for centuries was lost to humanity when the use of the checkerboard degenerated into sorcery, augury, and a simple game. He also points out that the universality of abstract numbers, a concept expressed with such insistence by the Maya in their ornamental boards, has only been repostulated in our century with dimensional analysis and the laws of similarity.

It is easier to picture numbers and their interrelationships with groups or sets of points than it is to do so with our symbolic figures.



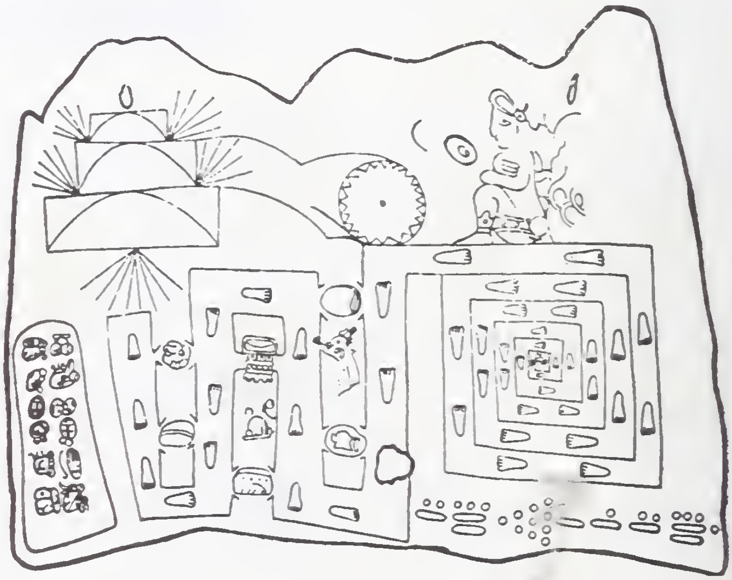
Aztec numbers.



Maya numbers.

Science, says Calderon, has now recognized that in the internal mechanisms of all phenomena there are certain mathematical relations which are independent of space, time, and the mass in which they are manifested. The recent rediscovery of this principle has made possible the deduction of several fundamental equations in every order of human knowledge. Thanks to these equations, says Calderon, there now exist hydraulic modules and constructional analogical computers for the rational compilation of statistical data. Now, for instance, it is possible to use a flow of water through an arrangement of levers and pivots to arrive at the results of a mathematical computation.

Calderon says the Maya identified man with the cosmos and created a school of philosophy based on the symbolism of numbers many centuries before Hermes Trismegistus or Pythagoras. Martinez says the Porrua Codex depicts the integration of man into the cosmos with symbols for one and zero to his right, left, and below him, in a square composed of calendrical hieroglyphs and numbers. The man holds a female serpent in his right hand and a male symbol in his left, interpreted by Martinez as man, time, and space.



Martinez points out how this "peregrination" from the Porrua Codex perfectly interprets the serpentine movement and the circle over the square, admirably depicting man and the cosmos. All took place within two geometric forms, the circle and the square.

Quipus, or knotted cords, used by Indians, Aztecs, pre-Incas, Mexicans, Egyptians, and Chinese as mnemonic devices like the rosary of the Catholic Church for recording and remembering long periods of history. The mathematical board with black and white pieces was used to make advanced mathematical calculations. Calderon says that throughout the Americas a similar if not identical system of mathematics, using colored beans or stones on a checkerboard, was employed before the Spanish conquest; he also points to the coincidence that our word for calculate comes from the Latin *calculi,* meaning little stones.

The great 260-day *tzolkin* calendar of the Maya known as *tonalamatl* by the Aztecs, showing grouping of lunar dates in three sections.

Intuitively considering the earth to be part of a whole, affected by the cyclical movements of the sun, moon, planets, and stars, the ancient Mesoamericans searched for the laws inherent in their recurring positions.

Well aware, long before the birth of Christ, that the foundations of chronology lay in the daily rotation of the earth on its axis and in its yearly revolution around the sun, Mesoamericans divided their year into 360 days plus 5 extra on regular years and 6 on leap years or 13 every 52 years.

On this point there is some discussion. Michael D. Coe of Yale University is categoric in his assertion that "there is no evidence that the Mesoamericans ever intercalated days or leap years." According to Coe, because the tropical year is 365.2422 days, the 365-day "vague" year simply gained on the seasons by a factor of 13 days every 52 "vague" years. But the fact remains that whatever system the Mesoamericans used, the result was a calendar more accurate than ours.

Calculating the orbit of the earth about the sun as 365.2420 days, the Maya marked the close of a year by the erection of a stone they called a *tun*. They did likewise for a twenty-year cycle or *katun,* a period they considered to be governed by the conjunction of Jupiter and Saturn.

Furthermore, they marked the passage of years by means of four distinct systems which acted as checks on all the others. Along with the year of 365 days and the more accurate tropical year of 365.2420 days there was a year of 365.25 days (the Egyptian Sothic year, whose .25 fraction was useful for the calculation of equinoxes, solstices, zenith passages, eclipses, and Metonic cycles), a lunar year of 354 days, and a very special "sacred" year of 260 days called *tzolkin* by the Maya, and *tonalamatl* by the Aztecs.

This special 260-day calendar, which has been called "one of the greatest jewels of human talent of all ages," was divided into 13 months of 20 days, and the multiples of 13 and 20 became the heart of a chronological computation "stunning in its simplicity and exactness."

On a monthly basis, twenty day names of the month were linked to the numbers from 1 to 13 to produce 260 different arrangements, such as 1-alligator, 2-wind, 3-house, 4-lizard.

A day with the same name and number could therefore recur only once every 260 days, forming a cycle which could repeat endlessly without regard to the actual movements of the sun and planets, which marked the natural time periods.

A greater cycle of 260 years was 13 consecutive Jupiter-Saturn cycles of 20 years, each one of which was considered to have a different quality depending on the series of angles formed between Jupiter and Saturn during each *katun*.

This sacred calendar was used as a divinatory almanac or *Book of the Good and Bad Days,* a *Book of Fate* rather than a calendar dependent on the seasons.

Each day of the *tzolkin* was governed by a deity who was thought to influence that day for good or evil, each separate day being regarded by the Maya as an individual god, whose glyph was a stylized portrait of his attributes. The numbers 1 to 13 were also personalized as the heads of the gods they represented.

A baby was given the name of the day on which he was born. The name of Cortes' mistress, La Malinche, for instance, was a corruption of Ce Malinalli, or "1-grass."

The imposition of this 260-day calendar was in no way arbitrary. The Mesoamericans had figured out correctly that 260 × 18 is the same as *360* × 13, that 260 × 7 is the same as *364* × 5, that 260 × 73 is the same as *365* × 52 and that 260 × *1461* (the Egyptian Sothic cycle) is the same as *365.25* × 1040.

To these calendars, which all fell into the 260-day pattern, were added more refinements for calculating the synodic returns of the moon and the planets.

In the latitudes of Mesoamerica the planet Venus looms in the dawn sky with extraordinary brilliance, and the astronomers of both the Nahua and Maya devoted particular attention to the planet, and especially to its heliacal rising.

Venus revolves around the sun every 224.7 days; but because the earth is moving along its own orbit, the planet appears at the same place in the sky in a little less than 584 days. As 5 × 584 is equal to 8 × 365, the Maya considered eight Venus years equal to five solar years. And as 365 × 104 is equal to both 146 × 260 and 65 × 584, the solar, sacred, and Venus calendars become coincident every 37,960 days, or 104 years, which was two Mesoamerican centuries of 52 years.

Actually the Maya knew the Venus cycle to be 583.92 instead of a round 584 days, so they dropped 4 days every sixty-one Venus years in order to compensate for the discrepancy and make a round number divisible by 260.

As astronomers are quick to point out, such an accurate knowledge of the cycle of Venus, whose revolutions are by no means regular, points to long and sustained observation.

The Mesoamericans furthermore devised a lunar calendar that would fit with the others. Calculating that 405 lunations or 11,960 days was exactly divisible by 260 (or 260 × 46), they obtained a lunar period of 29.53 days with a mere discrepancy of .112 of a day from what we know today. This would give them a lunar calendar accurate to within a day over a period of 300 years.

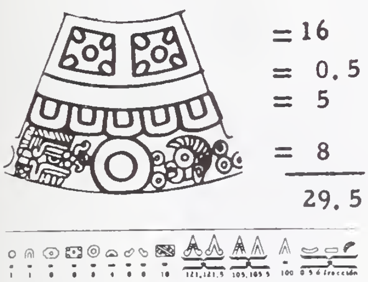
Hieroglyphic representation of an eclipse of the sun.

They also realized, as had the Athenian astronomer Meton in the fifth century B.C., that 19 Sothic years of 365.25 days were equal to 235 lunations, or 6940 days, which the Maya correctly figured to be one *katun* of 7200 days less one *tzolkin* of 260.

As a simple way to cope with the fraction slightly more than half a day over 29 for a lunar cycle, the Mayans reckoned their moons in groups of five or six, alternating between periods of 29 and 30 days. They could thus accurately state how many days after a new moon a date in question might be, how many moons of the group had been completed, and whether the actual moon, then running its course, was on a 29- or 30-day cycle.

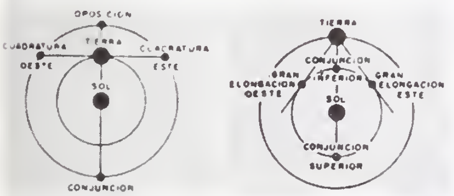
From a glyph they could tell how many days the date was after the full moon, which moon it was, and how long the previous moon had run.

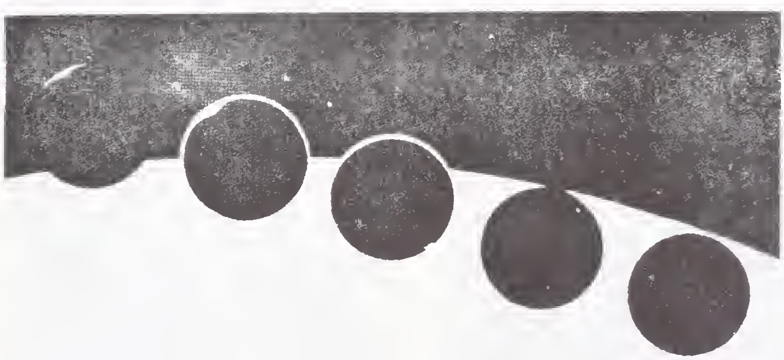
As for eclipses of both the sun and the moon, instead of being terrified by them as were their contemporary Europeans, the Mesoamericans calculated them accurately to use as a further check on the interrelation of returns of the planets.



Noriega's decipherment of the 295 days in the Aztec lunar cycle.

Raul Noriega's analysis of the Aztec Sun calendar of a 243-year period between passages of Venus before the sun.
121.5 + 8 + 105.5 + 5 = 243





The phenomenon, first calculated in modern times by Kepler in 1631, and first observed in 1639 by two Englishmen, William Horrox and Benjamin Crabtree, was seen in Mexico City in 1882.

The same phenomenon is recorded in the Tizoc stone in a slightly different manner.

In the early 1930s J. Antonio Villacorta, a Guatemalan lawyer, put together a set of books in which he reproduced the three main Maya codices—known for convenience as the Madrid, the Dresden, and the Paris—giving descriptions of their various glyphs and figures with whatever meaning for them he was able to glean from various sources. For the finely drawn copies of all the pages of the codices he enlisted his nephew, Carlos.

The effort itself did not bring much that was new to the art of decipherment, but the care with which the figures are reproduced, and the orderly manner in which they are annotated on opposite pages, made available to other researchers copies of the codices at a reasonable price to which they could apply their own talents of decipherment.

In the early 1950s a Soviet enthusiast, Yuri Knorosov, suggested that the Maya might have used two or three phonetic syllabic signs joined together to make a word. It was as radical an approach as Landa's, and met with as much opposition. Over the years, Knorosov produced a long book on the Maya and their hieroglyphs. He translated the *Chilam Balam* and other chronicles into Russian and added a short Maya dictionary along with reproductions of many of the glyphs—much as Thompson had done. Knorosov also reproduced Villacorta's drawings of the codices.

In the 1960s three Soviet mathematicians working in the Soviet Academy of Sciences Institute in Novosibirsk on the development of computer sys-

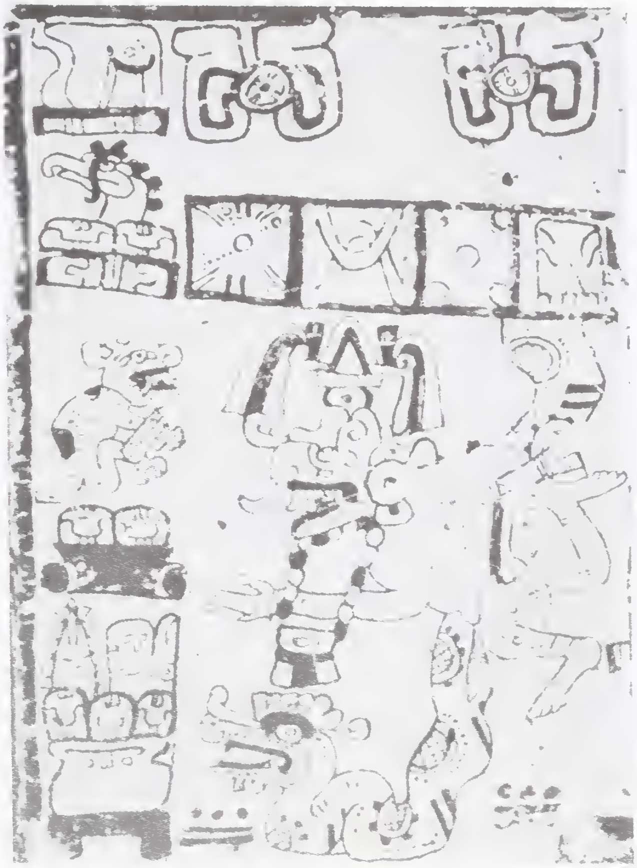
Villacorta describes the body of a large crocodile issuing from glyphs recognized as those of the planets Venus, Mars, Mercury, and Jupiter, from which hang all the glyphs representing the Sun and the Moon. From the crocodile's jaws pours a torrent of water which floods the earth, while a black god destroys humanity with a fistful of arrows.

Villacorta says that quite probably the Mayan priests wished to represent in this realistic scene the destruction of the world either in some distant future or possibly in the cataclysm produced by the flooding of the oceans as told in the *Popul Vuh*, when the gods wished to destroy humanity.

tems fell for the idea of using Knorosov's material in an attempt to decipher the Maya glyphs as a test project for a new large-scale computer they were designing. On the advice of Russia's most eminent mathematician—Soboliev, head of the Institute's mathematics department—the three Soviet computer experts, E. V. Evreinov, Yuri G. Kosarev, and V. A. Ustinov, fed into the computer all the known Maya glyphs, half glyphs, affixes, and prefixes they could find in the apprehensive expectation they might at last decipher the Maya texts. When all the data had been fed by number into the computer, the results filled four thick volumes with thousands of random phrases made up of Mayan words and syllables; but it did not do much toward an understanding of the Mayan writings.

J. Eric S. Thompson, the Polonius of Mayan hieroglyphics, accused Knorosov of doing violence to the language with his "disregard for all that is known of context and subject matter." Thompson was scathing in his criticism. "These numerous attempts to make silk purses out of Landa's sow's ear ended in disaster; the extravagances of the decipherers, growing with each failure, shrouded in clouds of fantasy the three or four reasonable decipherments."

In 1976 Knorosov brought out a new volume which was heralded by Reuters as a breakthrough; but Knorosov appears to have merely translated into Russian the random phrases put together by Villacorta, which were computerized by the mathematicians at Novosibirsk. Knorosov has promised a deeper analysis in a future publication. But the fact that the Russians have suddenly taken a distinct interest in the solution of the Mayan glyphs may indicate they suspect there is data of interest to be derived from them, or, indeed, may have already obtained such data.



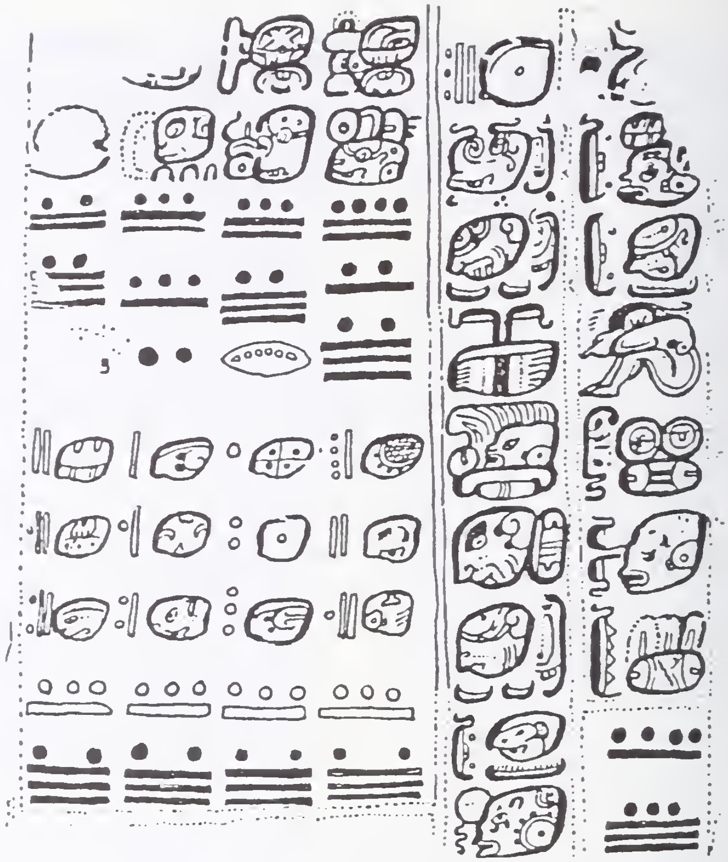
The boldest glyph recognized by Villacorta on page 12 of the Tro-Cortesianus Codex is that of the Sun surrounded by clouds producing tropical rainstorms. Immediately below, in four squares, are the glyphs for Mercury, Mars, Venus, and Jupiter. Villacorta says the large figure falling from under the four planets is the rain god painted in blue. Around his neck is a bag of copal painted red, yellow, and blue. Copal was burned as incense by the Maya with their prayers for rain. The large serpent entwined down the page has four Chicchan glyphs on his body each of which is interpreted as signifying "serpent." According to Villacorta the page is a prologue to the scenes depicted on the next seven pages (one of which is missing), where five large snakes (and possibly a missing sixth) represent time.

Page 60 of the Dresden Codex is interpreted by Förstemann as representing a "Battle of the Planets" including the Sun, Moon, Mars, Venus, Mercury, Jupiter, and Saturn, plus glyphs for an eclipse. In the top panel, according to Förstemann, the Sun is being threatened by the moon at an eclipse—symbolized by what he calls a dog under the platform about to devour the hieroglyph day-sign for *Lamat*. He believes the figure behind the moon to be Mars.

At the bottom of the page, Förstemann says the scene represents another struggle between the planets in their cyclical appearances, disappearances, and overtaking of each other. In this case, Sun, Moon, Mars, Venus, Mercury, and Saturn are shown.

Villacorta says the figure at the top left riding the snake represents Venus overcoming Mercury, whose eyes are bandaged—planets that alternate as "morning and evening stars."

Opposite them Jupiter is overcoming Saturn (with the black eye) and relegating it to a far corner of the sky.



In Vienna in 1739 the librarian of the Royal Dresden Library, Johann Christian Gotze, was given a mysterious 12 foot by 8 inch codex folded up like a fan into 39 sheets which he filed away with the notation, "A Mexican book with unknown characters and hieroglyphic figures written on both sides and painted in colors."

In 1813, Humboldt published a few pages of the codex in his *Vues des Cordilleras,* and Agostino Aglio copied it for Kingsborough's *Antiquities of Mexico,* which appeared in 1831. Yet little or nothing was understood of its 74 fig-bark paper pages illustrated with white, red, yellow, blue, and brown figures until they were chromophotographed by Naumann in 1880. With a working copy of the codex, Ernst Förstemann, director of the Dresden library and son of a Danzig mathematician, was able to study it more carefully and see in its glyphs an astronomical treatise. Over a period of fourteen years Förstemann was able to piece together the Maya long-count calendar determining the positions of five numerical signs with relative values of 1, 20, 360, 7,200, and 144,000. He then noted the appearance of zero in almost all the computations, established a Venus cycle of 584 days, and found the base date for a lunar calendar.

The next major step in deciphering the Dresden Codex was made by John Teeple, an American chemical engineer, who took up the study of Mayan codices to divert himself on long train trips.

Teeple saw how the Mayans had computed the synodic returns of Venus, which vary between 580 and 588 days, averaging 583.92. To offset the discrepancy between the rounded figure of 584 days, they added 24 days every 301 revolutions, reducing the error to one day in 6,000.

During World War I another German, Martin Meinshauser, was able to decipher in the codex a calendar of eclipses, and during World War II an attorney friend of Förstemann's, Paul Schellhaus, who was killed by the Nazis in 1944, described fifteen Maya deities who appear throughout the codex. The manuscript, kept in a wine cellar for safety during the bombing of Dresden, narrowly escaped being destroyed by fire and was somewhat damaged by water.

Subjected to tense scrutiny in the middle 1970s by the hieroglyphic section of the Institute of Maya Studies of the Miami Museum of Science, the codex can now be described as a highly sophisticated astronomical computer.

Pages 57 and 58 of the Dresden Codex provide a perpetual lunar calendar of 11,960 days consisting of 405 months divided into 69 groups of 177, 178, or 148 days. It is a very accurate lunar calendar, with a table for new moons for prediction of solar eclipses. 11,960 divided by 405 gave the Maya 29.5308 for the lunar cycle. Modern astronomers compute it at 29.5309. In the Dresden Calendar 11,960 divided by 69 gave the Maya 173.3333 as an average period between eclipses. 69 groups give the days when solar eclipses can occur as the new moons pass between the earth and sun.

Another calendrical device in the Dresden Codex is made by the serpentine pattern found by moving from one space up two rows and over one, then down two rows and over one. This produces an unending count of 91 days between each day-sign for a total of 20 cycles or 1,820 days. As each season of the year is divided from the next by the 91-day interval between the solstices and equinoxes, the calendar makes it possible to plot the sequence of equinoxes and solstices on the pattern beginning at any particular point of the 260-day sacred calendar, returning to that point to begin again in a perpetual cycle. To account for the discrepancy of 4.968 days every four years, the Maya added five days.

Newly Discovered Codex.

During 1971 a fourth Mayan codex surfaced in New York, where it was exhibited in June at the Grolier Club. As its anonymous owner did not wish to divulge its origin, the manuscript has become known as the Grolier Codex. It is now safely back in a Mexican museum. According to Dr. Michael D. Coe of Yale University, who helped prepare the exhibit, the codex, which is a painting on "bark cloth," dates from between A.D. 1400 and 1500. The manuscript consists of an eleven-page fragment of an original book of twenty pages, but unlike the other codices it does not have a profusion of complex hieroglyphs. On each page are columns of thirteen day-glyphs with relevant illustrative glyphs, each of which can now be read.

Like the Dresden Codex, which is a 400-year Venus calendar, the Grolier Codex is clearly a calendar of the phases of Venus, but displays a much more sophisticated system. Though it appears on the surface to be simply a 104-year calendar, it is described as "the world's first and only known perpetual calendar of Venus ever produced by any civilization." According to Charles H. Lacombe, "this ancient Mayan document must rank among the supreme intellectual achievements of human history."

The codex predicts the appearance and disappearance of Venus in a great cycle of 845 revolutions equal to 1352 years; and after completion, the cycle repeats itself endlessly by means of a shift in the order of the lines and the way they are to be read.

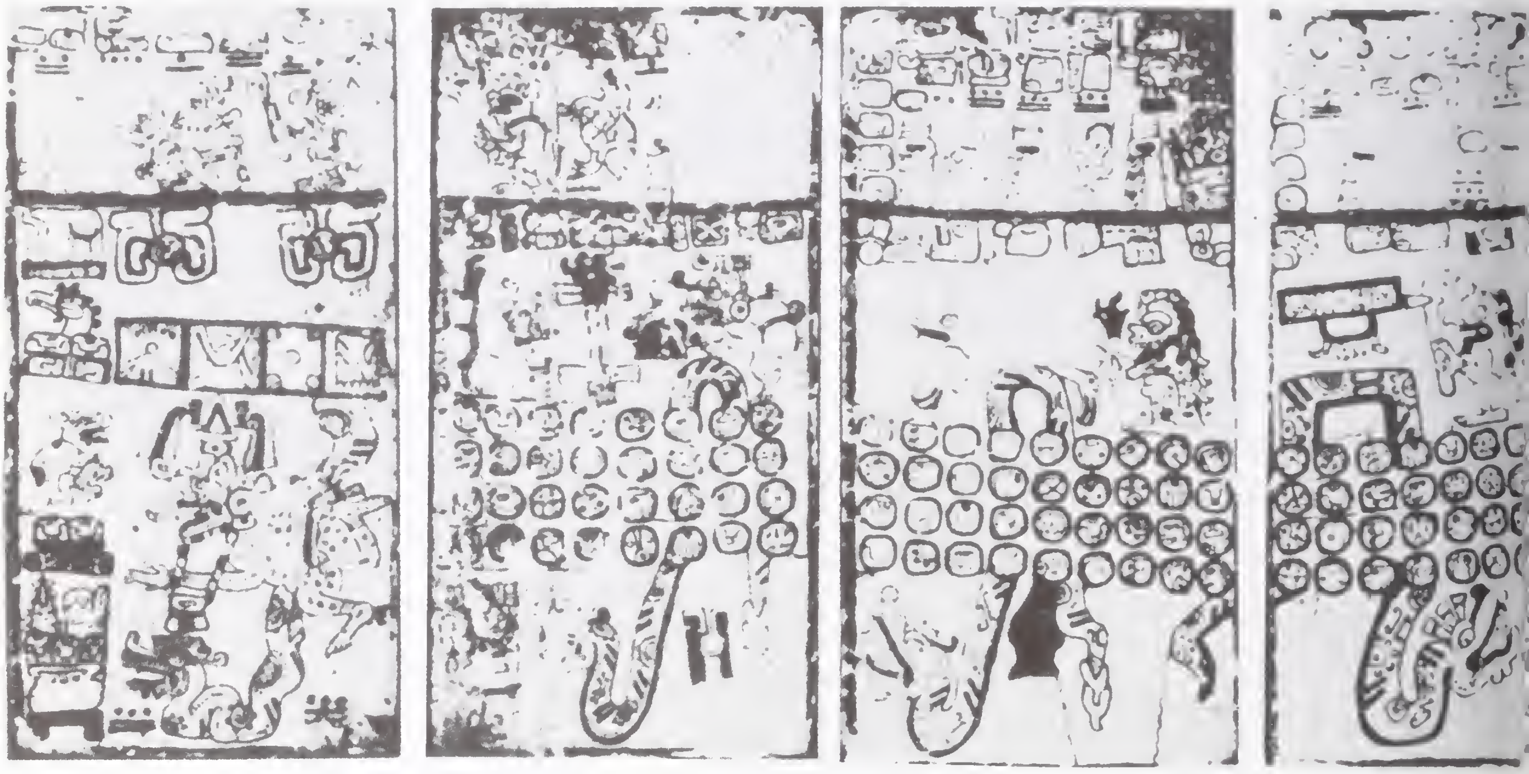
Viewed horizontally, each line of figures represents an 80-year cycle of the revolutions of Venus, and as there are 13 lines of figures, the chart represents 13×5, or 65 revolutions, equal to 104 years. But as each line moves up one place every 104 years and the top line goes to the bottom, every line is back in place at the end of 1352 years, at which point the process is repeated in an endless cycle for a perpetual calendar.

Curious as to why there appeared to be an extra 104 years in the calendar, Lacombe realized this was an essential correction built into the system to make it perpetual.

According to Dr. Douglas Duke, professor of astronomy at the University of Miami, Venus actually takes just 780 synodical revolutions, or 1247 years, to return to the exact spot at the exact time it started the cycle.

The Grolier Codex also supports the evidence for the Spinden and Makemson correlations, which place the date of the origin of the Mayan system in 3374 B.C.

To those who have suggested that this newly found codex could have been a fake, Lacombe replies that no forger could have been clever enough to fake such data for which there is no other source among Mayan scripts.



Tro-Cortesianus Codex.

Detailed analysis by the hieroglyphic section of the Institute of Maya Studies of the Miami Museum of Science, revealed that the illustrations function admirably as a computer for astronomical data.

In the words of Charles H. Lacombe, director of the hieroglyphic section, and Samuel S. Block, a Miami architect who has made several breakthroughs in deciphering the astronomical functions of Mayan hieroglyphs, this part of the codex is "unbelievable in its perfection and simplicity, instantly performing the incredible combination of mathematical functions required to program and retrieve the mathematical data."

The Mayan day-signs which run in columns of four from page to page of the codex are entwined with five serpents and a possible sixth which appears to have been on a page now missing. Read vertically, these day-signs provide a solar calendar of 365 days; as the sequences repeat themselves they provide a perpetual calendar of 4 times 13, or 52 years. The same day-signs read horizontally in groups of 5 times 13, or 65, give a Venus calendar (each of which takes 584 days), the equivalent of 104 years of 365 days, or two 52-year cycles.

Read diagonally in a succession of M's across the pages, or in what Block calls "a curious but fascinating economy of programming," the mechanism shows Venus appearing as the morning star, as the evening star, and in its superior and inferior conjunctions.

To identify two points on the diagonal separated by a Venus year, or 584 days, the computer shifts 65 spaces to the right, nine times, and one space to the left, for a total of $65 \times 9 - 1$ or 584.

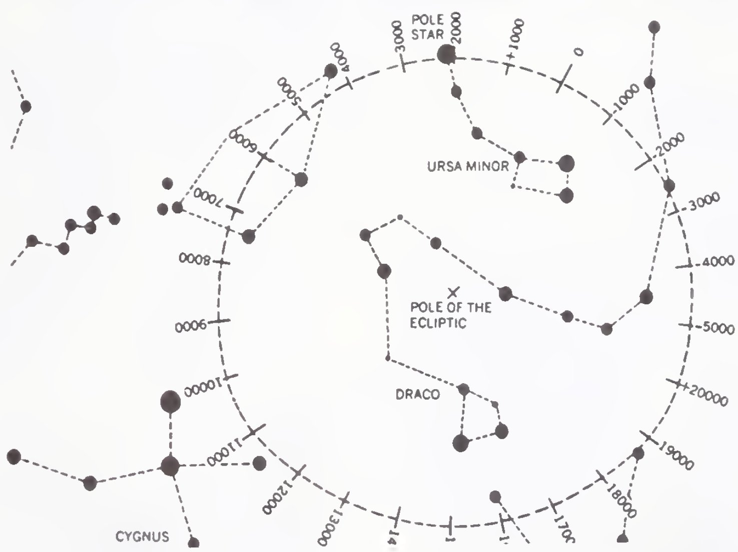
The five looped serpents entwined into the solar and Venus calendars are also arranged in such an exact manner, mathematically and geometrically, that they also function as a mechanism of the computer: they give the synodic cycles not only of Venus but of Mercury, Mars, and Jupiter. Explanatory panels across the top and bottom of the codex carry glyphs representing these planets as well as the long-nosed rain god Chac-Mool suspended over a serpent.

The first two serpent heads face left, the second two face right, and the fifth faces left, only in a reverse fashion, and each serpent intersects at four points. The total number of days covered in the intersections of all six serpents is 2600 days, or ten Mayan sacred *tzolkins.*

Lacombe and Block point out that the system is especially flexible in that the day-signs appear on the chart without the required numeral coefficient and can therefore be read up, down, or diagonally, producing readouts for different calendars, giving equinoxes, solstices, solar eclipses, and the days on which two or more celestial events can coincide.

After a great deal of careful observation, astronomer Marian Popenoe Hatch recently discovered that the various snake positions correlated exactly with the path of the constellation Draco as it would have appeared in the evening sky two thousand years ago.

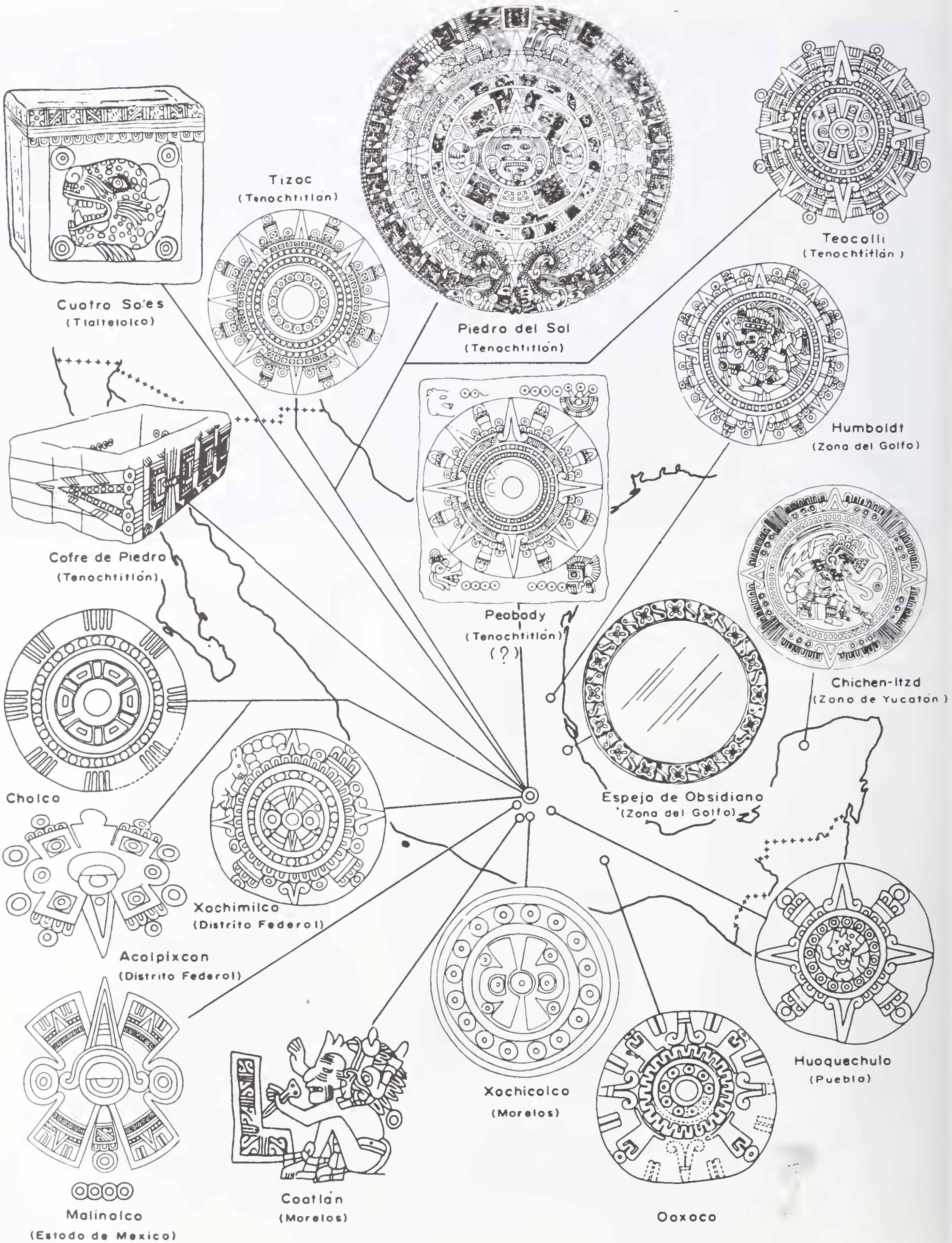
Dr. Hatch noted that the star Eta of the constellation Draco was unique in that it alone among all the stars remained virtually unchanged in right ascension for the 2300 years between 1800 B.C. and A.D. 500, regularly transiting across the meridian at midnight of May 23rd and November 22nd with a variation of less than one degree. Thus the star Eta Draconis provided the Maya with an accurate measure of the sidereal year, and a yardstick for comparison between the tropical and the sidereal years, as well as an indication of the processional lag in the other stars.



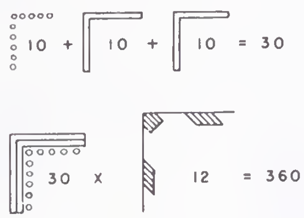
Hatch found that the path of Eta Draconis, as it moved through the celestial orb in the course of the year, correlated perfectly with the pictures of the serpents on the pages of the Madrid Codex, each of which astronomically represents a rotation in the sky of 45 degrees per page. When Draco is visible in the western part of the sky, the appropriate serpent looks to the left, when Draco is in the eastern sky the serpent faces to the right.

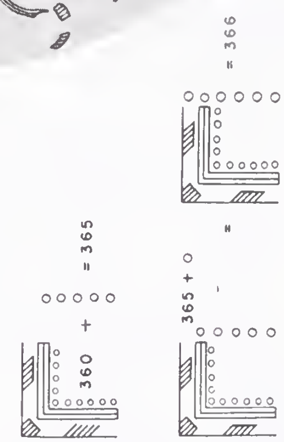
Noting that the word *Tzab* in modern Yucatec Maya means both the rattle of a rattlesnake and the constellation Pleiades, Hatch was pleased to find that the rattle on the snakes also correlated with various positions of the Pleiades in the sky.

The glyph with crossed bands which appears in the Codex was interpreted by Hatch as representing the constellation Cygnus whose star Gamma, when it transited at midnight, used to announce to Mesoamericans the advent of the summer solstice.


Tizoc
(Tenochtitlan)
Cuotro Soles
(Tlaltelolco)
Piedro del Sol
(Tenochtitlon)
Teocalli
(Tenochtitlán)
Humboldt
(Zona del Golfo)
Cofre de Piedro
(Tenochtitlon)
Peobody
(Tenochtitlon)
(?)
Chichen-Itzd
(Zona de Yucaton)
Espejo de Obsidiano
(Zona del Golfo)
Cholco
Xochimilco
(Distrito Federol)
Acolpixcon
(Distrito Federol)
Huoquechulo
(Puebla)
Xochicolco
(Morelos)
Malinolco
(Estodo de Mexico)
Coatlan
(Morelos)
Ooxoco

Noriega found a system of multiplication signs in the Sun calendar which he deciphered as follows:





Raul Noriega was able to achieve what Leon y Gama and Humboldt suspected but could not adequately accomplish: he demonstrated that the great Aztec monolith was a cosmic clock of extreme sophistication.

Noriega realized that with the exception of the obviously mythical figures, such as the twenty day-glyphs in the circle, and the four ages glyphs in the second circle, most of the other symbols carved into the great stone were purely mathematical, with algebraic functions, which could describe a great variety of calculations, harmonized into an aesthetic whole. With very few glyphs and some multiplication signs, the ancient Mexicans had been able to express at will either very small or very large astronomical-calendrical cycles, in days, weeks, months, years, and centuries.

Noriega found astronomical computations that showed an exact knowledge of the cyclical movement of the planets, calculated in their synodic (or apparent as opposed to sidereal, or actual) returns with an accuracy equal to our modern astronomers' five points of decimal.

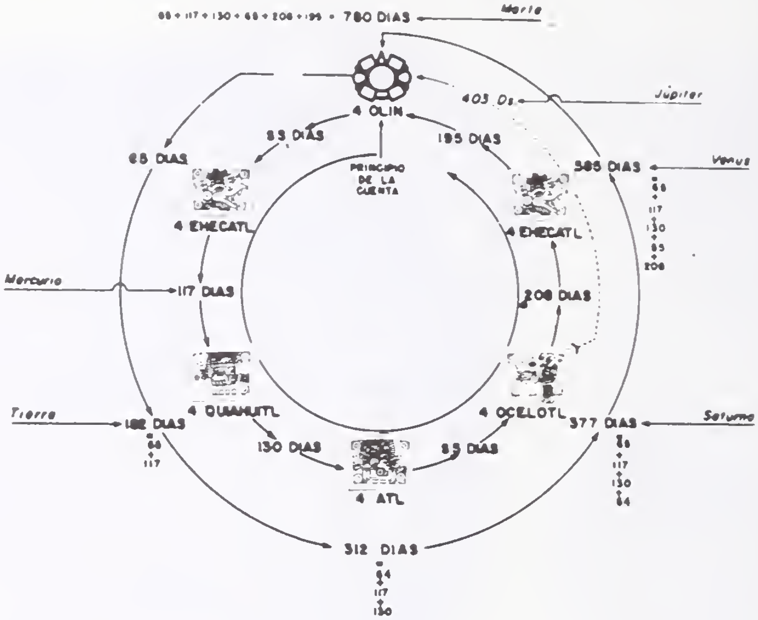
The calendar enabled its priests to compute the rhythmic cycle of solar and lunar eclipses, the passages of the sun at zenith, equinox and solstice, the furthest points reached on the horizon by the rising and setting sun and moon at different seasons, the phases of the moon, the heliacal rising of Venus, and the passage of Venus across the face of the sun (four times in 243 years), probably observed through fine sheets of obsidian or mica.

The third cycle of the calendar, says Noriega, will show a modern high school student how to determine the recurrence of planetary conjunctions going into the past or the future for thousands of years.

By locating in Oppolzer the 454 eclipses of the sun observable in the mid part of the North American continent from 1207 B.C. to A.D. 2161, Noriega was able to show the accuracy of recurrent periods of eclipses noted by the Ancient Mexicans in time lapses of 52, 104, 156, 208, 260, 416, 780, and 1248 years, all multiples of the Mexican century of 52 years.

The 1248-years cycle is quite remarkable. It is 12 centuries of 104 years each of 365 days. In that period the planet Venus makes as many synodic returns as there are days in a Mars revolution (780), and Mars makes as many revolutions as there are days in a Venus revolution (584). There are also exactly 1,752 calendars of 260 days in 1248 years.

Realizing that the earth was affected by the relative movements of the sun, moon, and planets, the ancient Mexicans, says Noriega, sought to master these cycles, by counting days, weeks, lunations, years, centuries, and synodic returns of the planets with the long-term object of being able to find the repetitive pattern in cataclysms, cyclones, tornados, earthquakes, floods, pestilence, and periods of relative serenity.



260 DIAS

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII
Cipactli	1	8	2	9	3	10	4	11	5	12	6	13	7
Ehécatl	2	9	3	10	4	11	5	12	6	13	7	1	8
Calli	3	10	4	11	5	12	6	13	7	1	8	2	9
Cuetzpállin	4	11	5	12	6	13	7	1	8	2	9	3	10
Cóhuatl	5	12	6	13	7	1	8	2	9	3	10	4	11
Miquiztli	6	13	7	1	8	2	9	3	10	4	11	5	12
Mázatl	7	1	8	2	9	3	10	4	11	5	12	6	13
Tochtli	8	2	9	3	10	4	11	5	12	6	13	7	1
Atl	9	3	10	4	11	5	12	6	13	7	1	8	2
Itzcuintli	10	4	11	5	12	6	13	7	1	8	2	9	3
Ozomatli	11	5	12	6	13	7	1	8	2	9	?	10	4
Malinalli	12	6	13	7	1	8	2	9	3	10	4	11	5
Acatl	13	7	1	8	2	9	3	10	4	11	5	12	6
Océlotl	1	8	2	9	3	10	4	11	5	12	6	13	7
Cuauhtli	2	9	3	10	4	11	5	12	6	13	7	1	8
Cozcacuauhtli	3	10	4	11	5	12	6	13	7	1	8	2	9
Olin	4	11	5	12	6	13	7	1	8	2	9	3	10
Técpatl	5	12	6	13	7	1	8	2	9	3	10	4	11
Quiáhuitl	6	13	7	1	8	2	9	3	10	4	11	5	12
Xóchitl	7	1	8	2	9	3	10	4	11	5	12	6	13

260 DIAS

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII
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Calli	3	10	4	11	5	12	6	13	7	1	8	2	9
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Ozomatli	11	5	12	6	13	7	1	8	2	9	?	10	4
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Acatl	13	7	1	8	2	9	3	10	4	11	5	12	6
Océlotl	1	8	2	9	3	10	4	11	5	12	6	13	7
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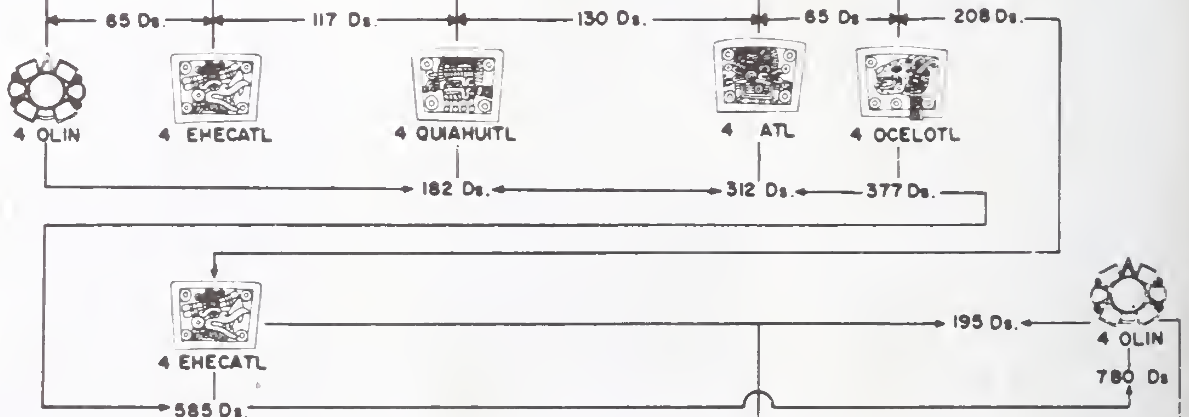
Olin	4	11	5	12	6	13	7	1	8	2	9	3	10
Técpatl	5	12	6	13	7	1	8	2	9	3	10	4	11
Quiáhuitl	6	13	7	1	8	2	9	3	10	4	11	5	12
Xóchitl	7	1	8	2	9	3	10	4	11	5	12	6	13



I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	I
1	8	2	9	3	10	4	11	5	12	6	13	7	1
2	9	3	[illegible]	4	11	5	12	6	13	7	1	8	2
3	10	4	11	5	12	6	13	7	1	8	2	9	3
4	11	5	12	6	13	7	1	8	2	9	3	10	4
5	12	6	13	7	1	8	2	9	3	10	4	11	5
6	13	7	1	8	2	9	3	10	4	11	5	12	6
7	1	8	2	9	3	10	4	11	5	12	6	13	7
8	2	9	3	10	4	11	5	12	6	13	7	1	8
9	3	10	4	11	5	12	6	13	7	1	8	2	9
10	4	11	5	12	6	13	7	1	8	2	9	3	10
11	5	12	6	13	7	1	8	[illegible]	9	?	10	4	11
12	6	13	7	1	8	2	9	3	10	4	11	5	12
13	7	1	8	2	9	3	10	4	11	5	12	6	13
1	8	2	9	3	10	4	11	5	12	6	13	7	1
2	9	3	10	4	11	5	12	6	13	7	1	8	2
3	10	4	11	5	12	6	13	7	1	8	2	9	3
4	11	5	12	6	13	7	1	8	2	9	3	10	4
5	12	6	13	7	1	8	2	9	3	10	4	11	5
6	13	7	1	8	2	9	3	10	4	11	5	12	6
7	1	8	2	9	3	10	4	11	5	12	6	13	7

260 DIAS

Raul Noriega, a Mexican jurist and anthropologist who spent a lifetime researching Mexican calendar systems to produce an extraordinarily handsome and informative book, *La Piedra del Sol,* on the Mexican calendar stone, used the Oppolzer catalogue of eclipses of the sun and moon visible in Mesoamerica from 1204 B.C. to A.D. 2250 to find that almost all the eclipses related by a number of days whose factor was 260.

The planet Mars also fits this system admirably, in that one synodic return of Mars takes 780 days, which is exactly three sacred calendar periods of 260 days.

From an analysis of a score of Mexican calendar stones Noriega shows that the Maya (as well as the Aztecs) were able to calculate the synodic revolutions of Saturn, Mercury, and Jupiter with great precision.

One of the basic mysteries of the Mayan calendar now appears to have been resolved by one of the NASA technicians responsible for the Apollo flights, Maurice Chatelain, who was born in France but has lived twenty years in California. In his *Nos Ancêtres Venus du Cosmos,* published in 1975 by Robert Laffont, Chatelain worked out the basic calendrical system of the Maya which turns out to be similar to that of the Sumerians.

Chatelain got onto the solution while puzzling over the extraordinarily high number 195,955,200,000,000 which appears on one of the 30,000 Babylonian cuneiform tablets found in Assurbanipal's Nineveh library.

Chatelain says he got the shock of his life when he realized the number was 86,400 times 2,268,000,000, and that 2,268 million was the number of days in 240 precessions of the equinox (of 25,890 years each).

In other words, some ancient astronomer had counted 240 precessions not in days but in seconds, 86,400 being the number of seconds in their day. Then Chatelain began to realize why the Mesopotamians had gone to such lengths. He was even more surprised to discover that the huge Babylonian number was an exact multiple of all the planetary revolutions and conjunctions he could check, including those of satellites and comets, correct to four points of decimal! It made the 2,268 million years, or 240 cycles of precessions of 25,890 years, the basic constant or common denominator of the life cycles of the solar system.

Chatelain then resolved the riddle of the extraordinarily high Mayan numbers by looking not for a multiple of our earth and other planetary conjunctions, but at the conjunctions of the other planets with each other.

The Mayan cycle of 942,890 days, or 2,582 years, turned out to be 130 Saturn-Jupiter conjunctions. (It also covers

Noriega realized the four boxes around the central face of the calendar stone—4 Ehecatl, 4 Quihuitl, 4 Atl, 4 Ocelotl—together with the basic 4 Olin glyphs signalled the lapses of synodic revolutions of the planets.

Noriega deciphered the second ring of the calendar stone as an indicator of the synodic returns of the planets. Computed from 4 *Sun* to 4 *Hurricane* to 4 *Cyclone* to 4 *Water* to 4 *Ocelot,* all fit into a 260-day calendar, which gives the following time periods.

From 4 *Sun* to 4 *Hurricane* is 65 days or 1/4 of a sacred calendar, which is other cycles: 15 Neptune-Uranus, 1,555 Jupiter-Mars, 2,284 Mars-Venus, 6,522 Venus-Mercury, and 2,720 Sun-Mars.) Twice this cycle, or 5,163 years, is 260 Saturn-Jupiter conjunctions, which gives a grand cycle with the same number as there are days in the Mayan sacred year.

also 1/9 of a Venus and 1/12 of a Mars cycle. From 4 *Hurricane* to 4 *Cyclone* is 117 days, or one Mercury revolution (+ 1 day), the same as 1/5 of a Venus cycle. From 4 *Sun* to 4 *Cyclone* is 182 days, or 1/2 a terrestrial revolution (− 1 day). From 4 *Cyclone* to 4 *Water* is 130 days, or 1/2 a sacred calendar, which is 1/6 of a Mars cycle. From 4 *Sun* to 4 *Ocelot* is 377 days, or one Saturn cycle (− 1 day). Noriega points out that all the cycles are based on multiples or submultiples of 13, the fundamental Mesoamerican calendrical number, and that 44 lunations are counted as 1300 days, or 260 × 5. (The actual number is 1299.34596.)

To see where such a cycle would lead him into the past, Chatelain took the 18,630 B.C. date which appears in the Codex Vaticanus and moving forward in increments of 5,163 years (or 260 Saturn-Jupiter conjunctions) he lit upon 13,467 B.C., 8,304 B.C., and 3,141 B.C., the last of which coincided very well with the accepted beginning of the last Maya cycle of 13 baktuns.

Chatelain saw that this grand Saturn-Jupiter cycle of 5,163 years, or 1,885,780 days, could be divided into 13 baktuns of 397.2 years or (145,060 days) a katun of 19.86 years (or 7,253 days) each katun of which was divisible into 20 tuns of 363 days. He also calculated a grander cycle of 18,720 katuns or 135,776,160 days.

Next Chatelain realized that the next figure of 34,020,000,000 days which appears in the Mayan glyphs was 15 times the Nineveh constant of 2,268 million years, and that the even next higher number of 147,420,000,000 days in the Maya glyphs was 65 times the Nineveh constant. He also saw that 147,420 million days is 78,170 cycles of 260 Saturn-Jupiter conjunctions. It was clear to him that the Sumerians had used the same basic constant as the Maya, only multiplied by the 86,400 seconds of their day.

Furthermore, the Mesopotamians had linked their measures of time and space—in seconds of time and seconds of arc. 34,020 million days is not only the number of days in 3,600 Sumerian precessions of the equinox but 3,600 tenths of a degree—consisting of 36,000 Egyptian feet of .308 meter—is the circumference of the world in seconds of arc. The Mesopotamians had not only chosen as a unit of measure a foot that was earth-commensurate, it was also commensurate with the great Platonic year of 25,890 years. Odd would it be if the unit dispensed by Hunab Ku to the Maya were not equally earth-commeasurable. At Teotihuacan and at Palenque this ancient Middle Eastern foot fits Cinderella's shoe as neatly as it did at Cheops.

Frank Waters finds it useless to speculate on how the Mayan priest-astronomers "without telescopes, measuring apparatus, computers, and the use of fractions, could have achieved with such remarkable accuracy this immense and complex calendar system," and finds it even more incomprehensible that they could combine "the science of abstruse mathematics and astronomy with a metaphysical cosmology and mythology." The problem leads him to wonder whether "astrology, symbology and mythology could have been a shorthand to describe a galactic type of science of a different dimension from the conventional physics we use to describe earthly phenomena."

A clue as to how the Mesoamericans may have achieved such prodigious results was obtained in the 1950s by Geoffrey Hodson, the extraordinarily clairvoyant Theosophist, when he went into a semi-trance at the top of the Sun Pyramid of Teotihuacan. With closed eyes he was able to conjure pictures of the past. To Hodson it was clear that the ancient Mesoamerican priests had clairvoyant powers by means of which they could know when and where the various planets would be situated and from this knowledge deduce an accurate system of astronomy without benefit of high-powered telescopes. Such an accurate astronomy married to an accurately accumulated knowledge of the evident effects of planetary relations could have produced a valid science of astrology.

Hodson says that initiates were specially trained to detect combinations of planetary forces during astrological aspects. They could apparently feel or sense them, knowing when and where planets formed aspects like conjunctions, squares, or oppositions, which either strengthened or weakened stellar, zodiacal, or higher cosmic influences as they manifested on earth.

Hodson says the physical, astral, and mental bodies of the priests thus trained became sensitized to such a degree that they became human observatories, aided by physical recognition of the position of the planets.

The French astrologer Alexandre Volguine believes furthermore, that Mayan eyesight in those days was more powerful than today, though even with acute eyesight it would be difficult to account for how the Maya knew of 400 stars in the Seven Sisters constellation of the Pleiades, whereas today we can spot only 6 stars with the naked eye. Human senses appear to have degenerated rather than evolved under the influence of so-called civilization. Volguine says that illiterate natives in Oriental Siberia can still see the satellites of Jupiter. He adds that there is no reason to believe that the Maya were unable to see with the naked eye Uranus, Neptune, Pluto, and perhaps even the trans-Plutonian planet postulated by Harleston and others.

The Mayan palm, considered by Domingo Martinez Paradez to be the oldest continuous unit of measure, was known to the ancient Maya by the same word used for undulation: *naab*. Several Mayan palms were in use, one of which was about seven inches long.

An English radionic expert has found that every seven inches, or very close to that amount, the rotational polarity of a field of radionic energy extending from a magnetic compass reverses. This is shown by a change in the direction of rotation of a pendulum held over the horizontal plane in which the compass lies. According to astrologer Michael Heleus, this would imply that the ancient palm of nearly seven inches could have been a measure having a character intrinsically linked with the magnetic and radionic properties of the universe. Heleus suggests that the pendulum, sensing the magnetic undulation, reverses polarity at nodes whose distances are harmonic multiples of the palm, multiples whose sequence of alternation is reminiscent of the earth-commensurate palms in the ancient Greek (and Egyptian) foot and cubit.

Theoretical considerations supporting these observations are provided by D. B. Larson in *Structure of the Physical Universe*. In this work, Larson advances the hypothesis that the spacing of atoms, and indeed their production, is the result of the interplay of two opposing forces. The first, which he calls the space-time progression, moves outward from every point continually at the velocity of light, which he considers unitary. The second is rotation, which, where it exists, opposes the space-time progression, and if it exceeds that progression, creates an inward force giving rise to matter and gravitation.

21. Astronomical Observations

All the great temples of antiquity, as Livio Stecchini has abundantly shown,* served to locate man in the cosmos, both in space and time, bringing knowledge of the heavens to the earth.

According to the Chorti priests of Guatemala, their forefathers had divided the cosmos into a quadrangle. To bring this quadrangle down to earth, they picked as geodetic points the four corners on the horizon where the sun rests at dawn and sunset of the solstices.

The *Popol Vuh* says the surface of the earth was divided into four sections corresponding to the four points of the compass, each with its own colors, fates, and gods. Bishop Landa reports that towns in Yucatan were so designed, with four principal entrances in the form of a cross; and still today in Mayaland villages are laid out in the old pattern, the sun being observed at equinox and solstice in order to establish the points at which to put up stone markers.

The Dresden Codex shows that Mayan geodesy took into consideration both the cardinal points and the intermediate solstitial points, for which they eventually built complex observatories for determining the exact moment of the solstices.

A quote from the Roys book of Chilam Balam says, "When the eleventh day of June shall come, it will be the longest day, when the thirteenth of September comes, this day and night are precisely the same length. When the twelfth day of December shall come, the day is short, but the night is long.

* In his appendix to *Secrets of the Great Pyramid,* and other writings.

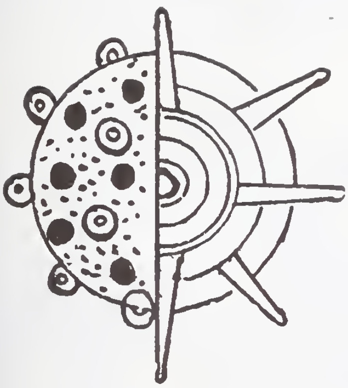
When the tenth day of March comes, the day and the night will be equal in length."

The discrepancy with our September 23 and December 22 is due to the shift of one day in seventy-two years caused by the precession of the equinoxes.

Diego Duran, Toribio Motolinia, and Fernando Ixtlilxochitl describe Mexican sun priests as spending long nights in systematic observation of the heavens, registering the movements of celestial bodies. With the use of the gnomon, they obtained accurate knowledge of the equinoxes and solstices.

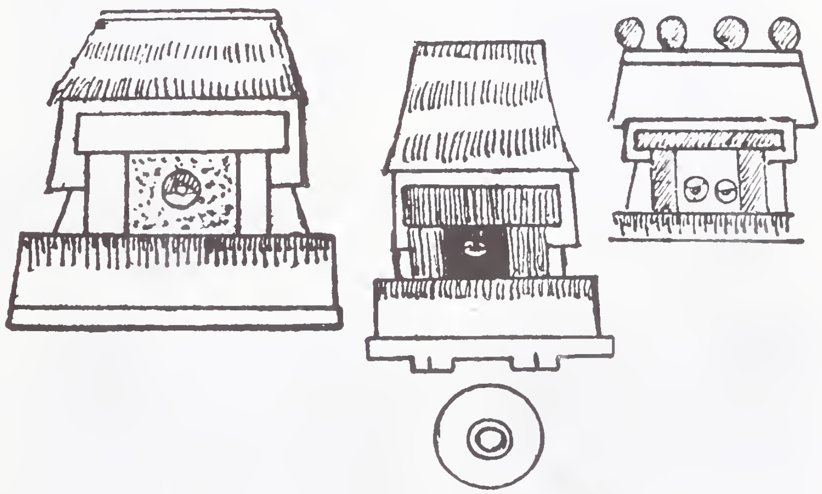
Motolinia says that in Tenochtitlan the festival called Tlacaxipeualiztli "took place when the sun stood in the middle of Huicholobos, which was at the equinox, and because it was a little out of line, Montezuma wished to tear it down and set it right." As part of his official duties Montezuma was required to rise regularly at midnight and offer incense to certain principal stars. Other priests watched for the appearance of certain stars at dusk, three A.M., and immediately before dawn, the time being heralded by drums and trumpets from the temples.

Zelia Nuttall demonstrated incontrovertibly, though little attention was paid her, that the ancient Mexicans not only employed carefully oriented temples and ball courts as astronomical observations, but also invented ingenious devices in and on these observatories for accurately registering the periodical appearances and disappearances of important celestial bodies: they had forked and bifurcated sticks, frets along the roofs of lined-up buildings, rows of upright sticks, and stelae carefully located several miles apart.



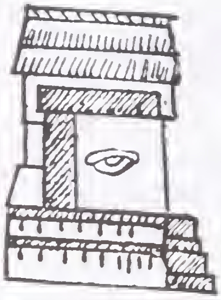
This circular figure with the sun symbol on the right and the star-filled sky on the left clearly shows an equal division of night and day—or the equinox.

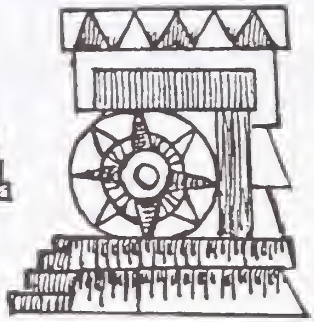
Figure 1. This illustration from the Codex Mendoza (reproduced by Kingsborough, volume V page 101) shows a seated priest whose vision is directed toward the symbol of the nocturnal heavens—an eye-filled hemisphere in which the eyes represent stars.

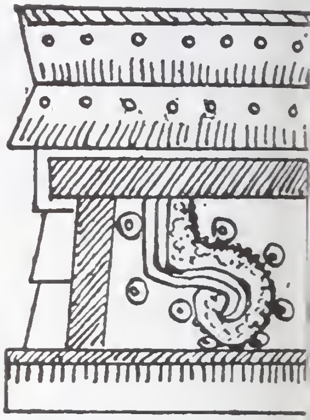


Figures 2 and 3 (Borgia Codex) show open doorways in the center of which float single stars. The first doorway shows the sky at dusk or dawn, the second at night. Below the second temple is a symbol for a great star or planet. The fourth figure shows twin stars appearing in the doorway.

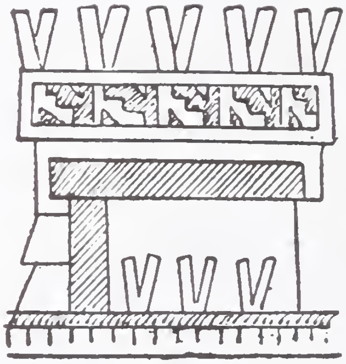
Doorways drawn in profile were the common conventional mode adopted by the native artists to represent temples. The first temple shows a single star, the second the sun, and the third an entire constellation in the form of a curved object studded with stars which is very similar to Scorpio.







Ancient Mexican astronomers did not limit themselves to observing celestial bodies through openings in buildings. Figure 10 represents a temple on the roof and in the doorway of which stand rows of bifurcated stakes. Their purpose, says Zelia Nuttall, is revealed by figure 11, which is clearly designated as a star temple by three stars attached to the back wall. On the roof is seen a star in a bifurcated stake. Frets on the roof of the third temple indicate another method of lining up celestial bodies.



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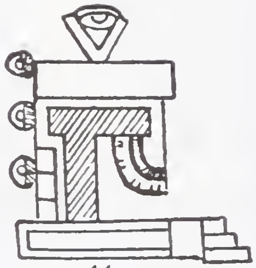

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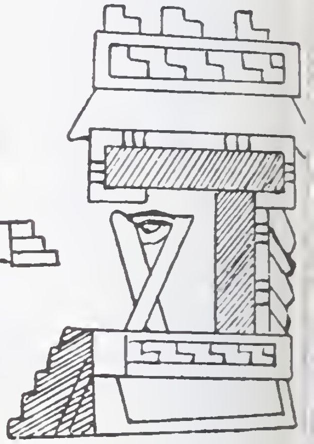

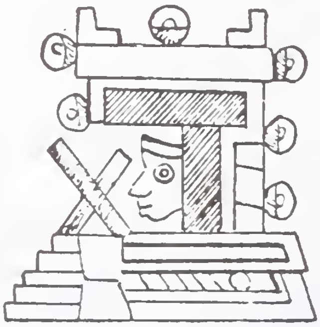

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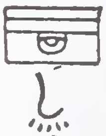

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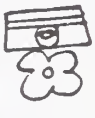

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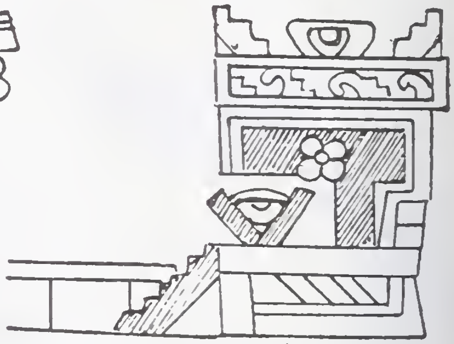

14

Figure 12. Here the temple walls and roof are studded with six stars, and a human face or mask is depicted peering out of the doorway through crossed sticks. Figure 14 shows a star lodged in the triangle of a forked stake erected on the summit of the temple stairway, while another large star rests on the roof exactly between the terraced corners of the edifice. On the lintel of the temple door is represented a four-petaled flower. Proof that this was the actual sign for a particular star is furnished by figure 17, which exhibits an identical flower on the band studded with stars, denoting the nocturnal heaven. Here in figure 15 a starband is painted above a footprint directed downward, near a seated figure accompanied by a day and year sign. Mrs. Nuttall believes this may have recorded the setting of some particular star on the date recorded. A similar footprint directed away from the temple in figure 14 suggests to Mrs. Nuttall that the doorway may have faced east, and that the footprint refers to the setting of the "Flower" star or of the adjacent constellation at a particular time of the year.

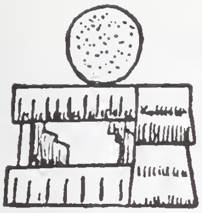

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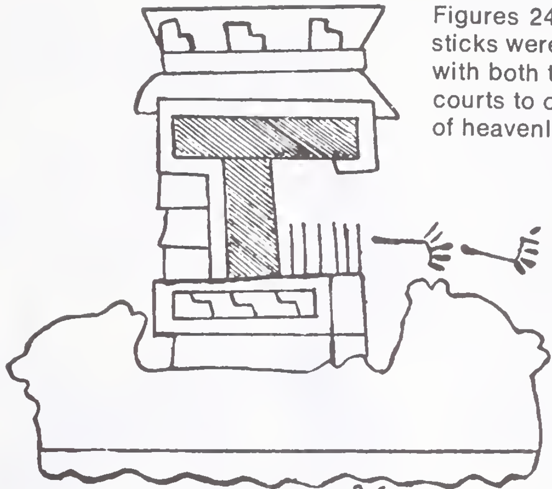
Figure 26 shows Venus atop a truncated pyramid without its winglike appendages, evidently at a different period of its revolution.



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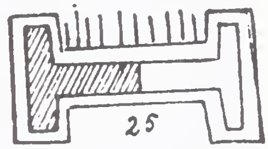

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Figures 24 and 25 show that sticks were used in conjunction with both temples and ball courts to observe the motion of heavenly bodies.

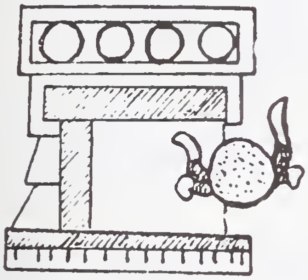

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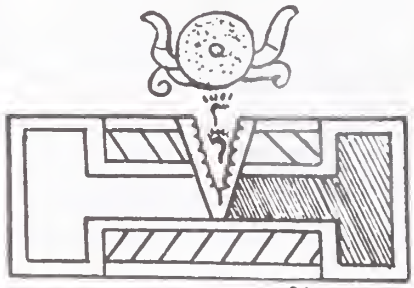
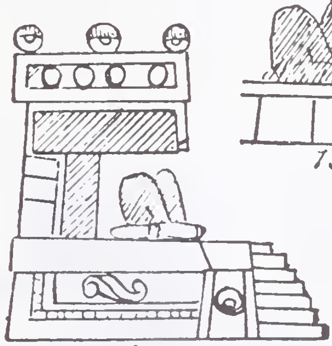
Figure 23 shows the planet Venus being observed by means of a temple.



27

Figure 27 shows Venus as the morning star at its period of greatest brilliance, a large dish with two winglike appendages. It also shows that it was observed from the center of a ball court, where it is seen rising. The fact that half the court is dark may indicate a heliacal rising of Venus at the equinox.



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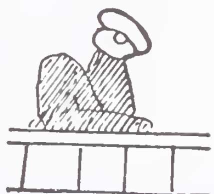

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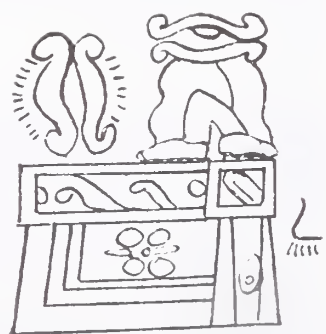


22

Figure 22 shows a combination of the "Flower" star and a footprint directed downward, presumably for its setting. On top of the terrace is a curious device which resembles the drawn-up limbs of a seated human figure. It is even clearer in figure 19. Zelia Nuttall says the device serves the same purpose as a bifurcated stake, pointing out that the Nahuatl word signifying "on the knee" can be read as a homonym conveying the meaning "on the summit or head of the earth or land."

As early as the turn of the century Mrs. Nuttall found illustrations in the codices descriptive of methods used by Mesoamerican priests to observe stars and planets. The illustrations showed ancient astronomers, as in Babylonia and Egypt, observing certain stars from a dark cell or chamber through the opening doorway of the temple situated on an elevation.

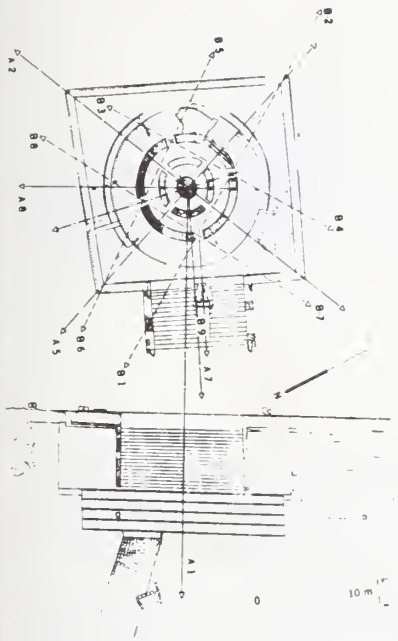
Zelia Nuttall also correctly suspected that the high dome of the Caracol at Chichen Itza constituted a gnomon which would be shadowless at noon on the days the sun crossed the

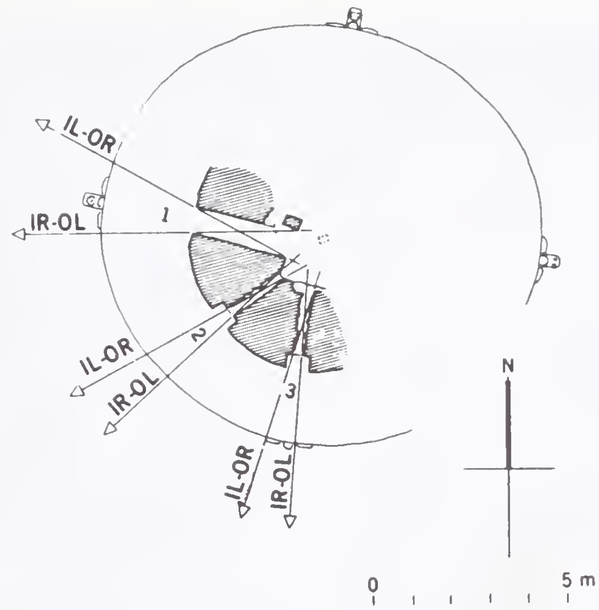
The Miztec manuscript known as the Codex Nuttall.

In Florence at the turn of the century Zelia Nuttall heard from Pasquale Villari, an Italian senator and ex-minister of higher education, that while he was doing research in the Library of San Marco some two years earlier he had been accosted by a monk with a strange manuscript. This was the turbulent period of the unification of Italy, and when the Library was taken over by the state the manuscript was sold to an Englishman living in Florence who gave it to a friend in England. Determined to recover the manuscript, Zelia Nuttall searched throughout England, eventually establishing that it had been given to Sir Robert Curzon, fourteenth Baron of Zouche. Among the papers of the fifteenth Baron, Zelia Nuttall found the manuscript where it had lain unopened for twenty-five years. It is now in the British Museum, and Zelia Nuttall's original facsimile of it, published in 1901, is available in paperback. The early history of the codex is doubtful, but it may have been among the prizes sent by Cortes to Charles V.

zenith in May and July (announcing to the populace the advent of the rainy season and the beginning of a new calendar year).

Luis Arochi, author of a new book on the astronomical orientation of the Castillo at Chichen Itza, also shows in a series of remarkable photographs that the steps of the building are so cunningly oriented and designed that only on the day of the vernal and autumnal equinox the sun's rays cause a great serpent (whose head is carved at the bottom of the steps) to slither up or down the stairway—up in spring and down in autumn, forming a set of seven perfect isoceles triangles patterned on the local rattlesnake, *Crotolus*.





(Above and right) Anthony Aveni's diagrams showing various astronomical alignments of the Caracol building at Chichen Itza.

Despite J. Eric Thompson, who is considered the foremost living authority on the Maya, but who disparagingly regards the Caracol as nothing more than "a two-decker wedding cake on the square carton in which it came," recent scientific investigation has shown this extraordinary building to be a sophisticatedly designed astronomical observatory and geodetic marker.

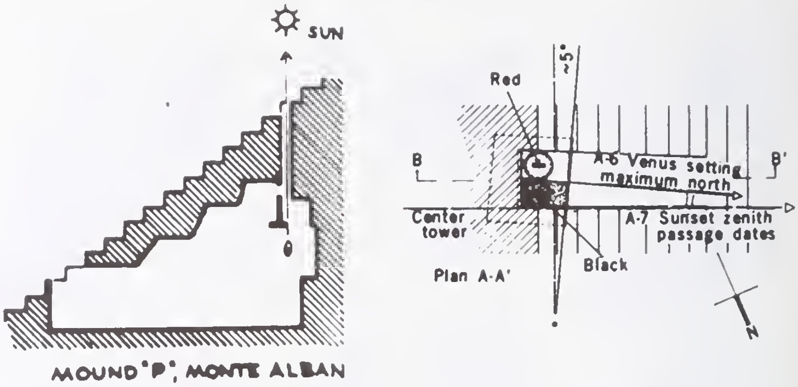
Anthony F. Aveni, an astronomer, Sharon L. Gibbs, a historian of science, both on the faculty of Colgate University in Hamilton, New York, and Horst Hartung, an architect on the faculty of the University of Guadalajara, Mexico, show that the diagonals of the main platform point to sunrise at summer solstice and sunset at the winter solstice, and that other astronomical observations could be made at different times of the year in different parts of the building by astronomer priests. In a paper presented to the forty-first International Congress of Americanists in Mexico City in 1974 they further suggested that many of the asymmetries built into the Caracol were intentionally designed to create alignments which would point to astronomical events.

(Left) Arochi's picture of a great snake with isoceles markings descending the steps of the Castillo at Chichen Itza at the equinox.

Hypothesizing that windows functioned as astronomical sighting chambers, and that one of them might have been deliberately designed to point to sunset at the equinoxes, the trio set themselves to observe the phenomenon and were able to see that the instant of the passage of the sun across the vernal equinox occurred within ten minutes of the movement of sunset. The edge of the setting sun lined up almost perfectly with a narrow opening in the window, enabling the sunset to be viewed through a slot.

As stellar observations are especially important at the time of the solstice or zenith in order to obtain greater ac-

Aveni's diagrams of stellar and solar methods of observation with Mesoamerican buildings.



curacy, they believe that weep holes, rectangular horizontal shafts of a width of from eight to twelve centimeters which pierce the tower at ground level both below and above the upper molding, may also have had an astronomical function. The trio found alignments for the heliacal rising of such major stars as Canopus, Castor, and Pollux, which led them to suggest that entire constellations such as the Pleiades could have been more carefully watched through the windows at important moments such as on the date of a Venus passage.

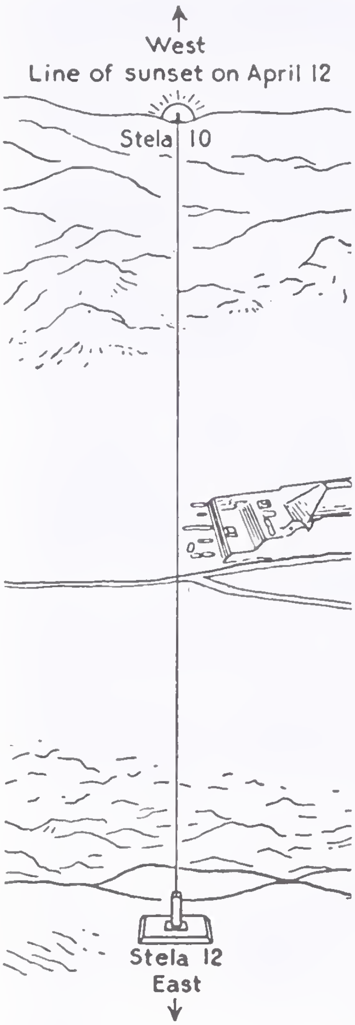
As Venus, which is exceeded in brilliance only by the sun and moon, reaches its greatest northerly and southerly extrema along the horizon at regular intervals of the calendar year, the trio suggest that the placement of the Castillo itself could have been determined by the setting position of Venus.

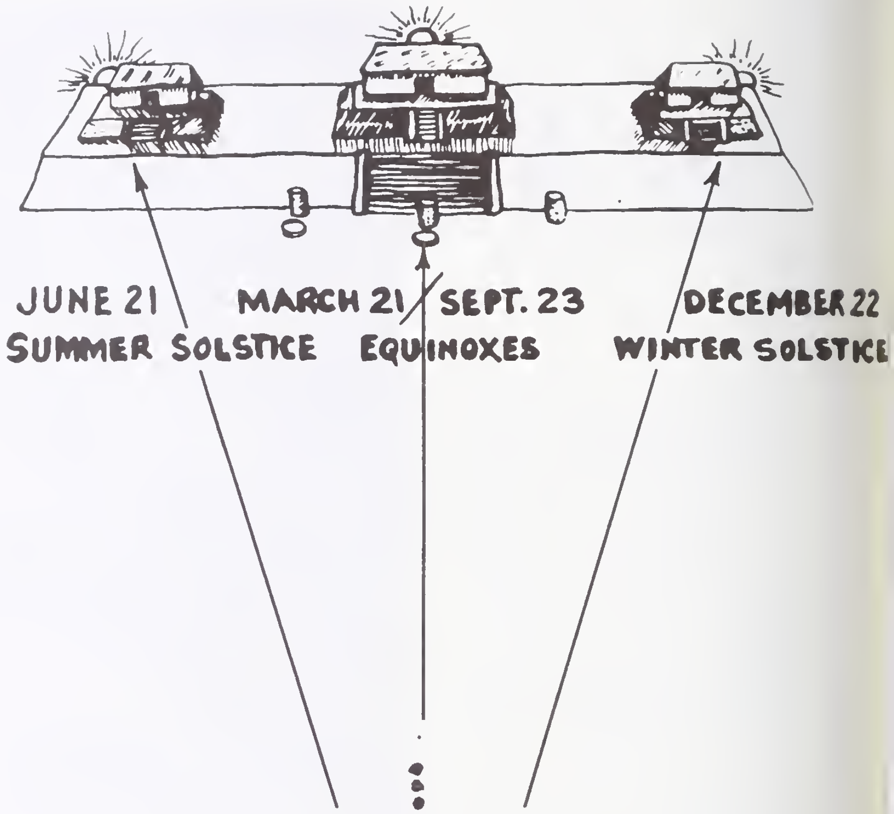
At Uxmal, the platform which serves as a base for the Palace of the Governor is oriented to the rising of Venus. For this, Thompson had the evidence of the elaborate Venus calendar in the Dresden Codex, believed to have been composed in the vicinity of Chichen during the Mexican period, which showed concern with the heliacal rising and setting of Venus. And the recent breakthroughs by the Hieroglyphic Section of the Institute for Mayan Studies at the Miami Museum of Science indicate that the codices contain sophisticated perpetual computer layouts for such ephemeral phenomena as the cyclical coincidence of heliacal risings of Venus in conjunction with eclipses of the sun.

Aveni, Gibbs and Hartung also found slots which point to the setting moon at its maximum northerly and southerly extremes. Every 18.6 years the full moon nearest the time of the winter solstice will be found to set at its greatest southerly extreme. This would have provided the Maya with a recurring cycle, such as the alignments at Stonehenge. The codices also contain refined data on various cycles of the moon.

Other round towers in Mayaland near Tulum, Ake, and Cozumel, also dedicated to Quetzalcoatl, are being analyzed for astronomical orientation.

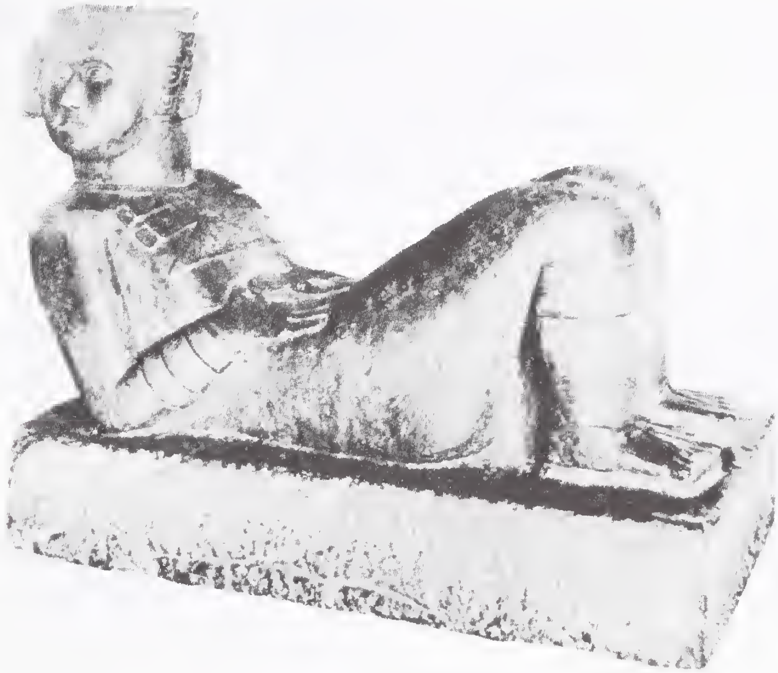
Aveni spotted a ceremonial center on a hill five kilometers by line of sight from the governor's palace at Uxmal—first noted by Stephens as Nohpat—which lined up with a pillar and Chac-Mool to indicate the maximum southing of Venus.





Equinox and solstice temples at Uaxactun.

Solar alignment of the "Sundial" stele at Copan, Honduras.



Chac-Mool.

The concave circular dish held on the stomach of the Chac-Mool first discovered by Le Plongeon, a copy of which has been placed at the top of the stairs of the so-called Temple of the Warriors at Chichen Itza, may well have been used as a receptacle for water or liquid mercury (with which the Maya were acquainted) on which to float a magnetic lodestone or compass point. The bowl could also have served as a mirror for watching the split-second transit of stars, the method still used today by the Naval Observatory in Washington, D.C., and at least 5000 years ago in the Great Pyramid of Cheops.

As the grid plans of a number of important sites in southern Mesoamerica possess orientations directed slightly east of astronomical north, close to the present compass direction, such as at Uxmal, Copan, and Ozibilchaltun, it has been suggested by Robert Furison in the *Annals of the Association of American Geographers* in 1969 that the Maya may have known the magnetic compass and used fragments of worked magnetite such as have been found and established as being pre-Columbian. There is no reason the compass, which was known in China a thousand years before Christ, could not have been brought to Yucatan by the Chinese explorers and Buddhist monks reported by Henriette Mertz to have reached Mexico in the second millennium B.C. and again in the fifth century A.D.

At Copan in Honduras a base line of 9 degrees north of west was established with a sundial to indicate sunset at the solstices and equinoxes. At Uaxactun three temples and two stelae give precise orientations of the sun's position at the solstices and equinoxes. At Xochicalco the great pyramid contains a vertical shaft down which the sun shines so as to cast a perfectly round shadow twice a year at the zenith.

Marquina and Ruiz suggest the setting of the Pleiades as a possible orientation point for the axis of the Teotihuacan and Tenoyocaca pyramids. Aveni says that at the time the Way of the Dead was constructed, the Pleiades would have touched the horizon point above the Cerro Colorado marker at azimuth 284° 40′, or 14° 40′ N of W.

Aveni says the Pleiades could also have served the function of "announcing" the first annual passage of the sun through the zenith of Teotihuacan, since the heliacal rising and the passage of sun through zenith occurred approximately on the same day—58 days after the vernal equinox.

The theory was supported by J. W. Dow in his *Astronomical Orientation at Teotihuacan* in *American Antiquity* in 1967. Dow suggests an east-west base line was fundamental to the layout of the city and that the Way of the Dead was oriented to it at right angles.

22. Geodetic Markers

Marker on the U.S.-Mexico border reported by Riva Palacios in 1889.

So far it has not been possible to establish precise dates when the markings could have been made. Were they inscribed as required alignment marks for the construction of the pyramids, sometime around the beginning of the Christian era, or earlier, maybe by many centuries, or much later, perhaps by observers attempting to re-establish solstitial and equinoctial lines of sight after the eighth-century fall of Teotihuacan?

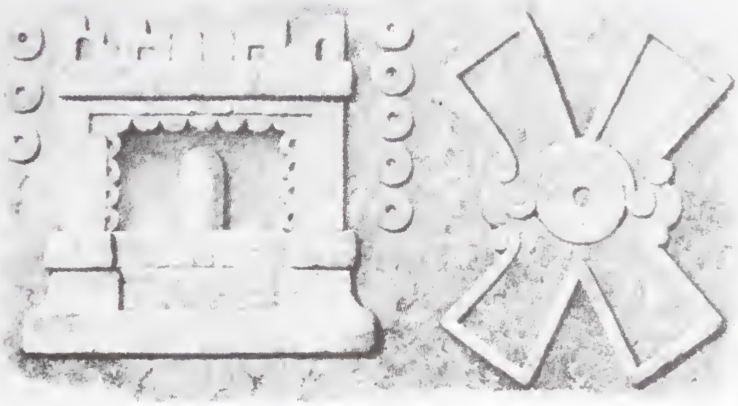
When the marker at Uaxactun from which the equinoxes and the solstices could be observed was first found by American archeologist Oliver G. Ricketson in 1937, he noted it was made in the shape of a cross formed by eighty-one holes. Many years earlier a similar marker had been used by Vicente Riva Palacio to illustrate his four-volume *Mexico Atraves de los Siglos*. But no one could figure out the purpose or significance of the eighty-one holes.

During the early 1970's, searching for temple sites on the hills around the Valley of Teotihuacan, Harleston and a group of amateur archeologists found a whole system of similar stone markers which clearly lined up with the Pyramid of the Sun, and other definite markers to indicate the rising and setting sun at solstices, equinoxes, and zenith passages.

The markers indicate that various buildings of the pyramid complex were used in conjunction with markers on the hills and mountains surrounding the valley for geodetic and astronomical sightings at least as early as the fall of the Roman Empire, and presumably much earlier.

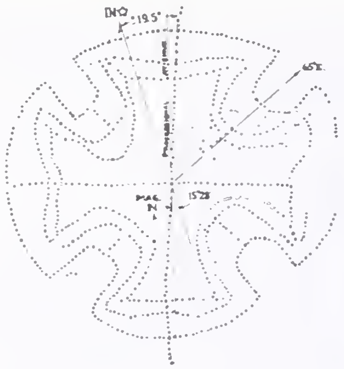
That the markers do just that was established by the researchers through repeated observation of sunrises and sunsets at Teotihuacan, where the markers line up with such fixed sighting lines as the corners of the Sun Pyramid to indicate the summer and winter solstices. Details of these discoveries and of the observed phenomena were presented at the forty-first International Congress of Americanists in Mexico City in September of 1974.

Petroglyphs found by Dupaix for which he could find no meaning.



The markers, some more than a meter in diameter, are in the form of crosses in single or double circles, or in triple cloverleaves. Small holes, a centimeter wide and about two centimeters apart, were pitted into solid volcanic outcroppings or into millennial mortar floors of lime and crushed volcanic rock in what appear to be mathematically significant numbers such as 4 legs of a cross of 20, plus a center of 1, for a total of 81, or 9 times 9. The series of holes either form angles of 90 degrees, or are aligned on specific azimuth readings from true north such as 48 degrees, 60 degrees, 66 degrees, 72 degrees, 144 degrees, or 228 degrees.The astronomical and geodetic functions of some of the azimuth lines have been deciphered by the researchers; others remain a puzzle.

The most complex of the markers, a triple cloverleaf around a Cartesian coordinate cross, was found on March 9, 1974,



Garcia marker.

In 1964 Mexican archaeologist Braulio Garcia, working on the restoration of the Processional Avenue's temples at a location called Area 7 some 300 meters south of the Sun Pyramid, uncovered a fourth-century A.D. concrete floor, on which were pitted two concentric circles and a Cartesian cross. The southern arm of the cross runs 19.5 degrees east of north. Garcia also found another configuration on the floor of the patio across the street in Area 6, and his colleague Alfonso Cuevas located a third marker in Area 8, some 83 meters to the south. The data on these markers were filed in the archives, but only the Garcia 7 marker reached publication.

by Alfonso Morales, an economist in hydraulic resource planning, who, like the other researchers, was anxious to accelerate archeological inquiry and the better preservation of Mexico's ancient monuments.

Morales found the marker under a loose layer of windblown earth and tourist detritus near the loggia of a patio west of the main Teotihuacan Processional axis, the so-called Way of the Dead, opposite the Pyramid of the Sun.

The cross contains 30 holes to each leg plus 1 at the center for a total of 121, or 11 squared: there are 63, or 9×7, holes per cloverleaf.

The north-south arm of the central cross was aligned 19.5 east of north. When the marker was shown to Harleston, he noted that one line of pitted holes indicated with special emphasis an azimuth which appeared to be almost 65 degrees.

To check this orientation with the greatest possible precision the researchers returned to the spot at noon of the vernal equinox equipped with a tripod and a pointer to center on the triple cross. They were then able to use the sun to trace a straight line across the marker without deviation from astronomical west to east, a line which was particularly accurate in 1974 because the sun happened to cross the equator at noon central standard time, which was also noon at Teotihuacan.

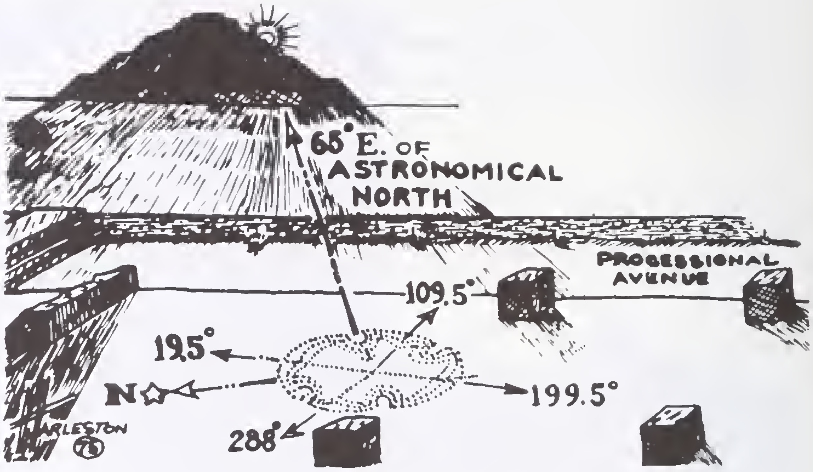
A perpendicular to this line gave the researchers a true north-south line from which it was possible to measure the azimuth marked out with holes on the mortar slab; it was precisely 65 degrees east of north.

By calculation, based on the latitude of Teotihuacan and the sun's declension, the solar azimuth on the morning of the summer solstice is 65.007 degrees.

To observe the actual occurrence of the phenomenon Harleston and Manuel Gaitan, a seventy-year-old professor of archeological restoration, who has been with the Mexican Institute of Anthropology for over thirty years, obtained permission from the institute to spend the night of June 20 in a tent on the Processional in preparation for the solstice of June 21.

During the night it rained on and off. The rainy season in the Valley of Mexico runs from June to September. But just after dawn on June 21, and shortly before sunrise, the rain stopped sufficiently for the two observers stationed by the triple cross to see the solstitial sun appear from behind the Sun Pyramid at the upper southeast corner of the third level in a way that was uniquely recognizable.

The phenomenon led the two observers to assume that another marker should exist from which sunrise could be accurately observed on the two mornings a year when the sun crosses the zenith above the Pyramid of the Sun—May 19 and



Sun at the summer solstice of June 21 as it appears behind the third level of the Sun Pyramid seen from the Triple Cross at Teotihuacan.

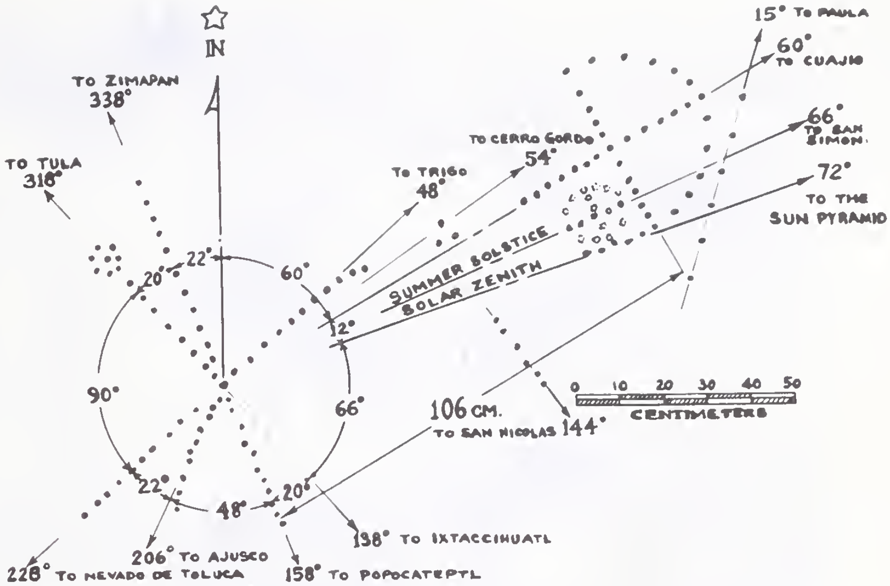
July 25 in 1974. Harleston calculated the spot where an observer would have to stand to be able to see across the top of the Sun Pyramid as being 14 kilometers southwest of the pyramid at an elevation of 2630 meters, forming an angle with the pyramid of 70.2 degrees east of north.

To be sure his calculations were accurate Harleston had them validated by three independent sources: by Mexico's leading geodesist, Manuel Medina Peralta, ex-director of the Geodesical School of Mexico's National University and author of *Elements of Positional Astronomy;* by Dr. Yogi Kondo, a NASA astrophysicist from Johnson Space Center in Houston, Texas; and by Dr. Paris Pishmish, an astronomer from Turkey. All agreed with his findings.

Three reconnaissance trips were made to the selected area near the summit of a hill called Chiconautla (the Place of Nine) 300 meters above the Valley of Teotihuacan and 2650 meters above sea level, but the trips proved fruitless; no marker could be found. Convinced that they had somehow missed the marker, Harleston and Gaitan spent the night of July 24 (which preceded the day of the zenith sunrise) at a campsite within half a kilometer of the calculated location. Again it rained, and the dawn was foggy and drizzly, but just at sunrise the clouds across the valley lifted enough for Gaitan to photograph the appearance of the solar orb above the Pyramid of the Sun, while Harleston, cussing the weather, ascended to the summit of Chiconautla, some sixty vertical meters higher than the encampment. He was then to be thankful for the rain.

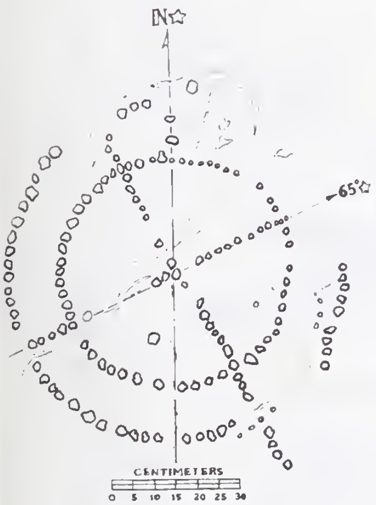
The wet shiny reflecting surface of the eroded lava outcroppings caused faint pittings of a multiangular marker to appear on the hilltop precisely at the calculated angle of 70.2 degrees and at an elevation of 2632 meters. The marker lined up perfectly with sunrise for that morning when the sun at noon stands directly over the Pyramid of the Sun at latitude 19 degrees 41 minutes.

Sunrise on May 19 and July 25, the days of the solar zenith at Teotihuacan, seen from the marker on the hill of Chiconautla.



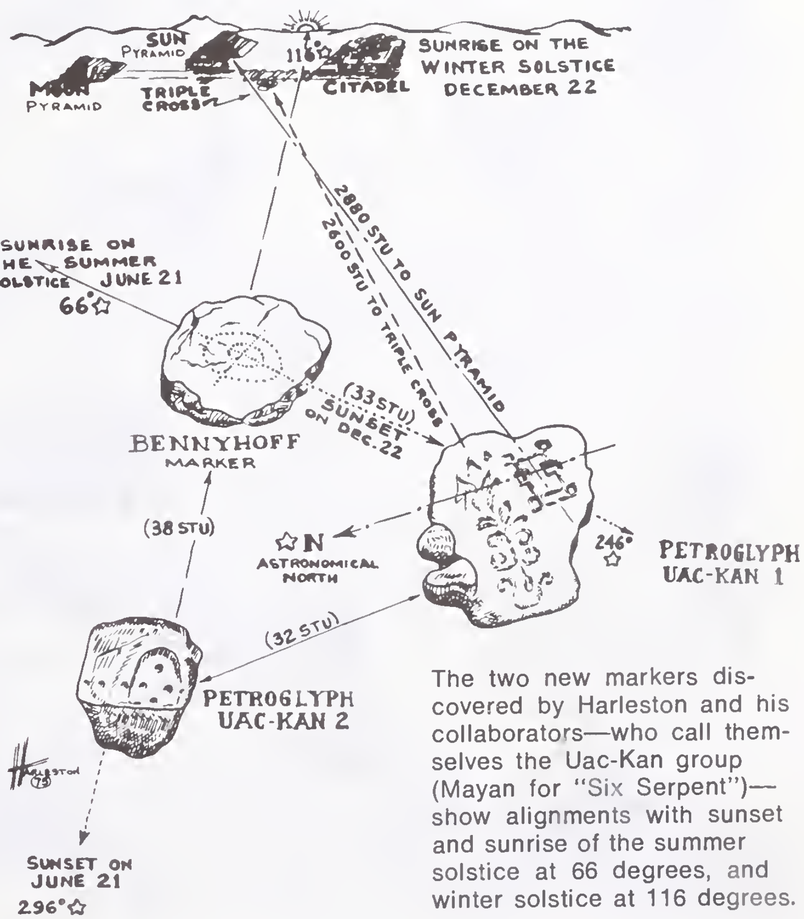
The marker named Uac-Kan Observatory No. 1 was located by Harleston thanks to an early morning rain that wet the surface and allowed the faint pittings to be seen. The pittings give angular directions to major mountaintops as well as alignments for the zenithal and solstitial sunrises, which strongly suggested to Harleston that the ancient Mexican geodesists used a system of 6-degree separations, the preferred Babylonian divisions.

Assuming that other markers would also have been placed for sighting the summer and winter solstices, the group found two more close to the marker discovered by James Bennyhoff, an American archeologist, in 1963. Used in conjunction, the markers form a triangle which enables an observer to sight along different legs to see sunrise and sunset on both summer and winter solstices.

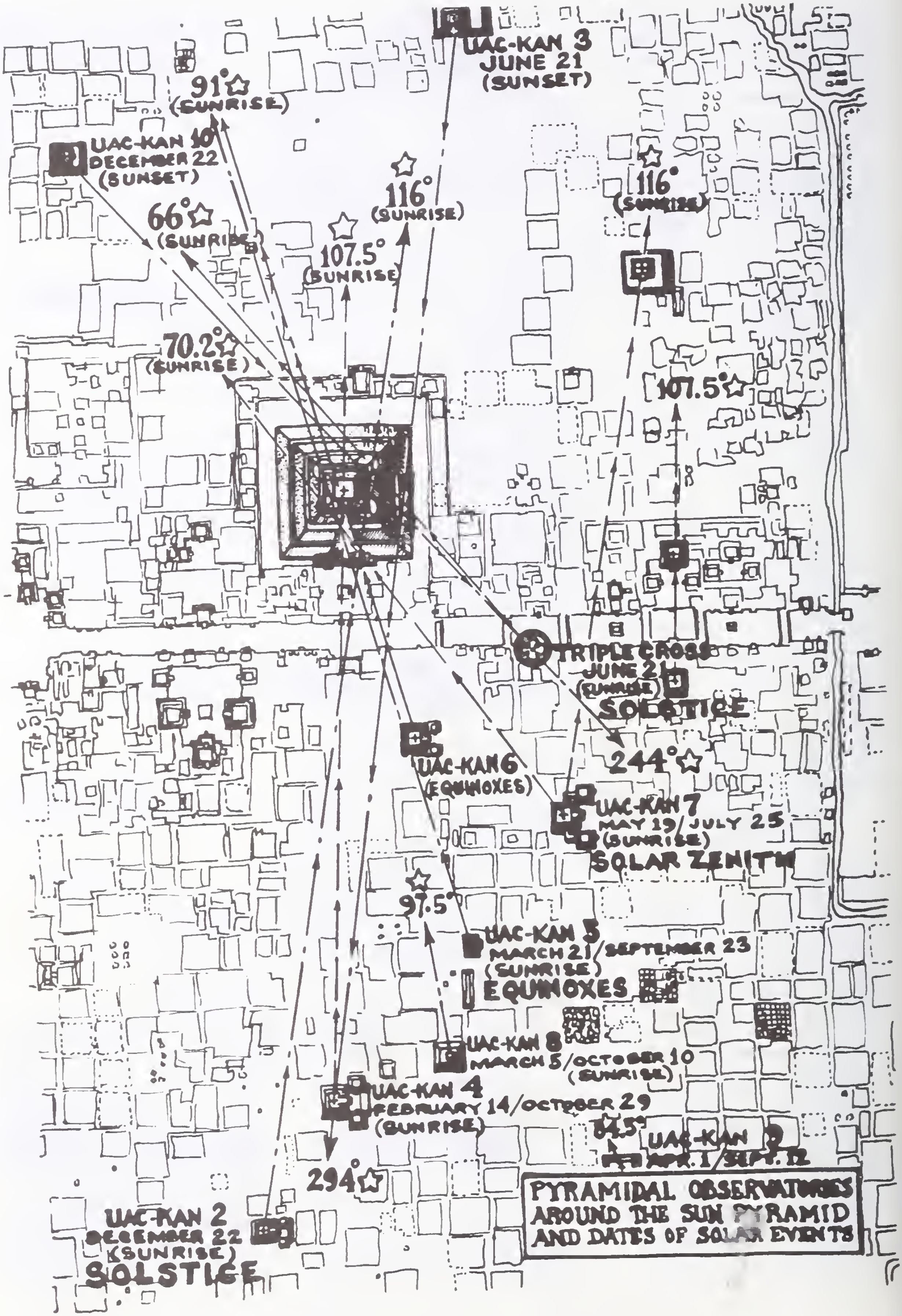


Bennyhoff marker.

In 1963, when the survey was being made of the hillsides around Teotihuacan for Millon's mapping project, archeologist James Bennyhoff, while walking the sloping southern flank of Malinalli in an area called Colorado Chico, found an almost invisible stone marker. The marker consisted of two circles and a cross; its arms were aligned on 65 degrees east of astronomical north, a fact that was not to be noticed until eleven years later. Bennyhoff's find lay dormant until its publication in 1973 as part of the introduction to the *Teotihuacan Map*.



The two new markers discovered by Harleston and his collaborators—who call themselves the Uac-Kan group (Mayan for "Six Serpent")—show alignments with sunset and sunrise of the summer solstice at 66 degrees, and winter solstice at 116 degrees.

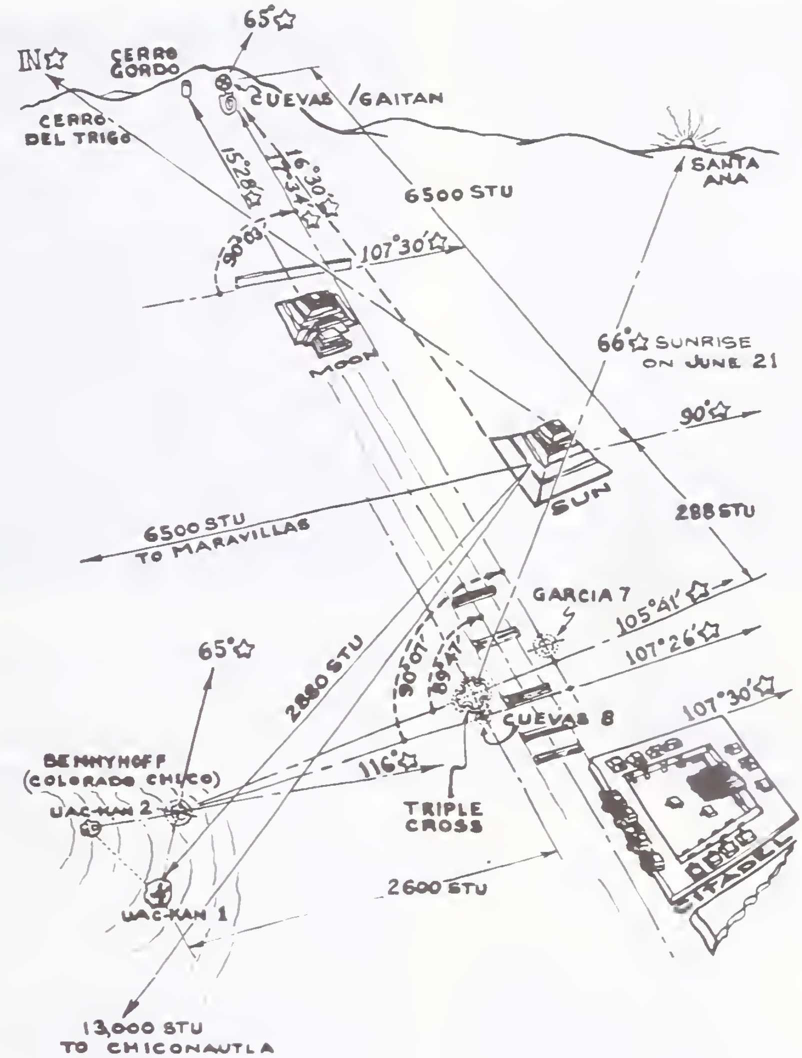

UAC-KAN 3
JUNE 21
(SUNSET)
91°
(SUNRISE)
UAC-KAN 10
DECEMBER 22
(SUNSET)
116°
(SUNRISE)
116°
66°
(SUNRISE)
107.5°
(SUNRISE)
70.2°
(SUNRISE)
107.5°
TRIPLE CROSS
JUNE 21
(SUNRISE)
SOLSTICE
244°
UAC-KAN 6
(EQUINOXES)
UAC-KAN 7
MAY 19/JULY 25
(SUNRISE)
SOLAR ZENITH
97.5°
UAC-KAN 5
MARCH 21/SEPTEMBER 23
(SUNRISE)
EQUINOXES
UAC-KAN 8
MARCH 5/OCTOBER 10
(SUNRISE)
UAC-KAN 4
FEBRUARY 14/OCTOBER 29
(SUNRISE)
APR. 1/SEPT. 12
294°
UAC-KAN 2
DECEMBER 22
(SUNRISE)
SOLSTICE
PYRAMIDAL OBSERVATORIES
AROUND THE SUN PYRAMID
AND DATES OF SOLAR EVENTS

Other observatories.

The Uac-Kan Observatory No. 2 was located by Dr. Matthew Wallrath as a tumulus, the ruins of an ancient pyramid 1240 meters (1170 STU) northwest of the Sun Pyramid. The alignment of 116 degrees east is across the southwest corner of the fourth body, exactly opposite to the one used for the summer solstice from the Triple Cross. This pyramid appears on the 1973 *Teotihuacan Map,* but was not identified as an observatory when the map was made.

Further investigations revealed that at least eleven other pyramids to the west and east of the Sun Pyramid could be used as observatories. All the observatories are located within a two-kilometer radius of the Sun Pyramid, and six of them are at positions for observations of the solar solstices, equinoxes, and days of zenithal crossing, six being the total number of major solar events per year. Other observatories may have been for ceremonies on February 14 and October 29, later moved to November 1, the important All Saints' Day, still a major Mexican holiday.

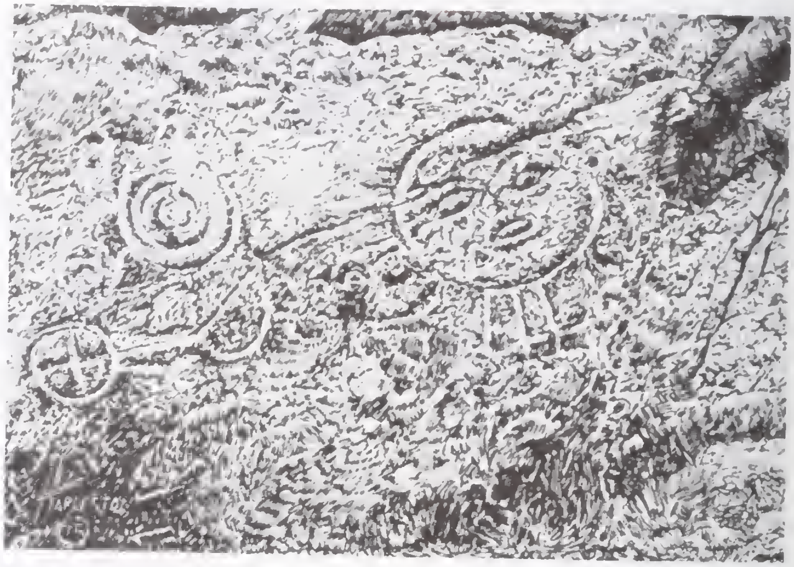
Further calculations led to the prediction and location of seven more observatories, including two that might have been destroyed and rebuilt as local land markers by the zealous clergy of the eighteenth century. These two markers are due east on Tepayo (U-K 11) and due south of the Sun Pyramid on Patlachique (U-K 12).



Convinced that another observation post must have been located closer to the Pyramid of the Sun from which to see the solar orb appear at the winter solstice, Harleston calculated it would have to be less than two kilometers from the pyramid, at an azimuth of 117 degrees, so that the mountains would drop away from the viewer, leaving only the pyramid to act as a mountain. With Dr. Matthew Wallrath, a Ph.D. in archeology who had worked with Millon's University of Rochester mapping project, they located a pyramid marked on Millon's map at 1200 meters from the Sun Pyramid, at exactly 117 degrees, from which the solstitial sun would appear above the second body of the southwest corner of the pyramid on December 22 or 23.

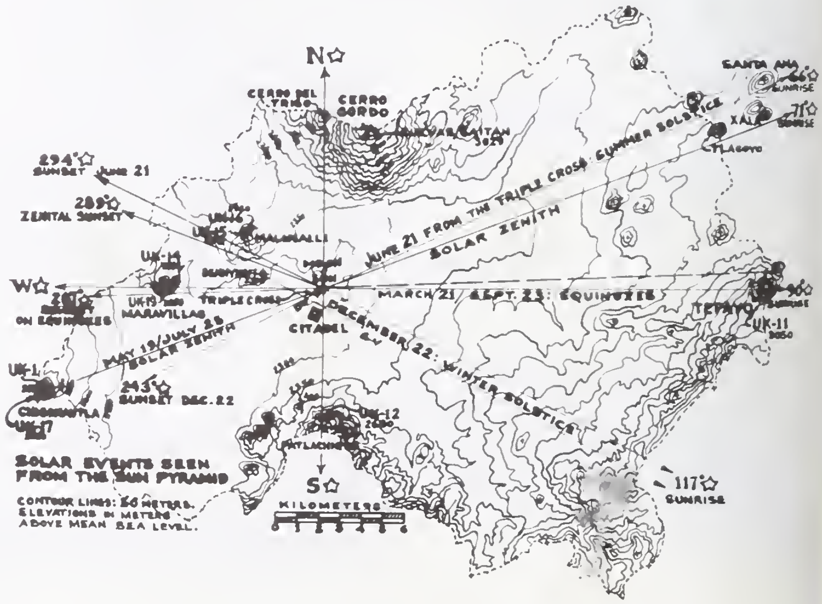
Further study of the Millon map revealed a whole series of remains of pyramids at different distances and angles, east and west of the Sun Pyramid, all within two kilometers. Azimuth angles for sunrise and sunset of summer and winter solstices, as well as of equinoxes and days of the zenith, were found to pass right through certain pyramids, indicating that

At the summit of Cerro Maravillas, Manuel Gaitan identified a marker named U-K 14 due west of the Sun Pyramid at an elevation duplicating the Bennyhoff stone. In addition to a circle and cross, this stone has an elliptical triple oval resembling the Garcia 6 configuration, and a circle with a face similar to designs already known at Teotihuacan, but with what appear to be shallow carvings of "sun rays" (not typical of Teotihuacan) believed to be the scratching of later visitors, perhaps the Aztecs of the fourteenth century, who could not resist the temptation to add their graffiti to the original.

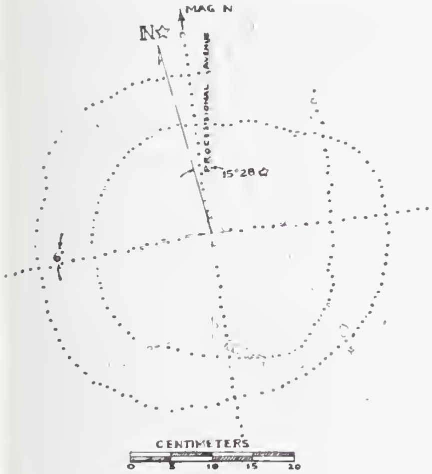


on these pyramids ceremonies may have been celebrated to mark important solar dates. From the location of many other pyramids scattered throughout the urban area it may now be possible to extrapolate the dates of other Teotihuacan celebrations marking lunar phases and stellar movements, such as the rising and setting of Sirius and the Pleiades.

From two other markers in the area southwest of the Moon Pyramid, it appears possible to sight across the third level of the Moon Pyramid and observe the maximum northward movement of the moon at the end of its nineteen-year Metonic cycle. If this is indeed possible, the Aztec attribution of "Sun" and "Moon" to the two great pyramids may be due to a vestigial tradition that they were once used for sighting the relative movements of these celestial bodies, a function which has only now been rediscovered.



The valley of Teotihuacan's solar events and marker orientations.

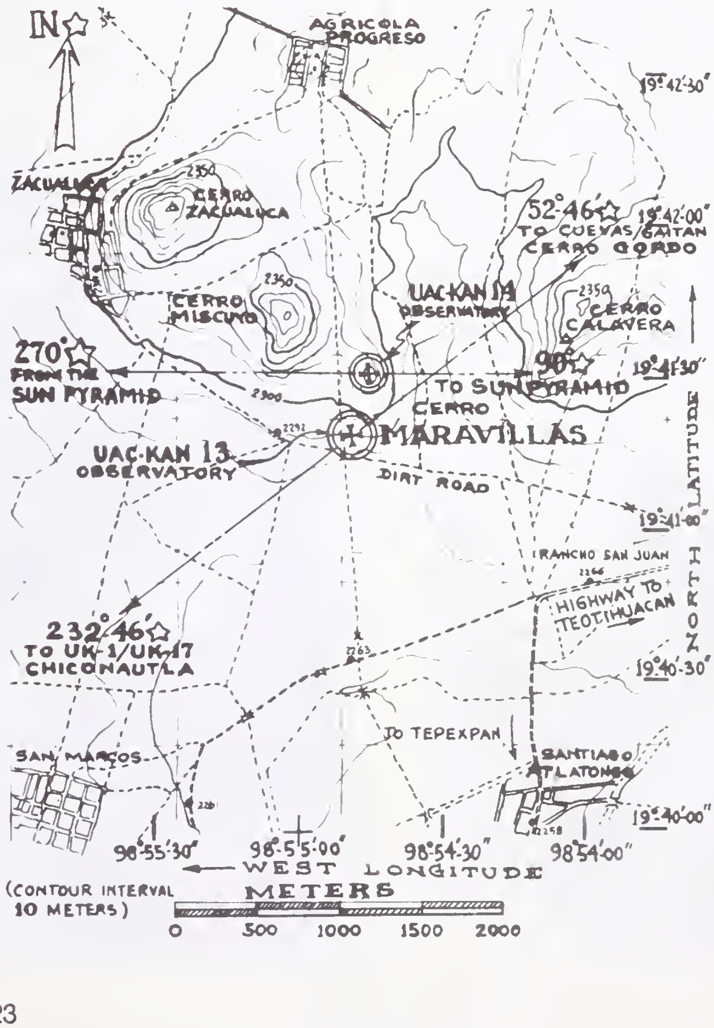


THE CUEVAS 8 MARKER

THE GARCIA 7 MARKER

THE GARCIA 6 MARKER

As in ancient Britain at midsummer, that is to say at the summer solstice, signals could have been sent with bonfires from the top of the Sun Pyramid, point to point over great distances; and it is noteworthy that Sahagun reported that Teotihuacan, as well as being known as "the place where men became gods," was also known as "the place from which the signals are made."



Markers on Maravillas showing angular relationships with other markers and with the Sun Pyramid.

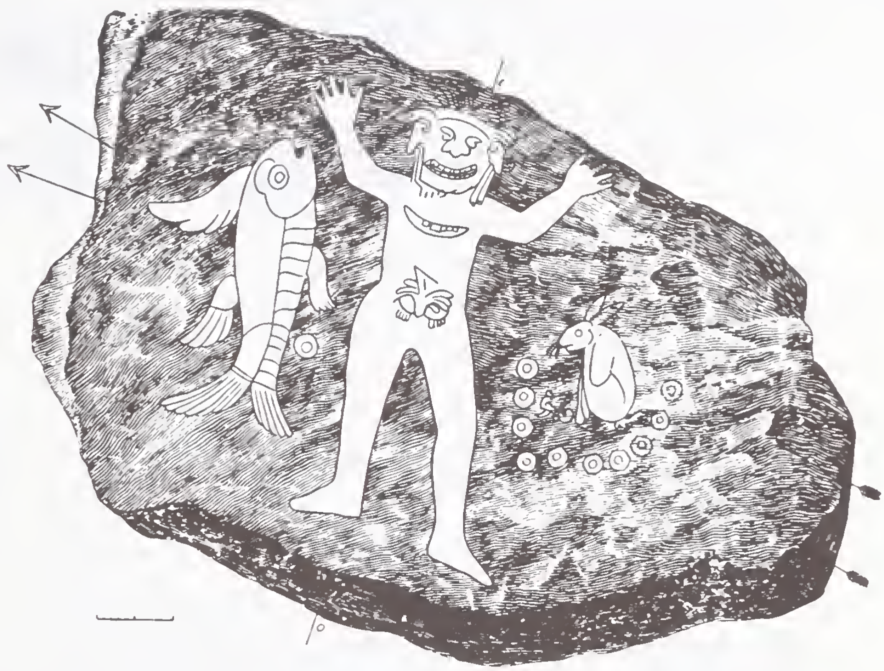
Similar stone marker designs have been found at distances on a great circle as far as 100 kilometers to the south of Teotihuacan and on the Mexico-U.S. border to the north. The coordinates of these stones permitted the prediction and location of previously unknown markers at telescopic distances from the Sun Pyramid, apparently used for the observation of astronomical events and for the definition of earth-commensurate distances and other cosmic information.

Surrounded by petroglyph murals, the egg-shaped omphalos of Observatory U-K 13 on Cerro Maravillas lies 7½ kilometers west of the Sun Pyramid. It not only provides a point from which to observe the sunset on the equinox directly aligned with the Sun Pyramid, but also has grooves for sighting the summer solstice at 66 degrees and three circles aligned on the winter solstice at 116 degrees east. An "astronomer's chair" on the west side allows the observer to lean back and comfortably watch a star cross the zenith. The backrest of the "chair" has the sculptured head of a combined man-serpent, with eroded fangs curled downward. The horizontal grooves and vertical lines of holes cut across the back of the serpent appear to have served as marks for a sundial that could be made by standing a 35-centimeter (1/3 of a *hunab*) wooden gnomon in a hole drilled to the right of the "astronomer's chair" in the main omphalos's body.

When the sun climbs skyward on the days of the equinox, the shadows of the west side of U-K 13 begin to move southward. The inclination of the chair is such that at ten o'clock A.M. the sunlight will start to illuminate the sculptured face. Within an hour, the chair has been converted into what Harleston calls "a vertical serpent of light, flying toward heaven, with the Sun Pyramid behind it: the symbol of Quetzalcoatl, the bird-serpent, which appears one week before and disappears one week after the day of the equinox!"

As the day wanes, the sundial shadow which had followed the line of holes up the serpent's back becomes a horizontal line at three o'clock, and then a vertical line by six P.M. At sundown the direct rays cross the omphalos stone to illuminate the Sun Pyramid, seven kilometers away, clearly seen through the V notch cut in the marker.

Dupaix found this stone giant (the figure is twenty-seven feet long) on the floor of a cabin near Orizaba. According to archeologist Daniel C. Brinton, who describes the giant as "an ogre of horrid mien," it is a depiction of Tzontemec Mictlanteculi, "the Lord of the Realm of the Dead, He of the Falling Hair." Brinton says "falling hair" represents the slanting rays of the setting sun at the winter solstice, and that the symbols convey a specific date: the winter solstice of the year 1 fish 10 rabbit.



This led Harleston to surmise that other ceremonial centers may have been built on what the English author Alfred Watkins called earthly magnetic "ley" lines at different azimuths from Teotihuacan, such as at Tupilco, 630 kilometers southeast of Teotihuacan, where a Mayan complex is presently being excavated.

Uaxactun, which was occupied by Teotihuacanos in the third century A.D., is 989 kilometers from Teotihuacan at an azimuth of 285 degrees, 30 minutes, forming a right angle to the Way of the Dead at almost 1000 kilometers.

Outside the ceremonial area at kilometric distances which appear to fit a module of 2268 of Harleston's *hunabs,* or 7800 Egyptian feet, other sites suggest that geodetic information was interlocked with the ceremonial zone's accurate display in what could be a global system of markers.

Additional information on a theoretical Teotihuacan geodesic system was presented at the Americanist Congress in Paris in September, 1976, that indicates a probable grid system that has been located by the Uac-Kan Research Group in the Valley of Tepoztlan, 85 kilometers southwest of the Sun Pyramid on the north-south alignment of 196° 30′.

23. Cosmic and Telluric Forces

John Michell, author of *The View Over Atlantis* and *City of Revelation,* is convinced that the Pyramid of the Sun at Teotihuacan, like the Great Pyramid of Cheops, is one of the fixed points in a worldwide geodetic system laid out on a vast scale with great accuracy by some former civilization with an advanced knowledge of science and what today is understood as magic. To lay out such a network of astronomical and geometrical lines across the face of the planet, says Michell, implies an advanced technology.

He believes that whoever built the system had "some remarkable power" with which to cut and raise enormous blocks of stone, vast astronomical instruments, pyramids, circles of pillars, cyclopean stone platforms, all linked together by a network of tracks and alignments, whose course from horizon to horizon was marked by stones, mounds, and earthworks, "a great scientific instrument sprawled over the entire surface of the globe."

From the evidence of old maps such as the portolanos, the Piri Reis, the Oronteus Fineus, and many others, it is clear that someone mapped this entire globe with a precision not reached again till the nineteenth century of our era. It is also apparent that they did not use Cartesian coordinates of latitude and longitude, but some system of spherical triangles, perhaps with some instrument by which they could follow earthly magnetic ley lines rather than a compass needle pointing to magnetic north.

Three Russian scientists, Nikolai Feodorovich Goncharov, Vyacheslav Moroz, and Valery Mokarov, have recently discovered evidence of faint magnetic lines which appear to run around the planet making of it a dodecahedron superimposed

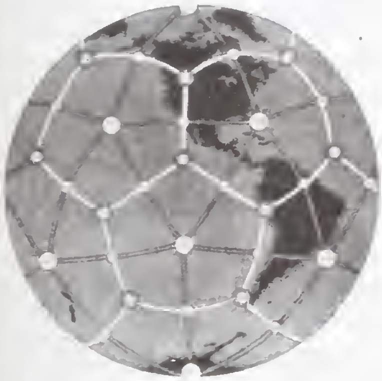
Alfred Watkins of Hereford (1855–1935), discoverer of the ley system.

on an icosahedron, as if the planet had once been a great crystal or was conditioned in its energetic nature by some crystalline core.

On a geographical map the Russians traced the seats of ancient cultures, which appeared to follow the magnetic or energetic lines of the icosahedron.

On metereological and geological maps they found that all the global centers of maximal and minimal atmospheric pressure occurred at the twenty nodes of the dodecahedral skeleton. These were the spots where hurricanes originate, or where there are gigantic vortices of ocean currents.

Christopher Bird reports that another Russian, Vitaly Kabachenko, while studying photos of the earth taken from space, found a deep-seated grid structure of the lithosphere, or upper hard core of the earth, which at times seems to "shine through." The phenomenon, says Kabachenko, appears as black streaks on the ocean, and in the sky as a barely noticeable network of nebulous streaks. Bird quotes another Soviet geologist and mineralogist, Dr. Vladimir Neiman, as suggesting a universal space-filling lattice which controls the position not only of planets and stars but of galaxies and intragalactic space. Like Wilhelm Reich, who suggested a basic ether or life force which traveled in spiral waves with matter forming where two spirals superimpose, Neiman substitutes for the idea of a primordial chaos a regulatory pulsation, with all matter—galaxies, stars, planets—being formed at the nodes.



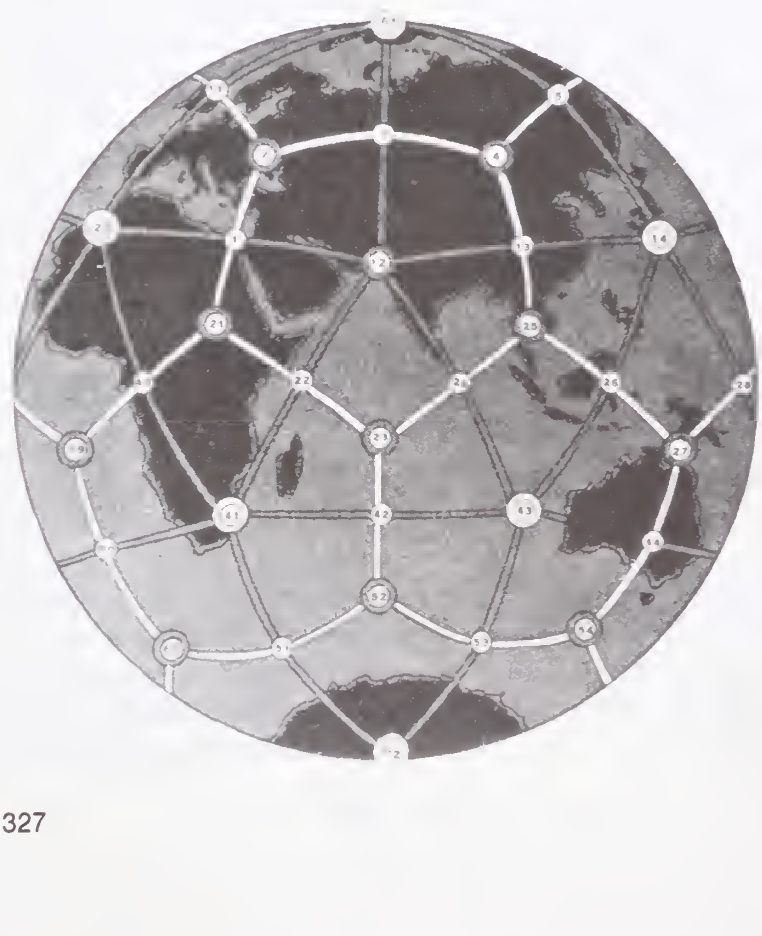
Soviet earth grid reported by Christopher Bird.

The thin lines of the grid form a dodecahedron solid with twelve pentagonal slabs. Plato has said that "the earth viewed from above resembles a ball sewn from twelve pieces of skin."

The thick lines form an icosahedron of twenty faces. The planet, therefore, appears to act energetically as if pulsating between one shape and the other.

The Soviets found that mid-oceanic ridges, core faults, and active zones occurred along the edges of these superimposed crystalline structures, and that such magnetically anomalous spots as the Bermuda Triangle fell on the nodes.

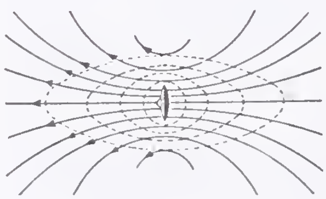
Ivan Sanderson, the professional biologist who founded the Society for the Investigation of the Unexplained, in Columbia, New Jersey, and fathered the vogue of the Bermuda Triangle, suggested nine more similar areas situated symmetrically around the globe, five above and five below the equator. To these the Soviets added the North and South Poles to obtain their dodecahedron.



Corroborative evidence for a lattice of ley lines on the earth comes from Aimé Michel, a French writer on UFO's, who says that sightings over the planet appear to run along similar magnetic lines, lines which Air Force pilot Bruce Cathy of New Zealand in his book *Harmonic 695* has drawn as a lattice covering the globe. Similar energized lines were obtained by Buckminster Fuller as great circles which define the lowest common multiple of his vector equilibrium triangles, of which there are forty-eight to a sphere. If one of the edges of Fuller's cuboctahedron lies along the equator, the intersection of three of his great circles will define the latitude of Teotihuacan to within a quarter of a degree.

From these approaches it appears that if the planet—as Goethe and Rudolf Steiner considered it—were a living breathing entity, it would take the form of a dodechahedron-icosahedron when compressed to its most compact stage. Medially expanded, it would take the shape of Buckminster Fuller's vector-equilibrium cuboctahedron. Fully expanded, it would have the shape of a truncated tetrahedron.

Wachsmith illustration. Part of a series showing a living breathing earth.



Suggested method of propulsion of UFOs along magnetic grid lines.

The ancients apparently considered the earth to be not only living but to have a nervous system related to its magnetic field, with nodes of power similar to the acupuncture points of a human body.

These straight lines running from node to node appeared to be involved with a power which was symbolized by a serpent or a dragon; the Chinese called these lines, which ran invisibly over the whole surface of the earth, lines of dragon current. The Chinese further divided the dragon current into two kinds, negative and positive, or yin and yang, represented by a white tiger and a blue dragon, symbols very similar to the jaguar Tezcatlipoca and the plumed serpent Quetzalcoatl.

The yang, or male current, was believed to run along mountainous ridges and ranges of hills, the yin, or female, along valleys, rivers, and subterranean channels.

These powers were also symbolic of cosmic and telluric forces which became creative in wedlock—such as the sun's rays impregnating mother earth.

Michell has no doubt that the dragon current is a natural flow of force related to the earth's magnetic field, something in the nature of the orgone energy rediscovered by Wilhelm Reich, which Reich postulated to be present throughout the universe in every particle of matter, every area of space, running in definite lines, and accumulating under specific circumstances, a force on the order of Franz Anton Mesmer's animal magnetism, Karl von Reichenbach's odyle, or what has now come to be known as *pyramid power.*

Like Reich, Mesmer, and Reichenbach, the ancients concluded the dragon power to be curative, invigorating, and

To Michell the mathematical rules of the universe are visible to men in the form of beauty: "The secret rules of poetry and aesthetics, which we now believe to be beyond rational expression, can be demonstrated in numbers, ratio and angles of the confluent lines of terrestrial geometry." Michell elaborates: "The key numbers are those which occur prominently in several different spheres and which express the element of unity or correspondence in phenomena apparently disparate in their nature and scale. The philosophers of the ancient world discovered that the peculiar qualities of these numbers could be discerned through measurement of the visible universe. Astronomers found these in the cosmic ratios, in the relative sizes of the heavenly bodies and in the intervals that separated them; mathematicians proved their relevance to the figures of regular geometry and discovered the magic squares and numerological patterns by which their geometrical relationships were further revealed. Musicians and artists observed that these same numbers and ratios were those that produced the most perfect harmonies and touched the deepest sources of human emotion. They contained in fact the secrets of magic."

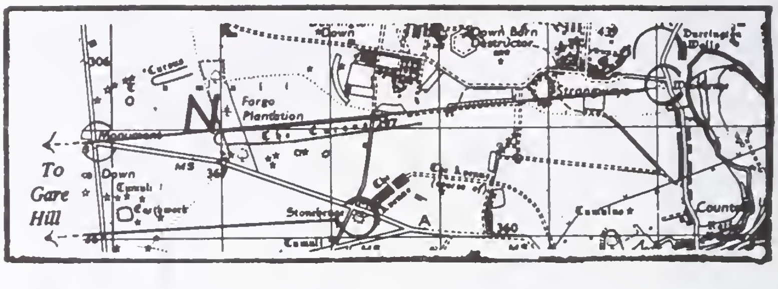
We all live within the ruins of an ancient structure whose vast size has hitherto rendered it invisible.

THE VIEW OVER ATLANTIS

John Michell

consciousness-expanding, a power which, as it passed down straight lines across the country, drew in its wake the fertilizing powers of life.

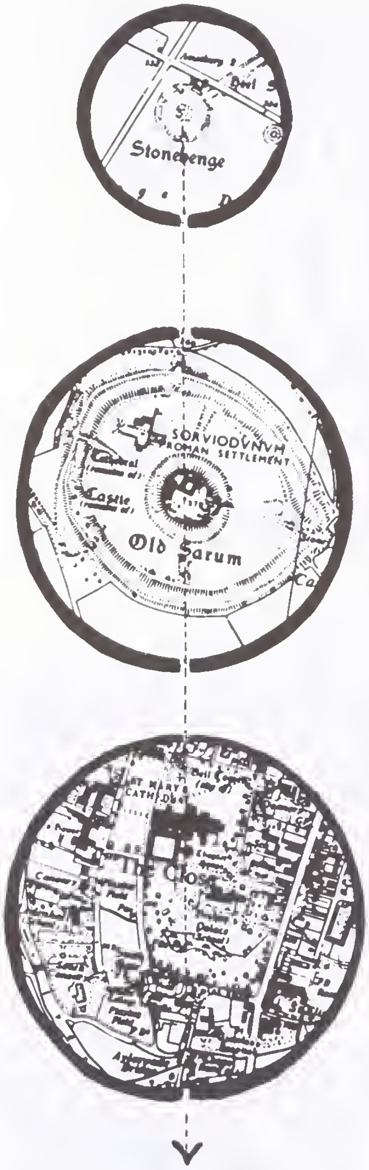
The most favored places were where two streams crossed. To find such spots, clairvoyants and dowsers were employed. Once found, temples and shrines were built on the spots, or great stones erected, linked by ley lines with other similar hot spots.



Michell says geomancers were used to detect these currents and interpret their influence on the land over which they passed, marking the course of the dragon power with alignments of mounds and stones, which then became the traditional paths of pilgrims from one holy place to the next.

According to Michell, the orientation of holy shrines and later of individual churches, including the details of their dimensions and architectural plans, was determined by these lines of current, of which the strongest spring was frequently located directly beneath the towers. At this spot the celestial influence was understood to combine with the terrestrial force to produce fusion.

Louis Charpentier, in *Les Mystères de la Cathédrale de Chartres,* says the cathedral stands on a large prehistoric mound over a buried chamber, which acts as a natural meeting place of several powerful streams of telluric current.



In *The View Over Atlantis,* Michell shows the remarkable ley-line alignment—noted by both Lockyer and Watkins—of Stonehenge, Salisbury Cathedral, and the prehistoric earth rings of Old Sarum, former site of the cathedral. The unit of measure appears to be the furlong of 220 yards.

From Stukeley's *Stonehenge.*

According to W. Y. Evans-Wentz there seem to be favored places on the earth where its magnetic and even more subtle forces are most easily felt by persons susceptible to such things. Carnac in France is said to be such a spot, as is Glastonbury in England, Iona in Scotland, and Fata in Ireland.

In ancient Britain, and once all over the world, buildings and stones were placed in landscapes according to a magic system by which the laws of mathematics and music were expressed in the geometry of the earth's surface.

Experts on geomancy such as Michell say the strength and activity of the magnetic currents is influenced by the composition of the ground over which it passes. Over firm, flat country it is said to be placid and regular; over rocky, broken land it becomes violent and disturbed, reacting with the elements that cause magnetic storms or polar lights. Near geological faults or volcanoes the magnetic flow is said to become particularly agitated because of springs of current which at these places burst through the earth's crust.

The strength and direction of the currents of the magnetic field, which is said to flow over the whole surface of the earth, are apparently influenced by such factors as the proximity and relative positions of the other bodies of the solar system, chiefly the sun and the moon, the sun imposing a daily rhythm modified by such influences as the lunar cycle, the moon exerting the same influence on the invisible magnetic flow as it does on the tides.

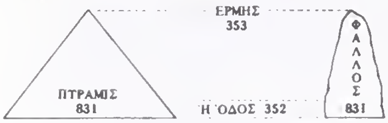
That is why, says Michell, the ancients were so preoccupied with lunar eclipses, which have no apparent physical influence on the earth other than on the level of magnetism.

At certain seasons the lines were believed to become animated by a current of invisible energy, reaching a peak on certain days, which could have a fertilizing effect on the land.

A dowser in the south of France, killed by the Germans during World War II, developed a machine whereby he could monitor cosmic forces which entered the soil, affected minerals, and then exited from the earth at other definite spots as telluric forces. By channeling these forces into his patients, he was able to cure humans of many varied diseases.

A young English engineer, Michael Watson, who worked on the construction of the Concorde, managed to salvage the Frenchman's notes, and claims with their help to have been able to photograph what he assumes to be the fourth state of water, or water in its plasmic state. He believes such elements as plasmic water have programmed goals which they follow like earth-encompassing genies, something close to the formative forces described by such authors as Gunther Wachsmith, and postulated and believed in by the ancient Mesoamericans.

SYSTEM OF SPIRITUAL ENGINEERING BY MEANS OF PYRAMID, STANDING STONE AND MAGNETIC PATH



From John Michell's *The View Over Atlantis.*

Michell infers a magnetic relation between pyramid and obelisk, or erect stone marker, saying that "Standing stones, which in many parts of the world are still regarded as the phallic instruments of fertility, are linked by the one mercurial principle with the Great Pyramid at the central storehouse of terrestrial current."

Michell quotes Iamblichus, the fourth-century theurgist, on the use of phallic stones as markers by means of which native geomancers directed the flow of magnetic current to fertilize the countryside.

"We say that the erection of Phalli is a certain sign of prolific power, which, through this, is called forth to the generative energy of the world."

Michell adds that an analysis of cabalistic numbers reveals a definite association between the terrestrial current and lunar influence.

The Austrian scientist and mystic Rudolf Steiner made numerous experiments which revealed the extent to which planetary influences affect not only the magnetic currents of the earth's surface but the layers of mineral ore deep below. The minerals within the rocks, says Steiner, are never inactive, but subject to regular cycles of motion in accordance with the orbits of the particular planet to which they chiefly respond. He says that at certain seasons they become charged with energy which they gradually release into the soil, and this allows seeds to germinate and stimulates vegetable growth.

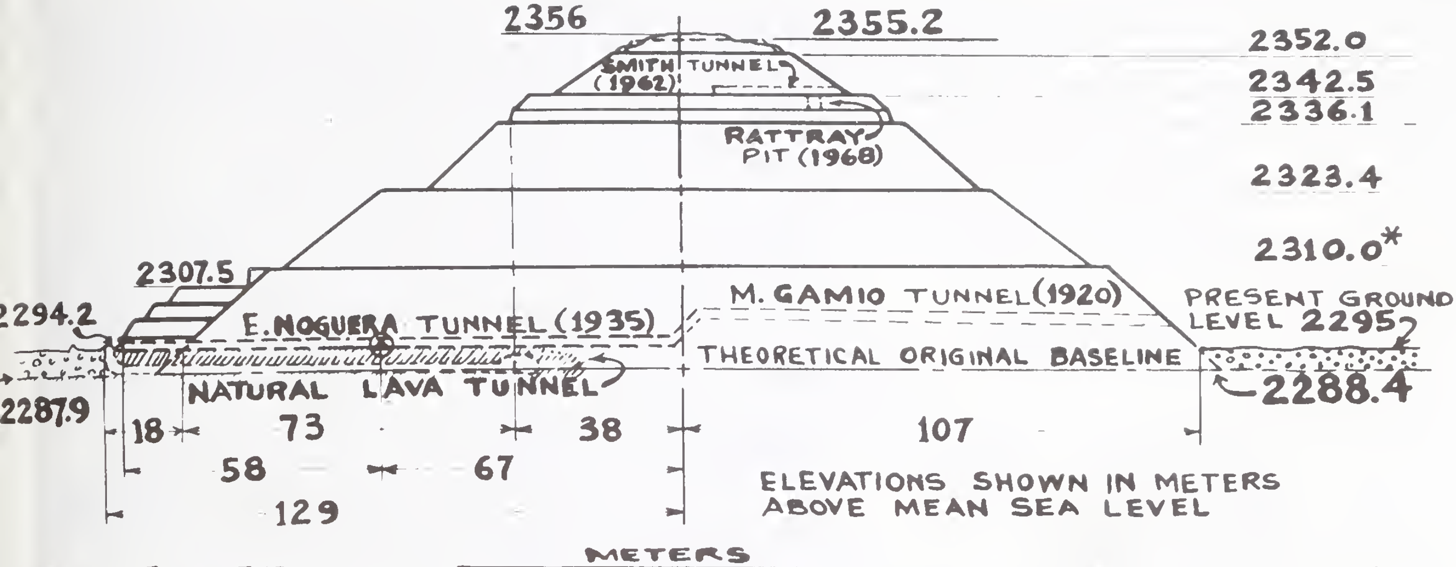
It is possible that seasonal feasts and "dragon processions" may have produced the vibrations of music and magnetizing effect, a sort of orgonomic injection, to increase vitality in humans and to stimulate the growth of plants, the plants on which the ancients survived and flourished, and which today we poison with toxic sprays and debilitating "fertilizers."

One of the most sacred locations where the ancients believed the most powerful telluric and cosmic forces met in a creative intercourse was in a cave with a natural spring under a pyramidal mound.

In 1930 a French dowser, Paul Berger, who styled himself "a prospector at great distance," dowsed a photograph of the Pyramid of the Sun at Teotihuacan and said he had found the hidden entrance to yet another gallery at an approximate depth of three meters from the base of the first level. Berger, who said he had specialized in locating mineral deposits while prospecting in Switzerland, Canada, and the United States, claimed the entrance had been plugged but that beyond the barrier a tunnel ran to the center of the pyramid, where it opened into a room closed on all sides, except for a small gallery on the right and another room on the left in which he could distinguish six articles in a row which appeared to him to be of gold. Berger offered to indicate the precise spot of the opening of the gallery so as to reduce to a minimum the necessary work of finding it.

When the editor of *Art and Archeology,* Arthur Stanley Riggs, tried to check on Berger's data with the Secretary of Public Education in Mexico City, he was told by the director of archeology, Don José Reygadas Veritz, that he had no knowledge of any such tunnel, nor did he believe it existed.

Unaware of this dowser's report, René Millon continued to be convinced that some sacred structure existed beneath the bulk of the Sun Pyramid, despite the failure of either Manuel Gamio or Eduardo Noguera to find it with their tunnels. Finally in 1959, Millon secured enough funds from the National Science Foundation in Washington, D.C., to organize a group



ADAPTED FROM THE R. MILLON DATA (1959) AND THE TEOTIHUACAN MAP, 1973, VOL. 2.

* SAME AS THE BASE ELEVATION OF THE MOON PYRAMID

Ⓐ STONEWORK FOUND IN NOGUERA TUNNEL (1959)

The tantalizing question of what might be buried either deep within the great pyramids or underneath them was first seriously broached by Manuel Gamio in 1917, when he decided to tunnel into the base of the Pyramid of the Sun. Starting just above ground level on the east side, he pushed a tunnel about two meters high and not quite as wide horizontally toward the center at a slight upward slope.

Gamio's main purpose was to establish whether any major interior structure of stone lay within the pyramid which would indicate that it had been built in stages. Leaning toward the theory that the pyramid had been built all in one piece, Gamio found no evidence of previous structures. When the tunnel reached a hundred meters he quit, satisfied that he had proved his point.

Second thoughts on the subject were had by an engineer called Eduardo Noguera some seventeen years later; so he obtained permission to drill a tunnel from the west side of the pyramid to meet Gamio's in the center. As the entire base of the Sun Pyramid would thus be traversed, he hoped to prove or disprove Gamio's theory. The entrance to Noguera's tunnel was slightly below present ground level, protected from rain by a masonry extension to the *adosado,* or lower structure, attached to the west facade. The tunnel ran to the center of the pyramid about 6 meters below the level of Gamio's tunnel and was offset about two meters to the north. A connecting staircase joined the two tunnels, which together ran 218 meters.

Though Noguera searched diligently, he found no signs of an earlier pyramid on which the later structure could have been superimposed, nor any internal strengthening features; so he concluded that the only way the great mound was held together was by the tensile strength of the outer skin of 15 to 20 centimeters of mortared adobe and stone.

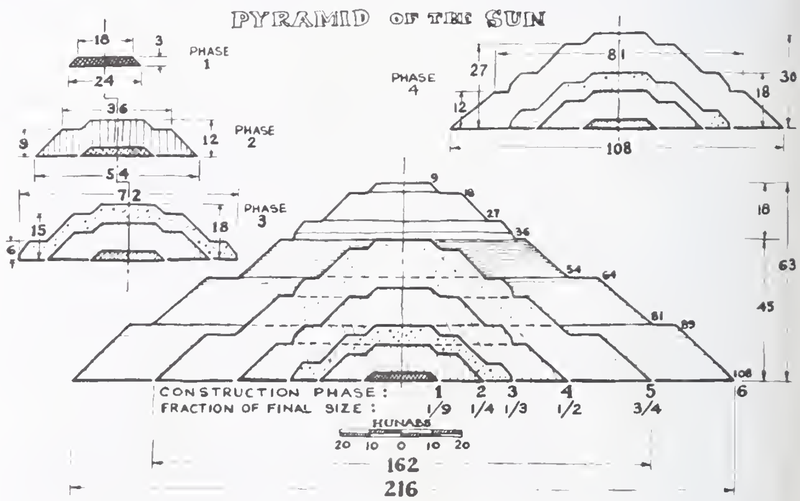
What Noguera did find were some 35,000 pottery shards, all of the earliest period of Teotihuacan development, called by the experts Archaic, or Teotihuacan I, or Tzacualli, which indicated that the pyramid had been built about the time of Christ or earlier.

If this seemed to settle the dating of the pyramid, it failed to settle the question of inner structures.

In 1962, Smith, with the help of the Peabody Museum, put a tunnel almost to the center of the east face of the fifth body of the Sun Pyramid, going west. Six years later Dr. Evelyn Rattray, working with Millon, excavated on the south side of Smith's tunnel till she ran onto a giant *talud* sloping wall, two meters high, indicating an earlier inner structure. Based on Dr. Rattray's papers, Harleston figured this wall to have had a slope up from north to south of 70.5 degrees, showing an earlier stage of construction similar to the one on the fourth level reconstructed by Batres—validating his claim of having learned to reconstruct more accurately as he approached the top of the pyramid. Since the wall was on the north side, its angular inclination could have served the same purpose as the present lower part of the fourth stage for shadow observation on or about the equinox.

to make a closer search in the tunnels for remains of earth and clay structures which might have eluded both Gamio and Noguera. Millon's group was interested in finding out what kind of fill had been used in the construction of the pyramid and in what way adobe bricks had been used.

At about fifty-five meters into Noguera's tunnel, the new investigators found evidence of adobe walls. Then, by running smaller branch tunnels north and south, near the center of the pyramid, they came across what Millon hoped they would find: the remains of what could have been a major structure, possibly a tomb of immense proportions. Here was a pyramid of much older construction, with an earth nucleus covered with adobe bricks, faced with uncut stones and cobbles, much of it destroyed. They also found evidence of what might once have been a huge pit. Millon still believed the additional blocked passages would reveal a mammoth tomb.



Hugh Harleston's Theoretical Construction Sequence of the Sun Pyramid.

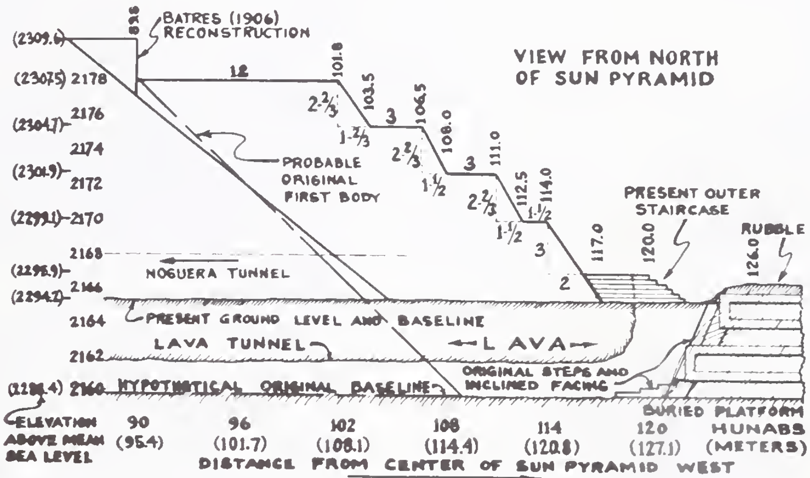
If the Sun Pyramid had been built in stages, by first building the sixth level on the ground, then superimposing on it a structure equivalent to the fourth and fifth levels, the upper outlines of the pyramid could have been progressively raised, maintaining a constant outline. Harleston suggests that the 70-degree angle of the third phase was used to obtain the day of the equinox. It could thus have been repeatedly in use till it was raised to the fifth level. Harleston suggests the builders may have built the stages in four 52-year cycles, constantly maintaining the shadow devices.

While Millon and his colleagues wrote papers on the results of these finds to be digested by the academic community and interested archeologists, a whole decade passed and nothing of interest was forthcoming for the laity. Then, in the fall of 1971, a heavy rain squall caused a deep depression at the foot of the main stairway of the Pyramid of the Sun. Examining the depression, Ernesto Taboada, locally in charge of the archeological zone, found the remains of an ancient and semi-destroyed stairway. As debris was removed, Taboada found steps that led six meters down into a pit to the entrance of a natural cave, two meters high, leading horizontally into the bedrock beneath the pyramid.

Jorge Acosta, in charge of all digs at Teotihuacan, was summoned to view the site and immediately took charge of clearing and consolidating the find. Ironically, it was he who had spotted a section of the same staircase six years earlier, but he had been obliged to cover the find for lack of funds with which to clear the pit. Now he determined to follow the cave or tunnel wherever it might lead.

As the entrance coincided with the center of the pyramid's main stairway, Acosta realized the cave entrance must have been known before the construction of the pyramid was started, which led him to surmise that its presence might even have determined the site for the construction of the pyramid.

Harleston's rendering of the entrance to the cave below the Sun Pyramid beneath the *adosado*.



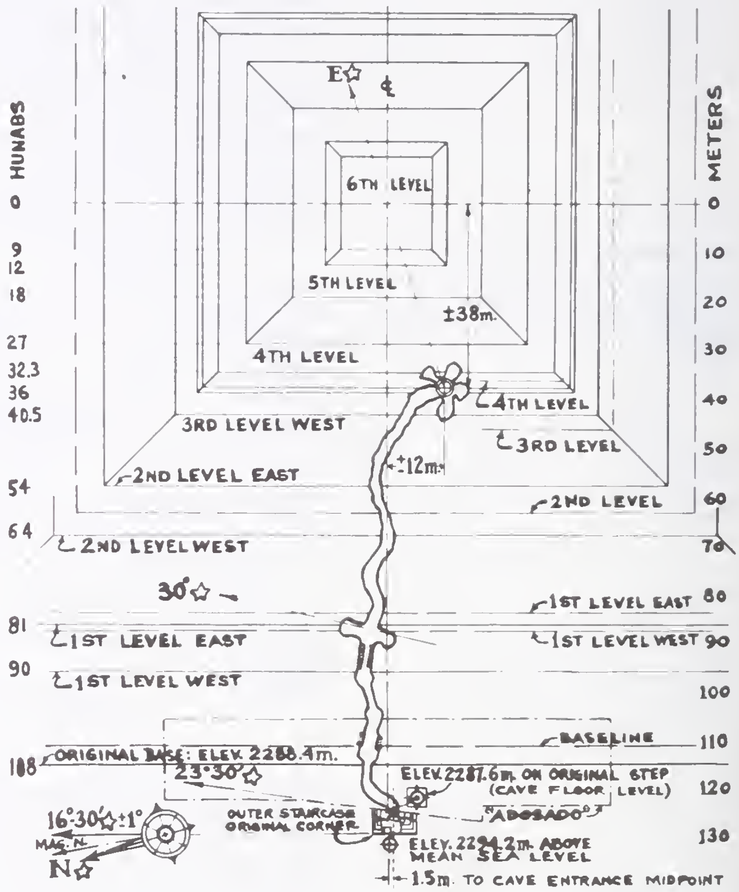
Entering the cave with a group of archeologists, Acosta found it to be a natural structure, two meters high and almost as wide, leading in an easterly direction. Frederick Mooser, a geologist of the Mexican University's Institute of Geology and a consultant to the Institute of Anthropology, said that in his opinion the cave was a natural formation, the result of lava flow that occurred more than a million years ago. The cave had been adapted by man for some purpose in that its walls were plastered with mud, and heavy stone slabs had been laid in the ceiling, some of them still in place.

As the group progressed along the subterranean canal by torchlight, they suddenly found themselves blocked by a wall of adobe and mortar which filled the cave with the exception of the top right-hand corner, which had been breached, apparently by vandals or by previous explorers, possibly much more recently than anyone cared to admit.

As the party advanced slowly down the tunnel, they encountered twenty-eight more blocking walls, all pierced. They also noted that the mortar on these walls was smoothed off between the adobe bricks only on the outer, westerly, side, evidently by masons *moving out.*

One hundred and three meters down the tunnel, the archeologists came upon an extraordinary sight: an arrangement of caves in the shape of an irregular four-leaf clover. Each chamber, which was ten to twenty meters in circumference, appeared to be of natural formation, deliberately enlarged by the hand of man.

Aerial view of tunnel beneath the Sun Pyramid, as drawn by Harleston from data collected in 1974 by the Uak-Kan group. Dotted lines are Batres' 1906 reconstruction. Solid lines show Harleston's hypothetical reconstruction.

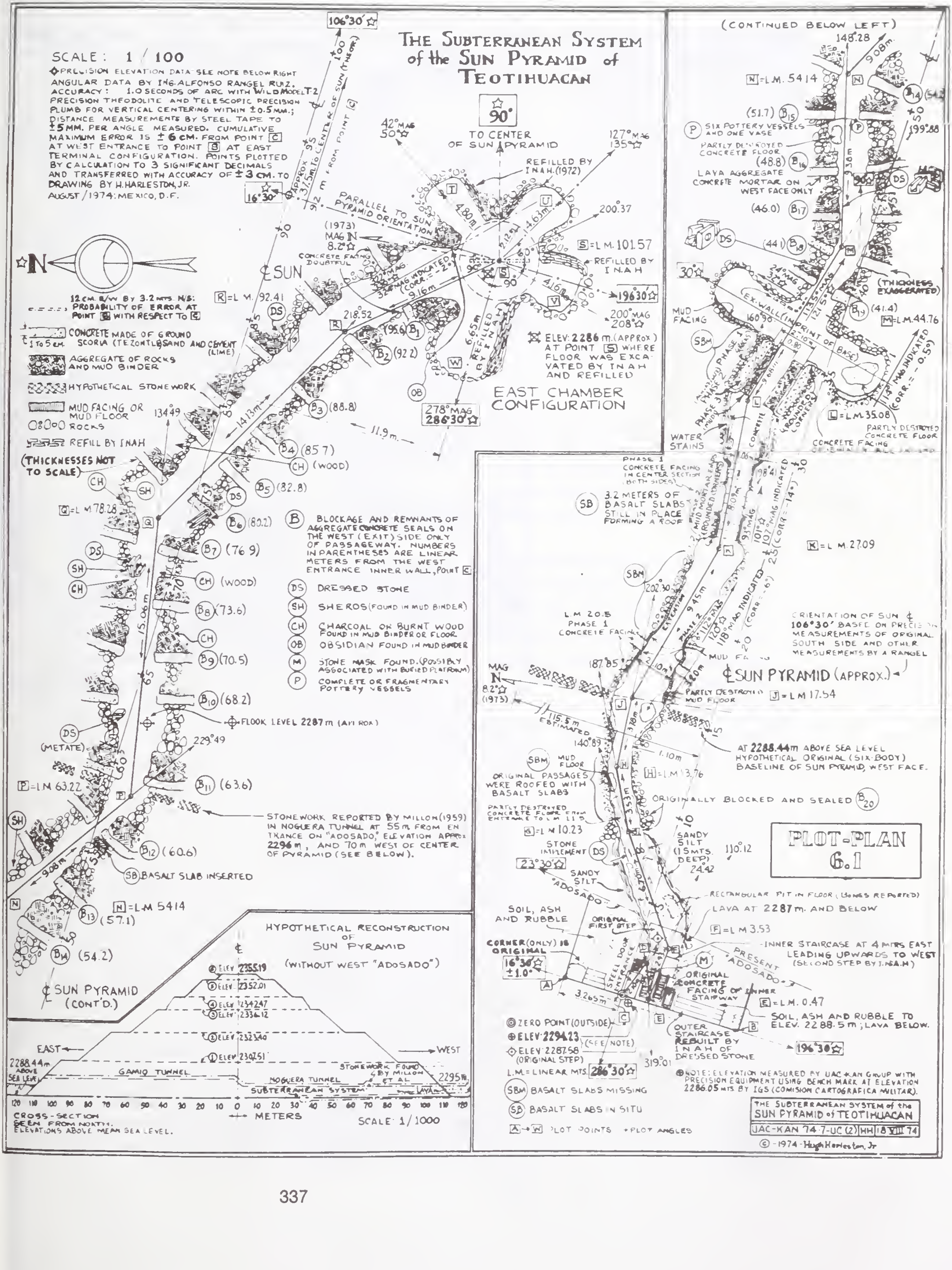


Doris Heyden, an archeologist from New Jersey who moved to Mexico after World War II to study art at the University of Mexico and marry her anthropology teacher, joined the Mexican Institute of Anthropology and History, and seized on the cave theme to write several articles and a doctoral dissertation on the *Social, Economic and Religious Symbolism of Caves in Ancient Mexico.*

Heyden first wondered whether the chamber caves beneath the Pyramid of the Sun could have been a prototype tomb, such as was found in the Temple of the Inscriptions in Palenque, placed beneath the pyramid to intentionally hide its contents from the eyes of men, a tomb long since rifled by intruders.

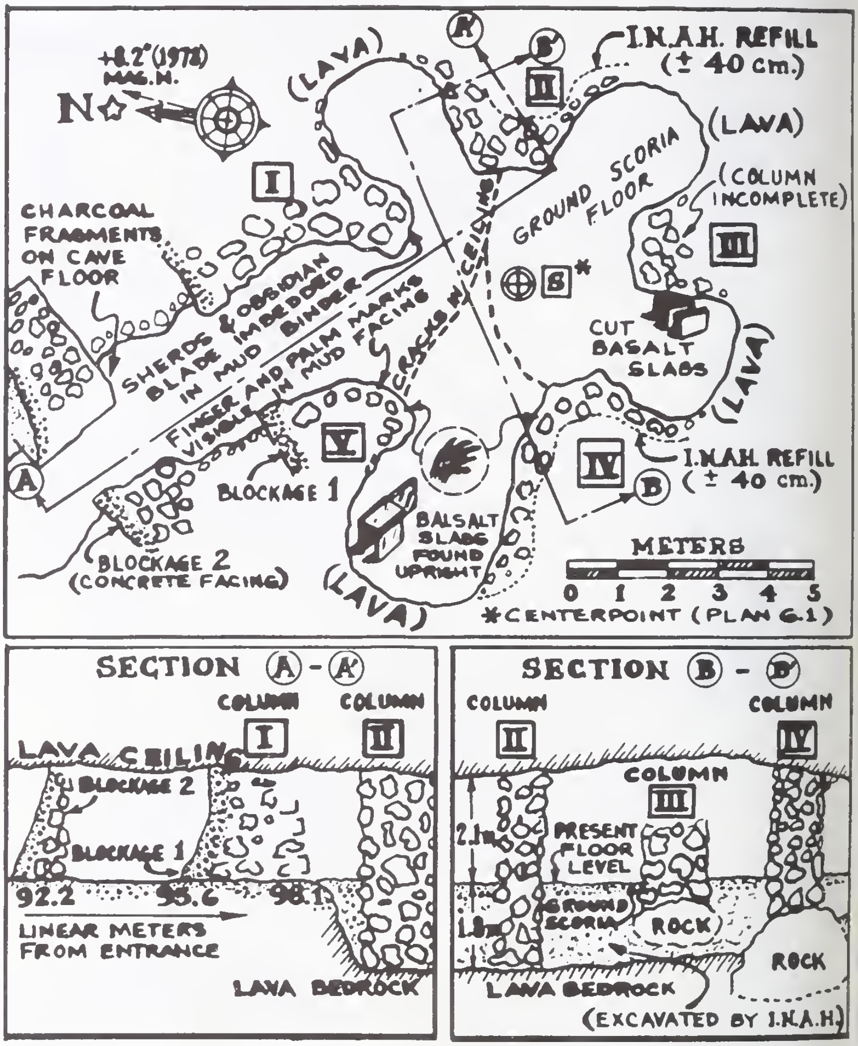
She then suggested that the caves could also have been for the ritual of burying children as offerings to a water deity. Brother Motolinia describes certain offerings to Tlaloc in which four children were sacrificed and their bodies placed in a cave whose entrance was sealed until the following year when the ceremony was repeated. Sahagun tells of a rite in which the victim was flayed, and after the priest had worn the victim's skin for twenty days, it was placed in a cave "in the pyramid called Yopico." This cave was said to be at the foot of a pyramid stairway, "in an underground place . . . which had a moveable doorway."

Heyden also pointed out that there are many indications in Mexico of oracles taking place in caves. In Morelos a rock carving dating from circa 600 B.C. shows a figure in a cave with enormous speech scrolls by his mouth, indicating, says Heyden, that he is saying something of great importance.



THE SUBTERRANEAN SYSTEM of the SUN PYRAMID of TEOTIHUACAN
SCALE: 1/100
PRECISION ELEVATION DATA: SEE NOTE BELOW RIGHT. ANGULAR DATA BY ING. ALFONSO RANGEL RUIZ. ACCURACY: 1.0 SECONDS OF ARC WITH WILD MODEL T-2 PRECISION THEODOLITE AND TELESCOPIC PRECISION PLUMB FOR VERTICAL CENTERING WITHIN ±0.5MM.; DISTANCE MEASUREMENTS BY STEEL TAPE TO ±5MM. PER ANGLE MEASURED. CUMULATIVE MAXIMUM ERROR IS ±6CM. FROM POINT C AT WEST ENTRANCE TO POINT B AT EAST TERMINAL CONFIGURATION. POINTS PLOTTED BY CALCULATION TO 3 SIGNIFICANT DECIMALS AND TRANSFERRED WITH ACCURACY OF ±3CM. TO DRAWING BY H. HARLESTON, JR.
AUGUST/1974: MEXICO, D.F.
(CONTINUED BELOW LEFT)
TO CENTER OF SUN PYRAMID
EAST CHAMBER CONFIGURATION
ELEV: 2286 m. (APPROX) AT POINT S WHERE FLOOR WAS EXCAVATED BY INAH AND REFILLED
CONCRETE MADE OF GROUND SCORIA (TEZONTLE) SAND AND CEMENT (LIME)
AGGREGATE OF ROCKS AND MUD BINDER
HYPOTHETICAL STONEWORK
MUD FACING OR MUD FLOOR
ROCKS
REFILL BY INAH
(THICKNESSES NOT TO SCALE)
B BLOCKAGE AND REMNANTS OF AGGREGATE CONCRETE SEALS ON THE WEST (EXIT) SIDE ONLY OF PASSAGEWAY. NUMBERS IN PARENTHESES ARE LINEAR METERS FROM THE WEST ENTRANCE INNER WALL, POINT C
DS DRESSED STONE
SH SHEROS (FOUND IN MUD BINDER)
CH CHARCOAL OR BURNT WOOD FOUND IN MUD BINDER OR FLOOR
OB OBSIDIAN FOUND IN MUD BINDER
M STONE MASK FOUND. (POSSIBLY ASSOCIATED WITH BURIED PLATFORM)
P COMPLETE OR FRAGMENTARY POTTERY VESSELS
STONEWORK REPORTED BY MILLON (1959) IN NOGUERA TUNNEL AT 55m FROM ENTRANCE ON "ADOSADO", ELEVATION APPROX 2296m, AND 70m WEST OF CENTER OF PYRAMID (SEE BELOW).
HYPOTHETICAL RECONSTRUCTION OF SUN PYRAMID (WITHOUT WEST "ADOSADO")
CROSS-SECTION SEEN FROM NORTH. ELEVATIONS ABOVE MEAN SEA LEVEL.
SCALE 1/1000
ORIENTATION OF SUN ℄ 106°30' BASED ON PRECISE MEASUREMENTS OF ORIGINAL SOUTH SIDE AND OTHER MEASUREMENTS BY A. RANGEL
℄ SUN PYRAMID (APPROX.)
AT 2288.44m ABOVE SEA LEVEL HYPOTHETICAL ORIGINAL (SIX-BODY) BASELINE OF SUN PYRAMID, WEST FACE.
ORIGINALLY BLOCKED AND SEALED B20
PLOT-PLAN 6.1
ZERO POINT (OUTSIDE)
ELEV: 2294.23
ELEV: 2287.58 (ORIGINAL STEP)
L.M. = LINEAR MTS.
SBM BASALT SLABS MISSING
SB BASALT SLABS IN SITU
A→W PLOT POINTS + PLOT ANGLES
NOTE: ELEVATION MEASURED BY UAC-KAN GROUP WITH PRECISION EQUIPMENT USING BENCH MARK AT ELEVATION 2286.05 MTS BY IGS (COMISION CARTOGRAFICA MILITAR).
THE SUBTERRANEAN SYSTEM of the SUN PYRAMID of TEOTIHUACAN
JAC-KAN 74-7-UC (2) HH 18 VIII 74
© -1974- Hugh Harleston, Jr

Historian George Baker's diagram of what was found at the end of the tunnel under the Sun Pyramid, indicating that at some time someone had built reinforcing walls to avoid additional cracking from earth movements; there were also indications of continual use of the chambers after the construction of the pyramid. Finger and palm marks were still visible in the millennial adobe, possibly made by violators.



On the compacted floor the searchers reported finding numerous crudely worked vessels, together with slate disks beautifully engraved with anthropomorphic figures, one dressed in jaguar costume, another as a bird. Acosta wondered if they could have been funerary offerings, but could find no trace of skeletal material or evidence of cremation.

Bits of mirror found on the floor of the cave indicated their possible use, as at Delphi, for prophetic reasons, mirrors having been used for divination in antiquity. More interestingly, Zelia Nuttall says the priests "of the below," the personifications of Tezcatlipoca, or "Shining Mirror," employed an actual mirror of polished obsidian as an aid in pronouncing final judgment on criminals, apparently using it as a crystal ball to reach the powers beyond.

Though there was no evidence of any spring or course of water, usually associated with underground shrines, such as at Lourdes, broken pieces of interlocking segments of drainpipes made of carved rock indicated they may once have been used to channel the flow of an underground stream. A thin line of vegetation stemming from beneath the pyramid, visible to Millon on his aerial maps, indicated the possibility of a former underground watercourse, which may have dwindled to a trickle.

Altogether the tunnel and cloverleafed caves presented a major and baffling discovery, the news of which the experts decided to sit on to give themselves time to conjecture on the possible uses and original function of their discovery. Caves, they knew, had from the remotest antiquity been of key importance in the religious history of Mesoamerica—a symbol of creation and of life itself.

Springs, they also knew, had been regarded as openings to the underworld and to the earth gods, the unnumbered spirits of the earth. Many of the legends spoke of gods or of extraterrestrials creating men in their present mold inside labyrinths of caves.

Zelia Nuttall maintains there were two basic rituals in ancient Mesoamerica: one by sun worshipers, with male overtones, performed on the steps of and atop the great pyramids; another, with female overtones, dedicated to the earth mother and to the powers of darkness, which took place at night and in caves.

Of the night ceremonies Nuttall says that the dangers and evils attendant on the earth cult became irretrievably associated with the female sex, so that "the votaries of Heaven naturally came to regard women as a source of temptation and degradation." Eventually, in Yucatan, says Nuttall, because of an unbridled use of pulque during the night ceremonies, the nocturnal cult of the female principle degenerated into such abominations that the incensed population actually rose in revolt, murdered the high priests, and scattered the votaries.

On the other hand, for what might have actually occurred during the sun ceremonies atop the pyramids, Geoffrey Hodson's clairvoyantly witnessed account is chillingly affective. He describes the evocation of earth forces, and of the Kundalini in particular, together with forces from the sun and from what he calls the higher planes. Hodson says he could observe the solar forces as they were made to pass rapidly down the head and spine of the officiants and others at the ceremonial to meet the ascending earth forces. These, says Hodson, combined to make a very powerful concentration of solar and planetary forces in the bodies of those present and of "associated Intelligences within and about the Great Temple of the Sun."

Hodson believes the ancient Mesoamericans considered—as indeed do modern Theosophists—that the constellations, stars, suns, and planets were governed by intelligences and

Geoffrey Hodson and the Theosophists claim that Kundalini, or the Serpent Fire, has the power of giving or transmitting Life, in a contradistinction to Prana, or vitality, which has the power of organizing Life, and Fahat, or cosmic electricity, which has the power of manipulating Life. To Theosophists, these three cosmic forces "ensoul" all substances.

Fahat, or cosmic electricity, Hodson calls the universal constructive force in all creation. Coiled in the center of the earth, it is a storehouse for solar Kundalini. When specialized and enclosed within the spinal cord of man, it is called Kundalini, or Serpent Fire, "the power that moves in a serpentine path." As the Godlike force within man, coiled at the base of the spine, it needs to be set free. When fully aroused either by Yoga or as a result of evolutionary progress, Kundalini is said to flow up an etheric canal in the spinal cord, vivifying and awakening the individual to self-conscious awareness in superphysical worlds. Kundalini is also said to give the power of astral travel.

The force opens up knowledge of the oneness of life, direct intuitive spiritual perception. It enhances the powers of clairaudience and clairvoyance, of being able to leave and return to the body at will without any break in consciousness.

Hodson says that the cerebrospinal system of man, when occultly vivified by Kundalini, resembles in many ways a TV set with superphysical broadcasts projected on the screen of the mind-brain.

The symbol of Kundalini is the caduceus, staff of the god Hermes: a rod entwined by two serpents. The winged sphere represents the freed soul of man who has awakened and learned to use his hidden powers. Hodson adds that like all the basic forces in nature, Kundalini is the manifestation of an intelligence, of an archangelic power.

powers which the priests in Mesoamerica had learned to contact without mediation, especialy those of the sun, Venus and Mars.

Hodson thinks the colors of the priests' robes and the paintings of their temples were designed to be in mutual resonance or harmonious vibration with these superphysical forces and intelligences.

The high priest and his helpers, says Hodson, evidently knew full well of the Kundalini, the fiery serpent force in the center of the earth and in man, for they employed certain ceremonies, postures, and words of power to evoke the earth Kundalini and cause it to flow along the spines of officiants and others present.

Hodson says the chief officiant at the ceremony at the temple on the summit of the Sun Pyramid at Teotihuacan seemed to be what he calls in Theosophical terms an "Initiate of the Fourth or Atlantean Root Race"—a tall man with reddish-brown complexion, very clear-cut features, large aquiline nose, eyes full of power, and a facial expression of sternness and great strength. As Hodson describes him, he wore a high feathered headdress and beautiful robes of many hues, the chief colors being red, yellow, green, and purple. His neck, arms, and legs were ornamented with jewels.

Hodson says that high in the air above Teotihuacan he observed a great circle, at least a mile in diameter, of golden Devas or angels hovering above the Sun Pyramid at a height of several thousand feet. "Their auras kept touching to form the bowl of a Deva chalice filled with solar 'wine,' a form of energy derived from a higher plane."

He says the stem of the great chalice built of intelligences and forces passed down through the temple and the pyramid into the ground while a large number of other Devas moved about high in the air above the rim of the cup, and one very great Atmic Deva supervised the proceedings, having apparently been in charge of the religion and area for many centuries.

This temple, says Hodson, was a spiritual center for the whole region, and at least three great ceremonies were regularly performed there, at sunrise, high noon, and sunset, high noon being the most important. Hodson notes that the very moment of high noon was measured by means of a vertical staff above the topmost temple, now demolished.

He says some of the people had psychic powers enabling them to see the auras of the leaders, which were brilliant and large, and that it was this direct experience which assisted in the maintenance of order throughout the land.

At the special time of the ceremony, performed when the sun was at its meridian, the summit of the pyramid seemed to become superphysically on fire, with "astro-mental flames" reaching out for a hundred yards or more above and on all sides. This, Hodson said, represented sun worship at its greatest and purest, because it was produced by the responses to invocations to the Solar Logos and the Solar Devas.

Whereas to the average citizen and even to the average scientist the sun appears to be part of a strictly mechanistic universe, to the Theosophists the sun is the visible aura of a mighty solar consciousness, part of a living, pulsing universe, an all-pervading Divine life in which we all live and move and have our being. To the Theosophists, all the entities within the Solar System, regardless of their kind, are subservient to what they call "Cosmic Vitality"; they give as a parallel the case of the human being. "Each of us," says L.

Gordon Plummer in his *Mathematics of the Cosmic Mind,* "is composed of myriads of subservient entities, better known among which are the cells of our bodies, which include the blood cells. Every one of these is a living organism, highly complex in itself; yet they all function within the dominance of the vitality of the man while he is alive."

The Theosophists say that just as in human bodies there is a constant circulation of vital essence via the blood and nerve fluids, so in the solar system there occurs an incessant interchange of vital essences along electromagnetic patternings, with every planet contributing to every other planet and to the sun, which, like a beating heart, revitalizes the system.

Man, they say, is an integral part of the universe which environs him, to which he must return parts of his vitality, a notion which could give meaning to the Aztec sacrificial ritual in which, while blood is shed, a spirit is freed from the body. Like the Theosophists, the Aztecs believed that vast hosts of other-dimensional entities in all degrees of development, from atoms to gods, inhabit the system, moving from body to body along the electromagnetic pathways of the universe.


Georges Ivanovitch Gurdjieff in New York in 1924.

Georges Ivanovitch Gurdjieff held that cosmic emanations in the form of matter or substance were, and are, transmitted by the planets, the solar system, the stars, and the suns of the Milky Way, on out to the ultimate principle he refers to as the "Absolute." Emanations of matter from the Absolute, upon meeting the stars, the solar system, and the planets, says Gurdjieff, change in density according to an order which corresponds to the musical notes do, si, la, and so on up the scale through different octaves.

According to the Ancient Wisdom, the Galactic Universe in its totality is a sort of living being, "an entity of such mighty power that nothing short of a universe could possibly represent it." A pretty conceit which Theosophists qualify by pointing out that the "space" of the scientist is in fact an illusion produced by our consciousness, not that it does not exist, but rather that we do not perceive it for what it truly is.

PART VI PREHISTORI

EAPPRAISAL

24. Origins of the Maya

Hodson's re-creation conjures up the picture of a spiritually evolved priesthood, descendants of Atlanteans, performing still vital ceremonies on the pyramids of Mesoamerica. Does such a picture fit with what is known of the Teotihuacanos, Olmecs, or Maya? Sylvanus G. Morley, who, though he died some decades ago, is still North America's leading authority on the Maya, would have one believe that Mayan civilization developed suddenly, springing fully armed like Athena from the brow of Zeus.

"The ancient Maya . . ." as he puts it, "emerged from barbarism probably during the first or second century of the Christian era." To make his point he used what he believed to be the earliest Mayan stelae erected at Tikal and Uaxactun, but failed to account for the fact that these stelae incorporate not only a developed Mayan system of writing and numerals but a calendrical system so sophisticated that it alone indicates centuries if not millennia of previous careful astronomical observation.

Opposing experts—such as the California architect Robert B. Stacy-Judd, who spent fourteen years exploring Yucatan to produce a beautifully styled book, *Atlantis, Mother of Empires*—maintain that the Mayan civilization arrived in Central America already developed, its origin having taken place elsewhere—in his opinion Atlantis, or the island of Antillia, the last large surviving segment of the Atlantean Empire, approximately what is now the Grand Bahama Bank.

As there are no historical records contemporary with the appearance of the Maya in Central America, but only the archeologists' interpretations of the buildings, stelae, sculptures, and pottery found in a fraction of what may be hun-

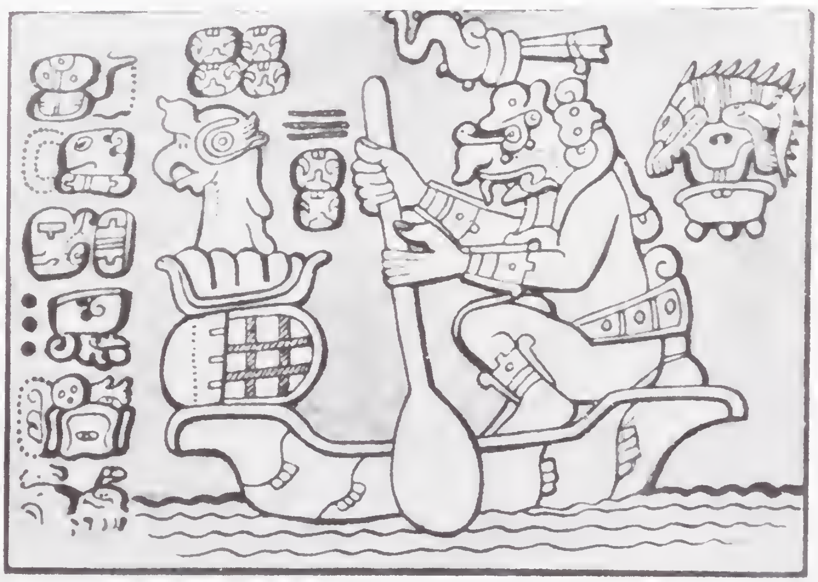
dreds or even thousands more undiscovered Mayan sites, the next best information derives from native sources, from the books concocted from memory by the Quiché and the Maya such as the books of Chilam Balam and the *Popol Vuh,* rediscovered and publicized by Brasseur de Bourbourg.

The books of Chilam Balam relate that the first inhabitants of Yucatan were the Chanes, "People of the Serpent," said to have come from the east in A.D. 219 in boats across the water with their leader Zamna, also known as Itzamna, "Serpent of the East," a healer who could cure by laying on of hands, and, like the Therapeuts, revived the dead.

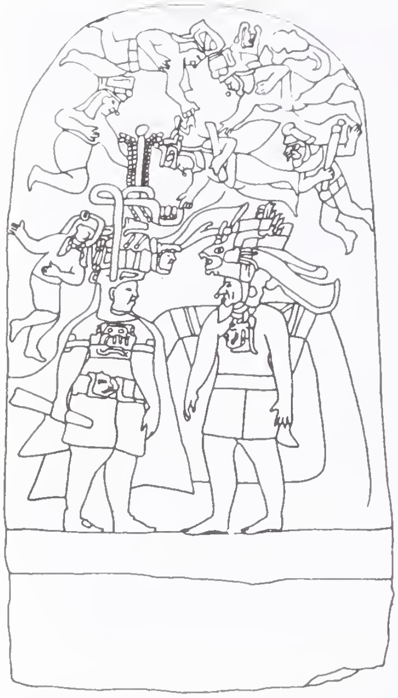
The Chumael book of Chilam Balam is even more specific. It speaks of the first inhabitants of Yucatan, known as Ah-Canule, or "People of the Serpent," having come across the water from the east in boats to locate on the island of Cozumel off the coast of Yucatan. As their population grew, these Itza moved to the mainland and built cities, altogether 150, including Chichen Itza (the "Mouth of the Wells of the Itza"), Izamal, Ake, Uxmal, and Mayapan.

The *Popol Vuh* is vaguer but more poetic: "Then they came; they pulled up stakes there and left the East . . . Each of the tribes kept getting up to see the star which was herald of the sun (Venus). This sign of the dawn they carried in their hearts when they came from the East, and with the same hope they left there, from that great distance, according to what their songs now say . . ."

The history of Zodzil, by Juan Darreygosa, incorporated into one of the earliest reports from the Spanish conquerors, the *Unedited Documents Relating to the Discovery and Conquest of New Spain,* picked up the same legend: "The most ancient people who came to this land were those who populated Chichen-Itza . . . and were the first after the Flood."



Drawing of Itzamna sailing from the east, taken from one of the codices.



Reconstruction of stele found near La Venta showing an exotic Middle Eastern figure known to archeologists as "Uncle Sam."

From Bishop Landa's reports it is clear that the strangers did not come, as Morley suggests, from the *south*east overland, but from across the seas: "Some of the old people of Yucatan say they heard from their ancestors that this land was occupied by a race of people who came from the east and whom God had delivered by opening twelve paths through the sea."

Morley maintains the Mayan area had been inhabited from two to three thousand years earlier by Maya-speaking peoples whom he labels as nomadic, but of whom he can say no more.

Archeologists then discovered remains of another whole civilization on the east coast of Mexico, just north of the Maya, complete with hieroglyphics, calendar system, and pyramidal religious complexes which appeared to antedate Morley's "civilized" Maya by almost a thousand years. For lack of a better name, the archeologists called these people Olmecs, or the "Rubber People"—though no one knows what these people might have called themselves.

When archeologists were digging in the soil of a swamp-surrounded island about twenty miles inland from the Gulf of Mexico, close to the western border of the state of Tabasco, known as La Venta, they came upon a fourteen-foot stele, seven feet wide and three feet thick, with two figures in apparent conversation. When the mud was cleaned from the carvings, the diggers discovered a tall, handsome figure with a commanding look, high-bridged nose, and flowing beard, in conversation with a smaller man. So much did the figure resemble Uncle Sam that he was so dubbed by the astonished archeologists. The features of the figure were clearly not those of an Indian. Furthermore, the figure was wearing a long gown, elaborate headdress, and shoes with oddly upturned toes.

Fascinated by this stylistic anomaly, Constance Irwin, who pursues the riddle of ancient seafarers to the New World in her controversial book *Fair Gods and Stone Faces,* asked herself who in the world was wearing upturned pointed shoes in the first half of the first millennium B.C., the date assigned by the experts to this stele.

After considerable research she traced the upturned shoes to either the Hittites or their successors and imitators, the Phoenicians, renowned as great seafarers, who regularly wore long clinging double robes, turbans with ribbons, pointed beards, and upturned shoes.

So impressive is the evidence accumulated by scholars to the effect that the Phoenicians reached the shores of both North and South America, it is hard to understand why it continues to be shunned.

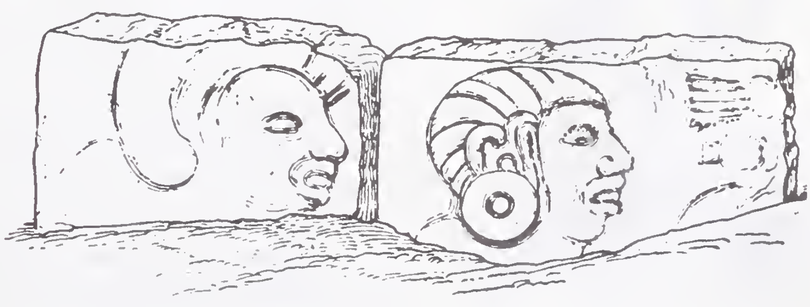
Support for a Phoenician land fall on the east coast of

At La Venta, on the east coast of Tabasco, 50 yards into the jungle, diggers came upon a huge hemispherical stone, vine-sheathed and almost unrecognizable till they dug further and revealed a colossal head eight feet high with broad nose and thick lips. Three more heads, all facing east, surfaced nearby, one of them 8 1/2 feet high and 22 feet in circumference. Later, several more were found further along the coast, many of them mutilated. One had a singularly Egyptian feature: a speaking tube that ran from a giant ear to emerge between two great stone lips through which the voice of a priest could have spoken. Nearby a huge pyramidal mound was discovered rising 100 feet above a base 300 feet square close to a colonnade with tightly fitted columns.

Mexico appeared in the form of enormous stone heads with marked Negroid features and what looked like baby caps or football helmets dug up from the subsoil of La Venta, dated to about 500 B.C. by the experts.

Pointing to other Phoenician carvings of black slaves wearing just such helmets, Constance Irwin suggests that nothing could have been more natural for Phoenician traders than to have picked up African Negroes on the west coast of Africa and sailed with them across the Atlantic to Mexico.

Further evidence of the presence of men with Negroid features accompanying bearded Semites also turned up farther west in Oaxaca.



Colossal heads in low relief found near Oaxaca.

Hugh Fox in his *Gods of the Cataclysm* says the association with the yogic trance is especially evident in these Monte Alban figures because the designs portrayed on the dancers' bodies are chakras, "the mystic centers connected with successful meditation."

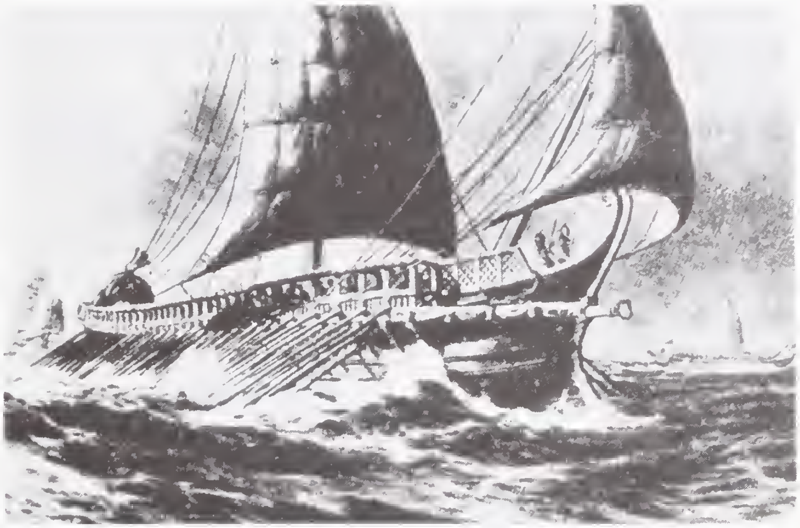
Like the Olmecs, the earliest known settlers of Monte Alban had a hieroglyphic system of writing, a calendar, and a mathematical system of computing by bar and dot. These settlers left some extraordinary cyclopean rocks built into buildings which portray life-sized Negroid dancers with flat noses, round faces, and thick lips. Alongside them are Old Testament types with hooked noses and spatulate beards, all very un-Indian. Archeologists date these finds around 500 B.C. and attribute the ruins to the Olmecs.

Startlingly Semitic figures found throughout Mesoamerica.

Fox points to the ecstatic face of the Mochica coca-taker with its inward-turned eyes, frozen, fixed, expressionless face, and compares it to the world of yoga ecstasy.

Among the institutions and customs shared by the Phoenicians of the first millennium B.C. and the inhabitants of Central America during the same era, Constance Irwin has listed several items starting with an advanced knowledge of mathematics and astronomy (which the Phoenicians picked up from the Babylonians). In common with the Maya, the Babylonians were the only known ancient civilization that had a place value in their mathematics, the concept of zero, and the ability to express large numbers—as indicated by the cuneiform text found in Mesopotamia with the now no longer so mysterious number 195,955,200,000,000. As C. W. Ceram points out, it was not until the nineteenth century that the concept of a million became common in the West. Like the Maya, and their possible predecessors the Olmecs, the Chaldeans had records of stars going back 370,000

The Phoenicians, whose origins are vague, are known to have sailed north from the Pillars of Hercules to Britain for tin, and even farther to Scandinavia for amber. Southward, they sailed down the coast of Africa, planting colonies as close to the equator as Dakar. At one point, in the employ of the Egyptian Pharaoh Necho, in 600 B.C., they appear to have circumnavigated the entire continent of Africa—2000 years before the Portuguese next accomplished the feat. Westward the Phoenicians sailed as far as the Azores and the Canaries, jumping-off place for Columbus, where the favoring trade winds blow from the east, and the northerly equatorial current along the fortieth parallel will thrust a boat irresistibly toward the Antilles and the Mexique Bay. Diodorus Siculus wrote of a land which lay far to the west and was known to none but the Phoenicians and Carthaginians. The Tyrians, he says, at the time when they were masters of the sea, proposed to dispatch a colony to it.

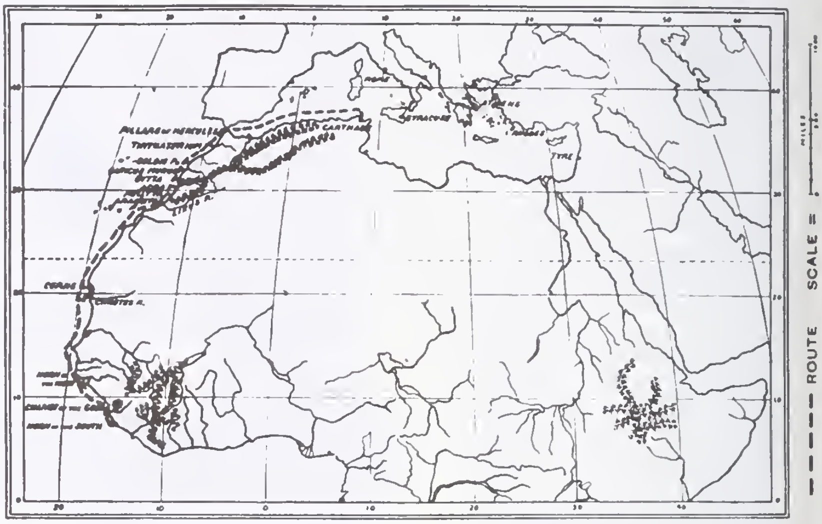


At Tula, the Toltec capital, shoveling rubbish from the remains of a house, Désiré Charnay found many curios, such as huge baked bricks, filters, curved water pipes, and what appeared to be small Phoenician seals, and a vase with a bearded, robed, mustachioed Tlaloc holding a bolt of lightning.

years, while the Babylonians kept the nativity horoscopes of all children born for thousands of years, from which to calculate the effects on humans of the various planets and constellations. Like the Maya, the Babylonians measured the year in 360 and 365 days; and they estimated the period of the moon's return to within a matter of seconds. Unlike the Romans, who thought the morning and evening star were two different bodies, Lucifer and Hesperus, the Babylonians and the Maya both knew them to be the same body: Venus.

Further traits held in common by the Phoenicians and their contemporaries in Central America were hieroglyphic writing, the custom of deforming the heads of newborn children, infant sacrifice, the use of incense, phallus worship, the depiction of deities floating horizontally over the heads of mortals involved in conversation, twisted rope borders on sarcophagi and seals, pyramidal temples that rose in terraces to a truncated top where they were used as astronomical observatories, worship of the sun and the moon, to whom temples were raised, the use of gnomons to measure the sun's shadow and determine latitude, the manufacture of clay figurines depicting dwarfs, and, most astonishing, representation of the rain god Tlaloc in Central America by the figure of a white man with a handlebar mustache and long beard, holding a thunderbolt of lightning—just as did his Phoencian counterpart. (See Charnay's vases.)

When the Phoenician stronghold of Tyre fell to Nebuchadnezzar the Great in the sixth century B.C., Carthage succeeded as the wealthiest city in antiquity. Founded by the Phoenician Queen Dido in 825 B.C. near what is now the city of Tunis, Carthage became the most important outpost of Phoenician civilization in the western Mediterranean, with a population of close to a million within its walls. As an



The periplus of the Carthaginian Captain Hanno describes a flotilla of 60 ships of 50 oars and 30,000 men and women setting off in about 500 B.C. down the west coast of Africa with enough provisions to travel 3500 miles from Carthage and 2500 miles beyond the Pillars of Hercules to found new colonies as far south as Senegal and Gambia—curiously named "Chariot of the Gods."

Archeologist Hugh Fox sees a profound religious link between the early Mesoamericans and the early Mesopotamians, a link that was forged by travel to the west of Phoenicians and Carthaginians. In his *Gods of the Cataclysm,* Fox has concluded that Huitzilopochtli, though an amalgam of various gods or god-qualities, is actually a Phoenician version of Zeus, or to be more exact, a Carthaginian version —a Jupiter Haman. He points out that there was human sacrifice to Zeus, including the ritual of flaying, and that in many Middle Eastern rites "worshippers were clad in the skins of animals sacrificed." He sees in Xipe Totec, the Aztec flayed God, an Adonis or Osiris or Dionysus or Baal Haman—all fertility gods. Flaying was a favorite method of torture among the Carthaginians.

outlet for this burgeoning population, and to insure its continued existence, Carthage sent out colonists to sail past the pillars of Melkarth (as they called them) down the coast of Africa, carrying their knowledge and their cults.

From that latitude these Carthaginians, like their Phoenician predecessors, could well have sailed to the New World and made landfalls in Yucatan, Tabasco, or Chiapas, giving substance to the tale of Votan. For the return journey to the Mediterranean, as is recounted in the *Odyssey of Votan,* the Gulf Stream would have swirled them clockwise around the Atlantic, eastward along the 39th parallel, to where the prevailing westerlies would drive a ship to the Azores, and home to Africa and Europe. On Corvo, the northwesternmost island of the Azores, just over a thousand miles from the shores of North America, a cache of Carthaginian coins was found dating from the fourth and the third centuries B.C. In 1975, stones were found on the Atlantic coast near Cape Cod inscribed in a southern Iberian alphabet attributed to Hanno and dated between 480 and 475 B.C.

Nor does the tale of travel to the West stop there. After the Phoenicians and the Carthaginians, Greeks, Romans, Irish, Welsh, and all manner of Scandinavians left tales and evidence of travel to the Americas. Books with information on these voyages fill several shelves in the stacks of the Library of Congress, some with specific studies like those of Professor Cyrus Gordon, others, popular summaries, such as Charles Michael Boland's *They All Discovered America.*

There is equally intriguing evidence of travel to America across the Pacific from the west. As an explanation for the abundance of Indians in Mexico with pronounced Chinese features, Henriette Mertz in her book *Pale Ink* tells of two Chinese expeditions to America, one in the fifth century A.D.

According to Fox, whereas Judaism developed away from human sacrifice, toward surrogate animal and then cereal and then symbolic sacrifice, "the Aztecs caught up the Canaanite religion in its most primitive phase and developed it almost solely along its cannibalistic/human sacrifice lines." He points out that the Phoenicians were the great child-sacrificers, and that in the Old Testament the gods were only appeased by blood sacrifice. Wherever the Phoenicians went they left behind a heritage of blood and sacrifice.

To the Phoenician mind, says Fox, whether in Syria, Palestine or North Africa "the whole sacrificial system was based on an attempt to prevent another—and final—Great Cataclysm."

Fox found Tanit-Baal-Haman, the god-goddess, at the very top of the Aztec Pantheon, and saw her as the Aztec version of Kali, the great Indian mother-goddess, destroyer-creator, and the simultaneous beginning and end of the whole.

To Fox, the benign, benevolent life-giving *mater magna,* mother of heaven and earth, may have become a malevolent destructive force as the result of some great cataclysm. It is clear to him that when the Mayas killed a victim and offered his heart to Venus, the Evening Star, they were offering it to the Phoenician Venus, Tanit, out of fear. He adds that the Hopi were Phoenicians, or strongly influenced by the Phoenicians, and that the Olmecs were black African Phoenicians or escaped Phoenician slaves.

Summing up, he puts the rhetorical question: "If this whole religion was Phoenician, as it certainly seems to be, and if the oldest memory of Aztec theological sources reached back to Teotihuacan, then didn't that make Teotihuacan a Phoenician colony? And the original Quetzalcoatl a Phoenician priest?"

and another much earlier in the twenty-third century B.C., both of which are in the Chinese records.

The fifth-century expedition is described by Hwui Shan, a Buddist monk who reported on the travels of five Buddhist missionaries to a country far to the east called "Fu-sang," which Henrietta Mertz and several other modern historians identified as Mexico, overall from Los Angeles to Yucatan, and specifically around Chichen Itza. Fu-sang was so named by the Chinese because of its trees, which looked like bamboo but produced an edible fruit, pear-shaped, and reddish in color, which could be preserved for a year without spoiling. At the beginning of the Christian era, corn in Mexico was only about three inches long, wider at the base, like a pear, with reddish kernels.

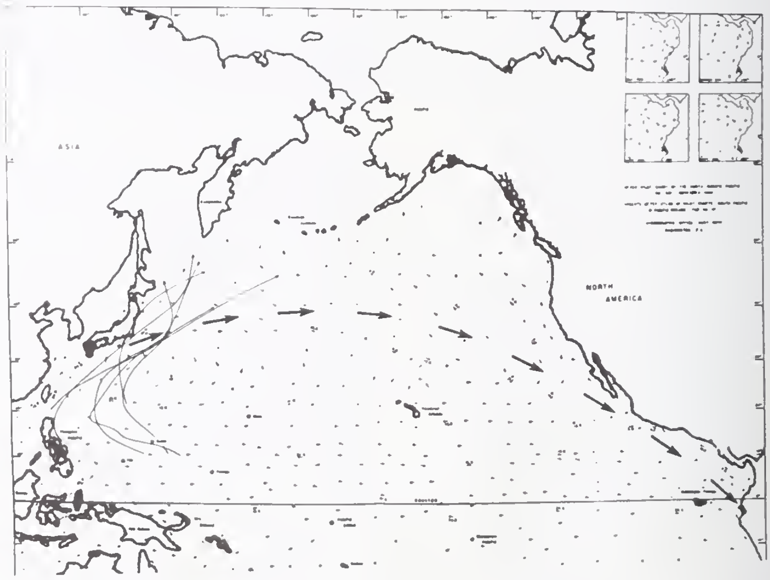
Hwui Shan describes finding a civilized people in Fu-sang who knew writing, which they did on paper made from a plant, and who, though they had no iron, had plenty of gold and silver. According to Mertz, this fifth-century visit to Mexico changed the entire course of Mexican history. In Hwui Shan's story, a Chinese nobleman of the first rank was called "Tui-lu," and the Mayan books of Chilam Balam tell of a leader who came from the west, from Tulupan, who had the title of "Tutul Xiu." Mertz describes Tutul Xiu as a Chinese Quetzalcoatl who contributed to the Mexicans Oriental knowledge of the calendar, astronomy, metallurgy, agriculture, jade carving, and the compass.

The earlier report of Chinese travel to America, known as the *Classic of Mountains and Seas,* is the record of a series of journeys about the globe compiled in 2250 B.C. at the request of the Emperor Shan by a man called Yu, his minister of public works, who later became emperor himself. The Chinese travels describe mountains and rivers across the Pacific, or the "Great Eastern Sea." This classic Chinese periplus, known as the Shan Hai King, or oldest Chinese geographical work, though severely truncated, miraculously survived the repeated burning of Chinese libraries and the emasculation of less interested or accurate Chinese historians, and Dr. Mertz believes it "will be found to be the most astounding ancient document detailing geographical phenomena that has ever been written."

The periplus tells of great rocky mountain ranges beyond the sea and names and describes a series of peaks stretching 2200 miles from Manitoba in Canada to Mazatlan in Mexico. With great pains Mertz has followed the record of the Chinese peregrination, whose geographical details described in vivid language are as recognizable today as when they were noted in the third millennium B.C.

As she puts it, "We can do no more than to stand with bowed heads before the intrepid Chinese who mapped those jagged snow-capped peaks over 4000 years ago."

At about the same period, the Japanese appear to have explored the west coast of South America. Both Japanese and Chinese histories abound in stories concerning boatloads of thousands of people sailing out across the Pacific Ocean in search of a promised land. From careful analysis of pottery on the Ecuadorian coast, which compares very closely with Japanese pottery of 2500 B.C., Betty J. Meggars and her husband, Clifford Evans, were led to the conclusion that the Japanese had reached Ecquador thousands of years ago.



Route taken by Japanese to reach Ecuador before the Christian era, from Betty J. Meggers.

These reports of voyages to the Americas from both east and west take the story back to the third millennium B.C., but much earlier remains of buildings, often extremely sophisticated, have been found in North, Central, and South America, and various authors have hypothesized advanced civilizations which long preceded the Mayan and the Olmec. However, as there are no known historical records for such early periods, and no sure system for dating the remains, these stories float in a limbo between fact and fiction.

Their cumulative evidence, however, is too evocative to be ignored.

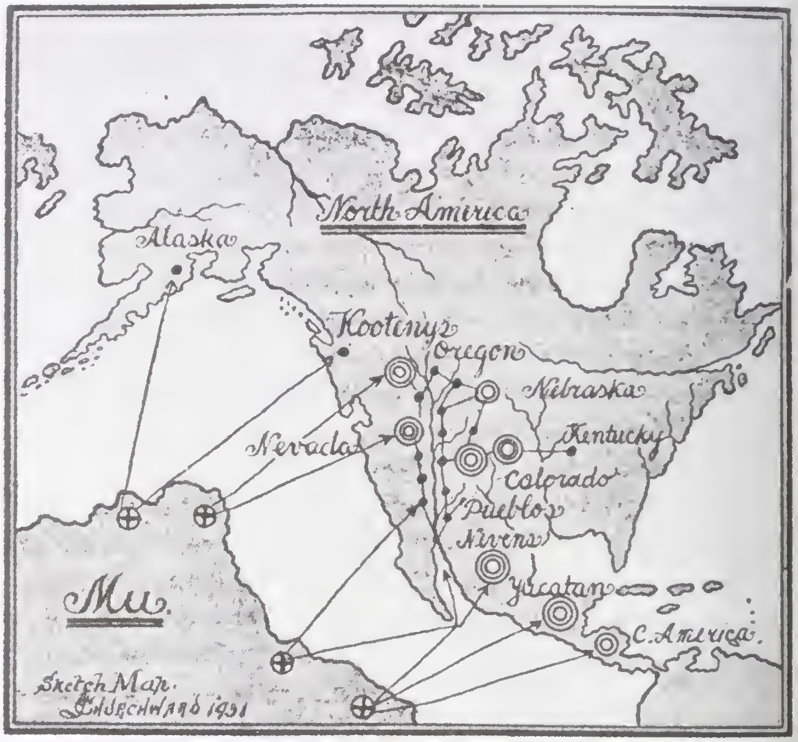
25. Prehistoric Mexico

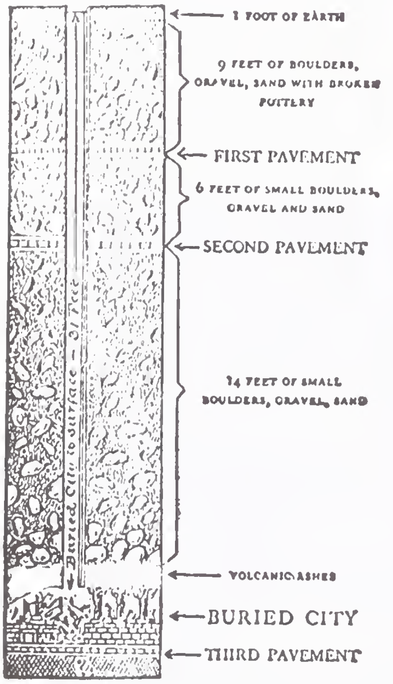
One indication that a far earlier civilization existed in the Valley of Mexico than was reached by Manuel Gamio's spades comes from the tantalizing discoveries made in the Mexican highlands by a Scotsman, William Niven. As a mining engineer working for a Mexican corporation, Niven described coming upon the remains of two separate prehistoric civilizations at depths of from six to thirty feet below the present level of the Valley of Mexico. These discoveries, made between 1910 and 1930, have hardly been considered by the "scientific world," partly because they fit into none of the preconceived notions, and partly because they were used by an even more unorthodox author, James Churchward, to validate his, to them, even wilder hypothesis—the existence of a vast continent in the Pacific Ocean which he called Mu, mother, says he, of several colonial civilizations which spread around the globe.

Churchward's efforts, though very popular with aficionados of Atlantean and Lemurian tales, and often prophetically exact in certain details, have, because of Churchward's unsupported and highly improbable notions, been thrown out by an establishment which may have discarded, along with Churchward's Lemurian bath water, some living, screaming babies.

Being befriended by fellow Freemason Churchward was of no greater help to William Niven than it had been to Le Plongeon, except that with the thousands of copies of Churchward's books sold around the world Niven was rescued from oblivion. When he died in 1937, his obit in the *American Historical Review* listed him merely as a professor who had been engaged for several years in mineralogical research, an

Churchward's rendering of prehistoric North America with part of his great continent of Mu in the Pacific.





Niven's Mexican Buried Cities
Now 7000 feet above level of sea. Mountains 5000 feet higher intervening

In the several strata clearly revealed by the pits, Niven says he found traces of what he describes as three well-preserved concrete floors or pavements at depths from about 6 to 25 feet. Above the first pavement there was a deposit of small boulders, pebbles, and sand, covered with a foot-thick coating of rich valley soil. Everywhere in the first layer of debris, Niven found fragments of broken pottery, small clay figures, diorite beads, spear- and arrowheads, spindle whorls, and other artifacts, mostly broken.

honorary life member of the American Museum of Natural History and various other such scientific societies who had become involved in Mexican archeology, nothing more. Nothing to indicate he might have made the most controversial archeological discovery of the Western world.

Actually, Niven had been exploring in Mexico since 1889. While digging among the ancient ruined cities in the unknown and uninhabited portion of the state of Guerrero, southwest of Mexico City in the Acapulco area, he began to receive periodic visits from local Indians who came to him with terra-cotta figurines and other objects for sale. Though the Indians pretended to have found these objects at the pyramids of the Sun and Moon at San Juan Teotihuacan, Niven realized that the source of the artifacts must be nearer; with a bribe of five pesos ($2.50 at that time) he managed to discover the actual spot.

Between Texcoco and Haluepantla, hamlets just north of Mexico City, he came across hundreds, if not thousands, of pits dug into the sand, clay, and tepetate used for material by the builders of Mexico City for more than three hundred years. Exploring these pits, which Niven says cover an area of about ten by twenty miles in the northwest corner of the Valley of Mexico, he came across vast layers of what appeared to be very ancient ruins, whole prehistoric cities lying as deep as thirty feet below the plain, which appeared to have been overwhelmed by a series of cataclysmic tidal waves, perhaps at several-thousand-year intervals, which, In 1920 William Niven (in light suit) was exploring a passageway in the Pyramid of the Moon with an enthusiastic Sunday archeologist, Charles Beeching, a bridge-building civil engineer from Boston, Massachusetts, when the latter fell into a well-like hole. Beeching described the event in a letter to his daughter Mariana Beeching de Prieto, a writer of children's books now living in Miami, Florida. "I fell feet first through a hoie and tumbled into blackness. One moment I was walking along a dim corridor, the next I was plunged from Aztec into a pre-Aztec or Teotihuacanic era. My undignified drop turned out to be a valuable archaeological discovery. I had fallen into the chamber of an ancient race. As soon as I could collect myself I let out a yell. Niven was within earshot. The only escape from the chamber was through a narrow opening which I myself had punctured in the roof. Niven lowered a rope and hauled me bruised and shaky out of the place.

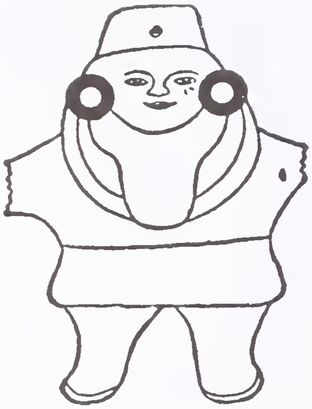
"While waiting for rescue, my eyes became accustomed to the darkness . . . in the corners of the stone-walled rooms there were heaps of images, tablets and pieces of pottery."

From Beeching's report it appears that passageways, wells, and hidden chambers, such as were reported by Ewing and Latrobe, still existed in 1920 before they were obliterated by a massive restoration of the Moon Pyramid.

as Niven described them, had left telltale strata of boulders, sand, and pebbles. By their depth beneath the surface, Niven estimated the oldest remains might go as far back as 50,000 years.

Four to six feet below the first pavement, Niven says he encountered a second "concrete floor," but in the intervening space failed to find a single piece of pottery or other trace to indicate that humans had once lived there. Beneath the second pavement, he describes coming upon what he considered "the great find of my many years' work in Mexican archeology."

Niven discerned, beneath a well-defined layer of ashes from two to three feet thick, analyzed as being of volcanic origin, traces of innumerable buildings, large, but regular in size, the remains of a vast city which appeared uniformly at the same level throughout more than a hundred clay pits. In one of the houses—most of which were crushed and ruined, filled with ashes and debris—he says he found an arched wooden door which had turned to stone. The walls of this house were bound together with white cement, harder than the stone itself. In one



Niven believes the figure of a Chinaman, which he found thirty feet from the surface in a pit which he had dug at San Miguel Amantla, near Haluepantla, nineteen miles from the national palace in Mexico City, had been buried thousands of years earlier. Niven says the oblique eye slits, padded coat, flowing trousers, and slippers make the statuette clearly Chinese. He explains the lack of a queue by pointing out that the Chinese did not have the queue till they were conquered by Tartar hordes from the north in the seventh century. The statuette is seven inches high, of friable clay, which on the outside has turned to stone. It is three and a half inches wide at the chest and one and a half inches through the abdomen. The ears are ringed; the skull cap has a button in the center like the caps of mandarins of the empire.

uncrushed room, about thirty feet square, full of volcanic ash, with a flat roof of concrete and stone, Niven says he came across many artifacts and human bones, which "crumbled to the touch like slaked lime." According to his detailed report, a complete goldsmith's outfit was still on the floor with some two hundred models of figures and idols molded in clay turned to stone, each model thickly coated with iron oxide, bright and yellow, presumably there to prevent the molten metals adhering to the patterns while in the casting pot.

Niven says the ornaments were unlike any found in Palenque or Mitla or anywhere between. The work was fine, beautifully polished, demonstrating an advanced degree of civilization. On the walls Niven found paintings in red, blue, yellow, green, and black, which he says compared favorably with the best he had seen from Greek, Etruscan, or Egyptian works of a similar sort. The ground color of the wall was a pale blue; six inches down from the fourteen-foot ceiling a frieze painted in dark red and black ran around the room, glazed with some native wax which had perfectly preserved the color and pattern, which depicted the life of some person, apparently a shepherd, from birth to death.

Beneath the floor Niven found a tomb three feet deep, lined with cement, in which were seventy-five pieces of bone, all that was left of a skeleton. A large fragment of the skull contained the blade of a hammered copper axe, which appeared to have been the cause of death, for it had not been removed. Niven also found in the tomb 125 small terra-cotta idols, manikins, images, and dishes, some with features strongly Phoenician or Semitic, one sitting crosslegged with a hollow movable head set on its neck by a cleverly devised truncated tenon fitted into a mortise at the base of the skull.

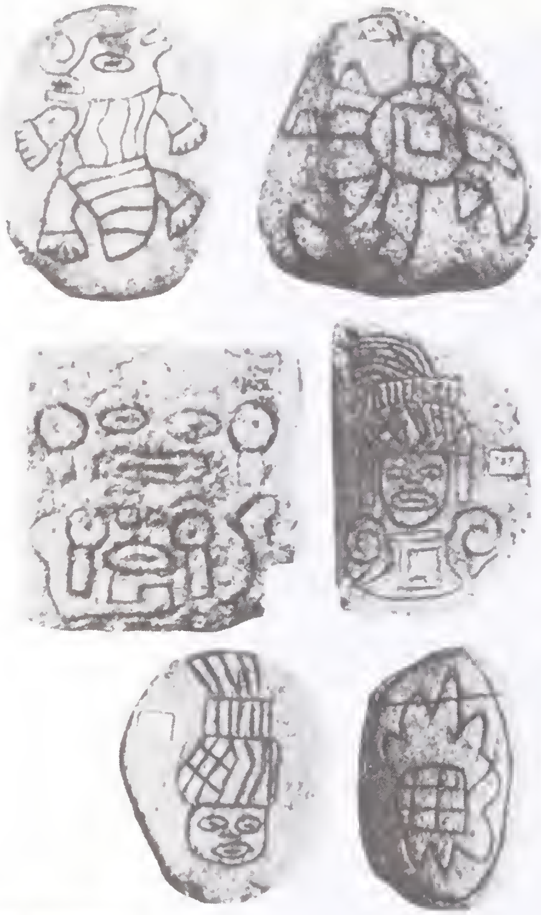
Less than three miles away Niven found an ancient riverbed in the sands and gravel of which he says were thousands of terra-cotta and clay figures with faces representing "all the races of southern Asia."

Then, in 1921, in the course of excavations at Santiago Ahuizoctla, a hamlet contiguous to Amantla, about five miles northwest of Mexico City, Niven came across a discovery so startling he says it opened up for him a whole new field of archeological research. At a depth of twelve feet Niven described coming across the first of a series of stone tablets with very unusual pictographs. Systematically exploring other clay pits and tepetate quarries within an area of twenty square miles, he claimed he was able to unearth during the course of the next two years 975 more tablets. In the end he says he found more than 2600. Though there was nothing in these tablets by which he could determine their exact

Niven's showcase number 6 containing a portion of his collection of carved stones from the Valley of Mexico. When William Niven died in Austin, Texas, in 1937, the New York *Times* described him as a distinguished mineralogist and archeologist who had discovered buried prehistoric cities beneath the Valley of Mexico. He was also noted as the discoverer of four new minerals including cytrialite, thorogon, and nivenite. According to the *Times*, Niven donated to the Mexican government the best of the relics he found in Mexico, keeping for himself some, which he sold to finance further archeological expeditions. With what was left over there were enough pieces to establish in Mexico City a private museum of 30,000 exhibits.

or even approximate age, Niven deduced from the depth at which they were buried and the accumulation of debris on top of them that they were over 12,000 years old and more likely closer to 50,000.

The tablets, which Niven carefully numbered in the order in which he found them, had no particular shape. They appeared to be water-worn stones with smooth surfaces on which the figures had been carved, often to conform with the shape of the stone, much like the so-called Cabrera stones found almost contemporaneously in Peru, which depict strange human beings with four-fingered hands in combat with dinosaurs, though such prehistoric creatures were



In the 1920s the American Museum of Natural History in New York was given a collection of artifacts by a man who informed the curator that many of them had been bought from Niven. In 1976 the curator of Mexican archeology, Gordon F. Eckholm, said the museum still possessed a collection of objects from Guerrero sold to them by Niven, but that he did not know what had become "of the famous Niven tablets."

thought to have been extinct many millennia before the appearance of man on the planet.

When Niven showed tracings of the tablets to "informed professors both American and foreign," including Sylvanus G. Morley, he was told the symbols were unlike anything they had ever seen. No prominent archeologist was able to decipher a single one of the tablets. So Niven went to the not inconsiderable trouble of making tracings of each and every tablet, which he sent to his old friend James Churchward for comment. And so Pandora's box was opened.

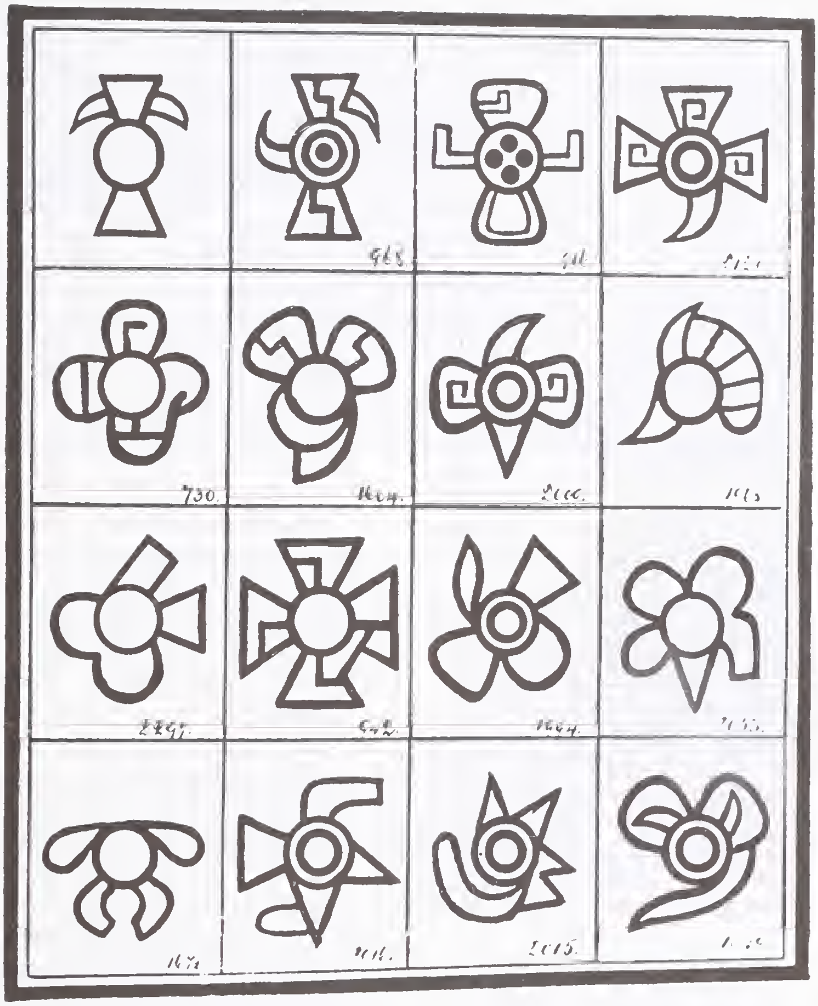
Churchward said he was not the least surprised that none of the archeologists could decipher the tablets. He, on the other hand, recognized in Niven's tablets symbols and designs similar to the ones he had been shown on tablets in a monastery in Tibet known as the Naacal tablets, which, Churchward said, contained "Sacred Inspired Writings" originating in the lost continent of Mu, which had sunk into the Pacific Ocean about 12,000 years ago at about the same time the last remnant of Atlantis had gone down in the Atlantic.

On closer study, Churchward said that Niven's Mexican tablets confirmed data he had derived from the Tibetan Naacal tablets, filling in many missing gaps.

From the intimate links in the content of Niven's tablets, Churchward concluded that they were the work of members of a colony of Mu which had been established in the Valley of Mexico, thousands of years before the birth of Christ.

This priestly brotherhood, said Churchward, had been sent out from Mu to teach the sacred writings, which contained the religion and science of the mother country, to colonists in southeast Asia. From there they had moved to India, where eventually the brothers had taken refuge from persecution in the mountain fastness of Tibet.

Stone carving of men fighting dinosaurs, part of a collection of twenty thousand such stones recently found in Peru by Dr. Cabrera, who believes them to be over fifty thousand years old. The collection includes an anatomical library accurately showing man's inner organs and an extraordinarily sophisticated series of heart transplants.



Designs found on Niven's Mexican tablets which Churchward said confirmed data he had obtained from Naacal tablets in India. According to Churchward the figures represent the "Four Great Primary Forces of Nature."

According to the tablets, as interpreted by Churchward, they took the history of man back 200,000 years. Archeologists threw up their hands; they not only refused to countenance Churchward but decided on a similar treatment for Niven. Undismayed, Churchward incorporated Niven's data to bolster his own thesis.

Churchward's books on Mu received a new impetus in the Aquarian age when the Paperback Library of New York reprinted his five books, plus one of explanation and support entitled *Understanding Mu,* by Hans Stefan Steffanson.

Then in 1970 Paperback Library went further: they published a thin volume, *Mu Revealed,* by Tony Earll, in which the author described recent excavations at Niven's site by a Professor Reesdon Hurdlop, who reported the discovery of a stone sarcophagus under the floor of a small temple found by Niven. The sarcophagus was said to contain sixty-nine scrolls or leaves of papyrus bearing strange writings.

Professor Hurdlop was described as well known in archeological circles for his work at Johore Lama, the site of the ancient city of Singapura, and at Kota Tinggi, where he followed up the work started by the late Dr. Gerald Brosseau Gardner, who discovered the original site; and he was said to have been advised in his work by Sir Richard Windstedt, British general adviser in Johore at that time.

By 1964, wrote Earll, the scrolls had been deciphered sufficiently to reveal that they held the intimate details of life on the continent of Mu (which the scrolls called Muror) over a period of years prior to its destruction; and Professor Hurdlop dated the scrolls at 20,000 to 25,000 B.C. The scroll writings, which purported to be the diary of a young priest called Kland, were said to include descriptions of homes and families, temples, transport, wars, elections, crimes and punishments, household accounts, and personal letters.

Though Professor Hurdlop had considered Churchward's discoveries deserving of further investigation, "little did he realize," wrote Earll, "that this was going to lead to one of the greatest discoveries of our time, comparable to Schliemann's discovery of Troy and Evans' work on the Minoan civilization."

Earll says he followed Hurdlop to Mexico from India via Egypt and England, where they talked with directors of the Marquina-Jolicoeur Institute in London in preparation for an expedition to dig at Niven's old site in Mexico, apparently the first to do so. The rest of Earll's book describes how the scrolls were worked on with probes and tweezers, opened a fragment at time, and the broken fragments pieced together. Carbon-dated at 23,000 years, the text, says Earll, was translated with the help of Dr. Eward Stich of Boston.

Unfortunately, Tony Earll turned out to be an anagram of "Not Really," who in real life is Dr. Raymond Buckland, a Canadian of Weirs Beach, New Hampshire, now deep into witchcraft. Professor Reesdon Hurdlop never made the dig near Niven's site, and never found a sarcophagus with the diary of a priest called Kland written on ancient papyrus. He is an anagram for Rednose Rudolph, the reindeer. So: *caveat* the *emptor* of quickie paperbacks, and let him beware of taking on faith the unqualified data of the precursors and followers of Erich von Däniken. There is no indication whatsoever on the covers—front or back, or anywhere between them—that Earll's work, which advertises itself as "the archaeological discovery that rewrites earth's history," is spurious. And that's the world we live in, not much better than the sixteenth century, when the Jesuits pirated important works such as those of Paracelsus to replace them with bowdlerized editions, spreading the notion that Paracelsus was a phony, a notion which lasted till the present century

One of the reasons Niven may have failed to receive the attention he deserved was his discovery of indications of both Masonic and phallic worship in the figurines he unearthed, both of which were subject to being glossed over. In lava fields dated at over ten thousand years, Niven found figurines with one hand pressed to the lips and the other resting on a muscle or against the head—gestures which he recognized as being similar to those still practiced in his day by Masons. Nor was Niven shy about pointing out that "these miniature figures, both masculine and feminine, in these secret mysteries, show the genital organs in a perfectly nude condition as if such rites had some relationship with those of phallicism."
Niven further noted that the female figures "reveal

the pudendum or vulva with every detail; and here is something more wonderful, there is an object which seems to be falling, which at first appears to represent a small timbrel, but on closer inspection is seen to be the representation of a drop of semen oozing from the feminine organ of generation."

Niven adds that in the Jonuta work of relief (number 26 in the gallery of monoliths in Mexico's Museum of Archeology) the symbols of the male organ of generation, which are portrayed in the manner of projecting cloves around the head of the priest of the temple, are evidently "ejecting semen."

when a couple of Swiss researchers finally produced a sounder version of his works.

Was Churchward a phony? Did he invent the Naacal tablets? And what of Niven's tablets?

At last some serious attention is being paid to Niven by Robert Wicks of the University of Washington in Seattle, who is preparing a book on Niven and his tablets. In correspondence with leading academicians in the field of Mexican antiquities, Wicks has managed to obtain their admission that negligence of Niven's work may have been an error.

In due course not only Niven but Churchward may be revalidated, as have been Mesmer and Paracelsus, who for centuries were treated with vituperative denigration. More digs on Niven's sites and a closer look at Mu may be in order, for beneath the ancient myths, as Humboldt and Brasseur averred, some history may surface yet.

Colonel James Churchward (1850–1936), of an old Devonshire family, was educated at Oxford and Sandhurst Military College: he served in India with the Royal Engineers and as colonel of a regiment of Lancers. When his marriage broke up he resigned his commission to become a tea planter and amateur painter, an exponent of the proverb: *"Les aventures arrivent aux aventuriers."*

After many adventures in many lands he settled in the United States, where he became renowned as an angler and a teller of tall stories.

Above medium height, sturdy, with an aquiline nose, the eye of a hawk, and a firm mouth which constantly broke into a smile, he is described as a man of affairs and culture, cordial and candid, a great lady killer, who, though charming, had a "thirty-third-degree efficiency in the art of making enemies."

After working as a civil engineer with the railroads and traveling to sell his own patented inventions, he made a killing in the steel business organizing the Churchward International Steel Corporation and

26. Churchward: Fantasy or Fact

On the basis of his interpretation of the Niven tablets, Churchward rewrote the text of his book *The Lost Continent of Mu* and dedicated it to Niven. In the book he describes the land of Mu as having been a large continent between America and Asia, its center lying somewhat south of the equator. Its area he bases on remains still above water, on rocky islands scattered over the Pacific, where there are still great cyclopean walls, stone-lined canals, paved roads, and enormous monoliths and statues such as those discovered on Easter Island.

Churchward saw Mu as having been about 6000 miles from east to west, and about 3000 north to south, a vast stretch of rolling country, extending from Hawaii to the Fijis, divided into three land areas separated by narrow seas.

He describes it—whether intuitively or on the basis of actual information—as a beautiful tropical country, with vast plains covered with rich grazing grasses and tilled fields, shaded by luxurious growths of tropical vegetation, a true Garden of Eden, teeming with gay and happy life, over which 64 million human beings reigned supreme, grouped into ten tribes, a white or olive-skinned race with large soft dark eyes and straight black hair, a yellow-skinned, a brown, and a black people, each distinct, but all under one government, builders of great temples and palaces of stone, navigators who took their ships around the world leaving inscriptions and legends from China to the Middle East, in both directions.

Churchward says that, according to the tablets, when a colony had advanced enough to govern itself it was turned into a colonial empire; one branch of colonization ran from Mu to Central America, thence to Atlantis, thence to the developing a nickel-chrome-venadium alloy, excellent for armor-plating. But he soon tangled with the magnets of steel and high finance who quickly disposed of him. Churchward accused the large mills of having "milked me dry of all I could show them, stolen my patents, tried to kill me by dumping tons of white hot steel on me, and were in cahoots with the Navy Department and fellows in there, to unload my steel on Uncle Sam at fabulous prices."

His attorney, Percy Tate Griffith, who at first considered the statement preposterous, later said: "Events proved that far more of it was true than I was willing to credit, and much that even the suspicious Colonel had not visioned."

Churchward claimed to have learned the truth about the dirty dealing in the steel industry from highly placed friends in Masonry. Churchward's brother Albert, a medical doctor and inventor, was a prolific writer on Freemasonry and its relation to primitive mankind.

As a comeback from his debacle in the steel business, Churchward turned to the story of Mu, bringing out *The Lost Continent of Mu* in 1930, *The Children of Mu* in 1931, *The Sacred Symbols of Mu* in 1933, and *Cosmic Forces as They Were Taught in Mu,* in 1934.

In the late 1930s his attorney, Percy Griffith, wrote a fourteen chapter, two hundred page biography of Churchward in which he set himself to validate much of Churchward's career, intimating that Churchward had solid data on which to base his fabulous tales of Mu. Unfortunately, only six chapters of the biography were salvaged by Griffith's daughter Joan, and the mystery of Churchward's sources remains to be revealed.

Mediterranean and Asia Minor; another branch ran from the west coast of North America down the east coast of South America, traceable as far as Argentina.

Before Mu went down, a great civilization existed in South America, in the area of Tiahuanaco, says Churchward, adding that the Inca are not a prehistoric people but a mixture of Quichés who emigrated to Peru from Guatemala, settling among the local Aymaras.

Among the tablets Churchward was shown in Tibet, he says some described an extended history of Atlantis; one included a map two feet square showing Atlantis with the contour of the lands around the Atlantic Ocean, vastly different from today, Atlantis being not an island but joined to America, Europe, and Africa, at a time "when great monsters roamed the earth and seas were filled with monstrous forms."

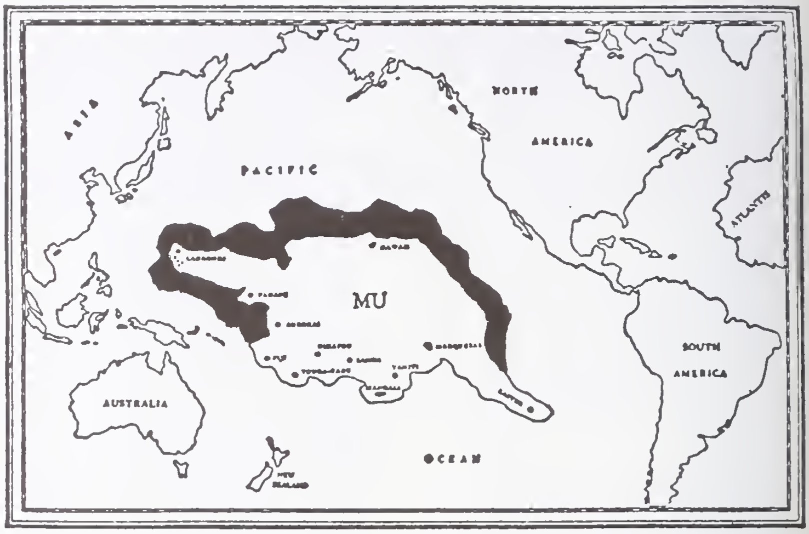
The tablets, says Churchward, also tell of Osiris being born in Atlantis, whence he traveled 20,000 years before Christ to Mu to become a master, so as to return to Atlantis to eliminate the "extravagances, superstitions, misconceptions and inventions that had crept into the Atlantean religion." Osiris is reported as having reinstalled in Atlantis an original religion of love and simplicity, of which he became high priest. From Atlantis, says Churchward, the Osirian religion was carried to Egypt by Toth about 16,000 years ago, a religion, Churchward says, which reportedly contained word for word and sentence for sentence the same teachings as those of Jesus, and from which Moses fathered his doctrine of monotheism.

In the other direction, westward from Mu, several lines of colonization are described; the best known ran from Burma to India to Babylon and upper Egypt, thus resolving the apparent conflict in legends about Egypt having been settled by strangers arriving from both east and west.

Churchward says lower Egypt was settled by colonists from Mu, via Mayax and Atlantis, both of which lay to the west, whereas the upper Egyptians came to Egypt from Mu, via Burma and India, which lie to the east.

The latter, as described by Le Plongeon, were known as the Nagas. Hindu records tell of the central parts of India (the Deccan) being first colonized by a white race who came to India via Burma from a motherland one moon's journey toward the rising sun, east of Burma, where now are the Polynesian islands. Churchward dates this migration as having taken place more than 15,000 years ago. The same Nagas are credited with starting the civilization of Babylonia, whose recently discovered cuneiform tablets contain religious concepts identical with those reported in the Naacal tablets.

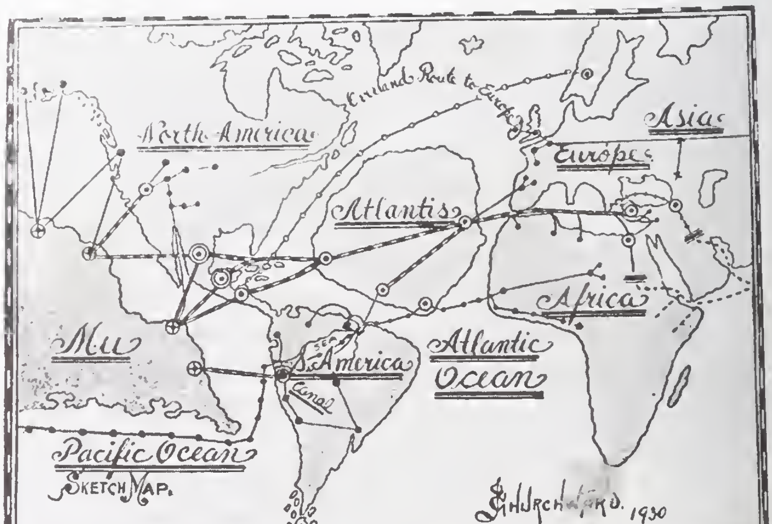
In support of the theory that numerous Pacific island groups form the last remnants of a once large continent, Stacy-Judd says the natives of Easter Island in the Pacific, 2000 miles west of Chile, state that their ancestors did not come from Lemuria but that they *are* Lemurianas living on a peak of a Lemurian holy mountain, the only portion of Lemuria remaining above the water.



Comparison of Easter Island glyphs (right columns) with those of the Indus valley.

Easter Island is known as one of the world's geodetic navels, or omphali. Barbieri says that a few years after the catastrophe which destroyed civilization on the island, missionaries found wooden tablets with hieroglyphs similar to ones found in Mohenjo Daro by the Hungarian Guillaume de Hevesy, and also to the archaic Chinese characters of the epoch of Chang as described by Dr. Hervé Geldren. One of the tablets was translated by W. J. Thompson in 1886 as saying "This (little island) was once part of a great continent of land, crossed with many roads . . ."

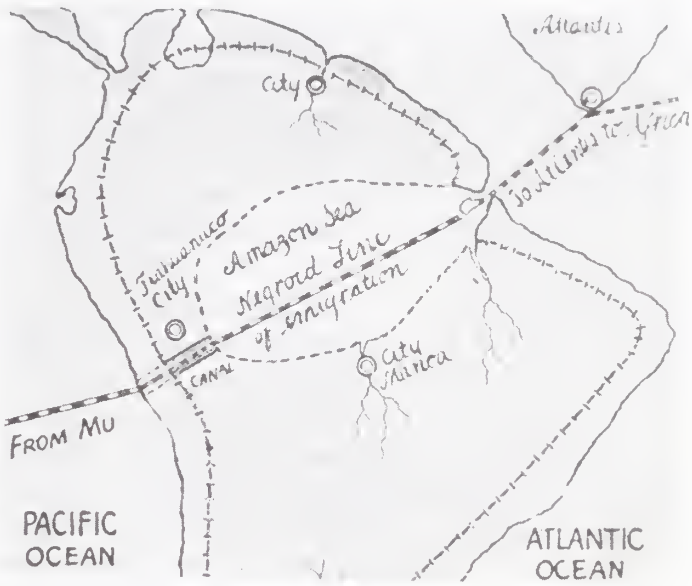
There are some twenty such tablets with Easter Island script scattered among the museums of the world.



Churchward's rendering of communications from Mu through North and South America to the Mediterranean via Atlantis.

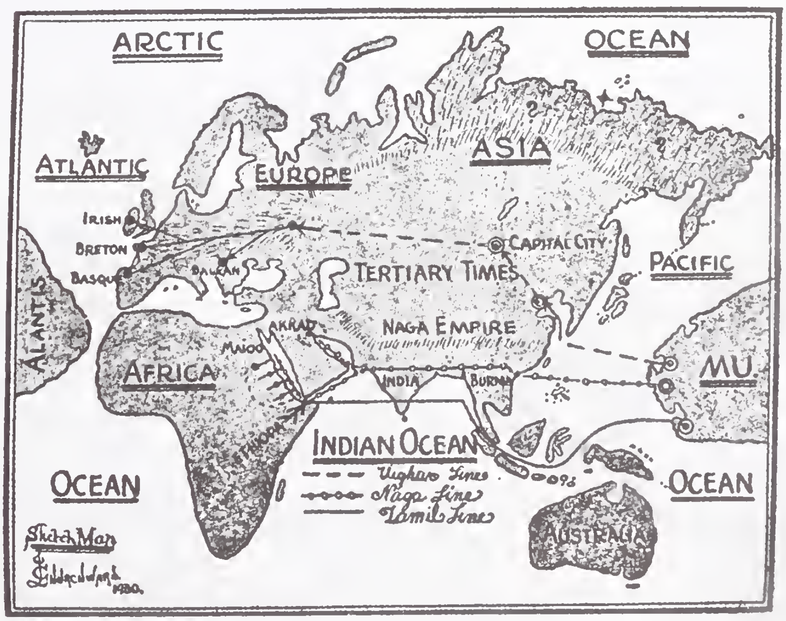
Amazon Canal.

This canal, and the Amazon Sea, are shown on a map of South America which Churchward says he found on a tablet in a monastery in Western Tibet on his last trip there. He says the date of the map was marked by the position of certain stars in certain constellations, and that astronomers told him it was twenty-five thousand years ago when these stars were in the positions given.



Churchward says that when he compared the writings of the old civilizations with the legends of Mu, he established to his satisfaction that the civilizations of the early Greeks, Chaldeans, Babylonians, Persians, Egyptians, and Hindus all derived from the civilization of Mu.

As for the Israelites, he says that when they were captives in Babylonia, they were able to study in the colleges of the Chaldi (or Chaldeans) where they learned the cosmic sciences. "The Chaldi," says Churchward, "were open and free to all who wished to come to them for learning. There was no expense to the student, and the slave was as welcome as the prince. Directly the threshold of the Chaldi was passed, everyone was on an equality. They were symbolically at the feet of the Heavenly Father, and became in fact brothers in truth.

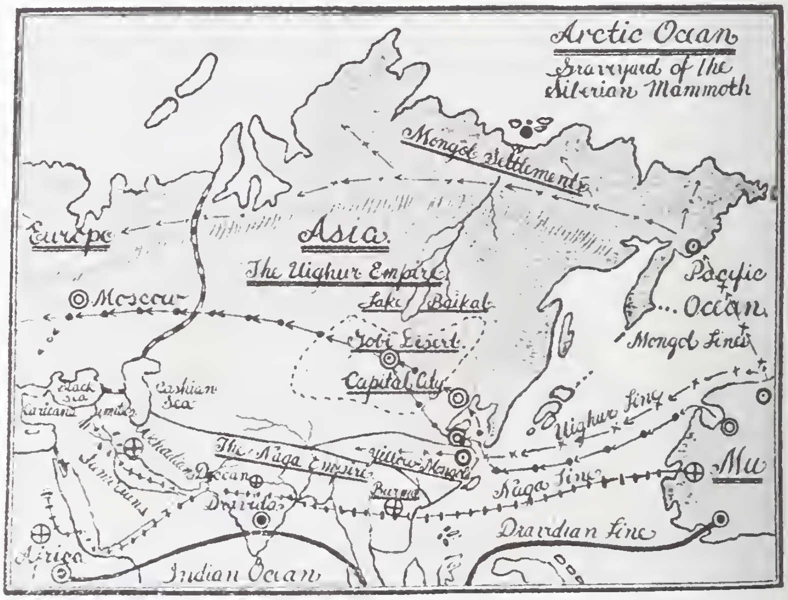


Westward lines of communication from Mu, according to Churchward.

These Israelites, although in bondage, attended the Chaldi and became Masters."

A secondary line in Churchward's scheme ran from Mu to the Malay islands and thence to southern India, called Dravida, and from India to Africa, where they settled south of Nubia, becoming the ancestors of the Ethiopians.

To the northwest of Mu the predecessors of the Japanese became a colonial empire; and on the mainland of Asia, says Churchward, was formed the largest and most important colonial empire ever derived from Mu, the great Uighur Empire, which stretched from the Pacific to Moscow, with outposts in Europe as far as the Atlantic, where the British Isles, at that time, 17,000 years ago, were still attached to Europe. This colony, whose southern borders were formed by Cochin China, Burma, India, and part of Persia, was said to have been destroyed partly before the cataclysm which ended Mu and partly afterward; its history, to Churchward, is the story of the Aryan races.



The Great Uighur Empire, which Churchward believes to have existed in the Tertiary Era, stretching from the Pacific to what is now the British Isles.

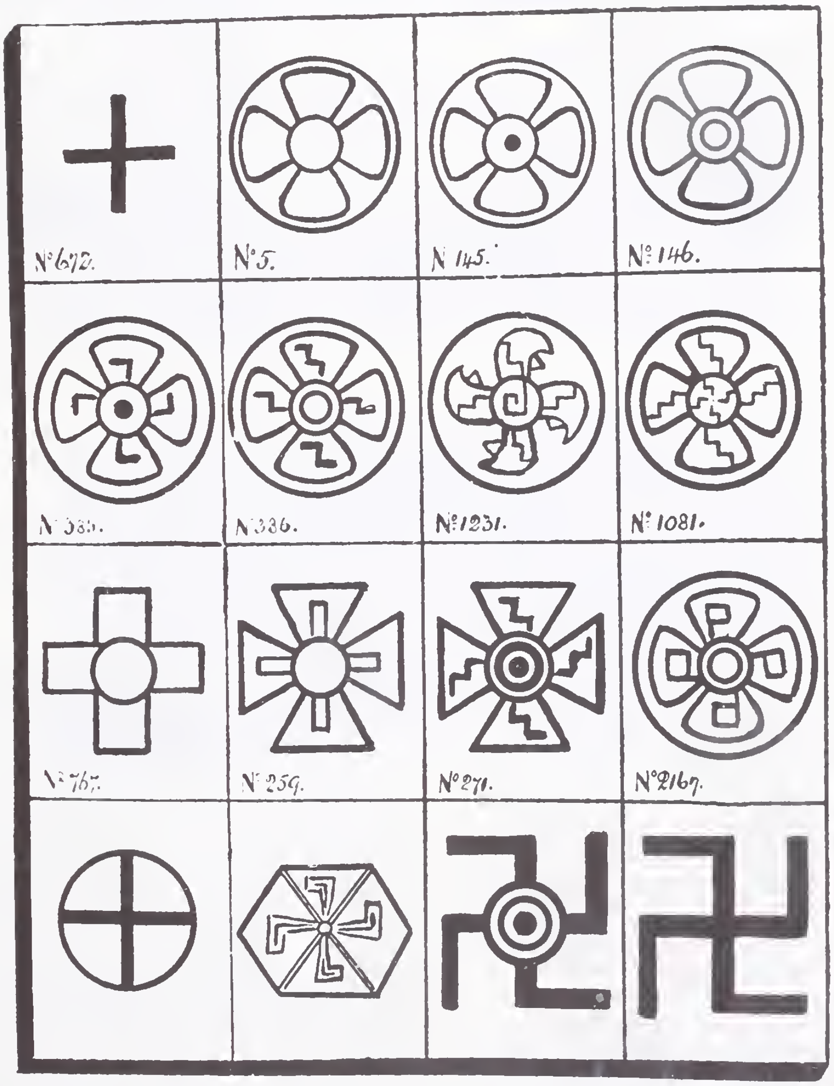
To the various colonies and colonial empires, says Churchward, the sacred writings of Mu were carried by a body of trained masters known as Naacals, who formed colleges in each country where priest-teachers could be taught religion and the sciences, the priesthoods in turn teaching the people.

As reconstructed by Churchward, the religion of Mu was without dogma, taught in the simplest and most easily understood language that the most unschooled mind could grasp. Confusion, he says, set in only after the collapse of Mu, when bigotry and impossible theologies were developed. "At various times in the history of man, unscrupulous priesthoods have caused the downfall of religion by introducing into it vicious systems of theology made up of inventions, extravagances, and immorality as well as false translations from the Sacred Writings from which all religions sprung, for the purpose of inspiring superstitious fears, to ensnare people body and soul into slavery to the priesthood." Having accomplished this, says Churchward, it did not take long for the priesthoods to acquire wealth and to become all powerful.

The Vedas, says Churchward, were stolen from the Naacal writings and changed by the Brahmins to be foisted on the world as sublime thoughts of their own, whereas the Brahminical theology became, as it was intended, a breeder of superstition and awe, dragging the nation down from a pinnacle of civilization to the lowest rung of the ladder.

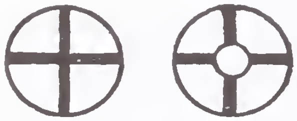
The priesthood in Egypt, says Churchward, caused a "cataclysmic wave of false gods, idolatry and spiritual degradation to sweep over the land."

Churchward maintains that the Naacal tablets he was shown in Tibet contain religious concepts and a cosmology of a very high order. He says the civilization which produced the tablets was in no way primitive, even though some of the workmanship of the tablets appears crude. According to his interpretation, their knowledge of the cosmic forces of "energy" was remarkable, and the tablets were the exposition of the knowledge of a profound science, "which is only dawning on the scientific world of today, and which has not been learned and mastered by modern man."

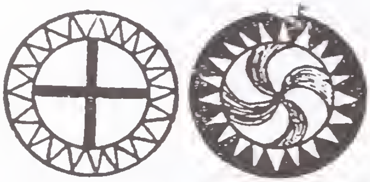


Group 6.
Ancient symbols of the Sacred Four.

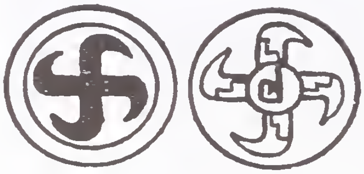
Churchward's interpretation of the Four Forces proceeding from the source.



And the Four Forces within the absolute.



Rays proceeding from the Four Forces.



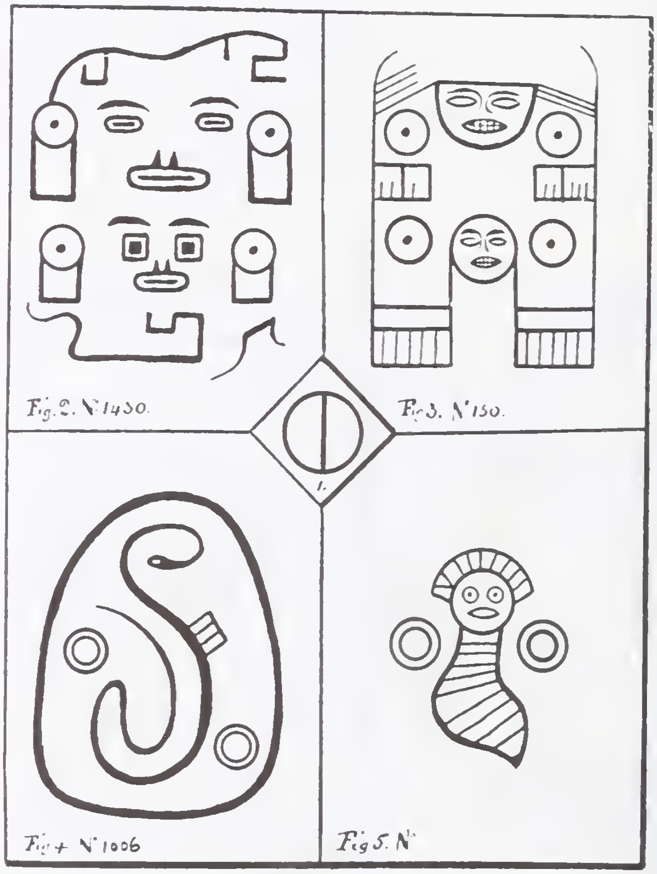
The Four Forces working from east to west.

A group of four tablets which Churchward says symbolize the dual principle of creation. Churchward says the alphabet of Mu consisted of sixteen letters and many diphthongs, each letter of which had three different glyphs to express it. According to Churchward, the first was the hieratic letter, which also carried a hidden meaning known only to the priests, and not even to all of them; the second was used in the body of words; and the third was an adjective for emphasis. He says the bulk of the tablets contained extracts and sentences from the Sacred Inspired Writings of Mu, and in most cases the esoteric or temple glyphs were used. He believes the ancient Mexicans obtained their cosmogony from the Sacred Writings of Mu, the fountainhead.

Churchward's interpretation of the Naacal and the Niven tablets indicates a much earlier awareness of where man had come from, why he was on earth, and how the universe is governed and controlled.

The tablets, says Churchward, tell of how originally the universe was all soul or spirit.

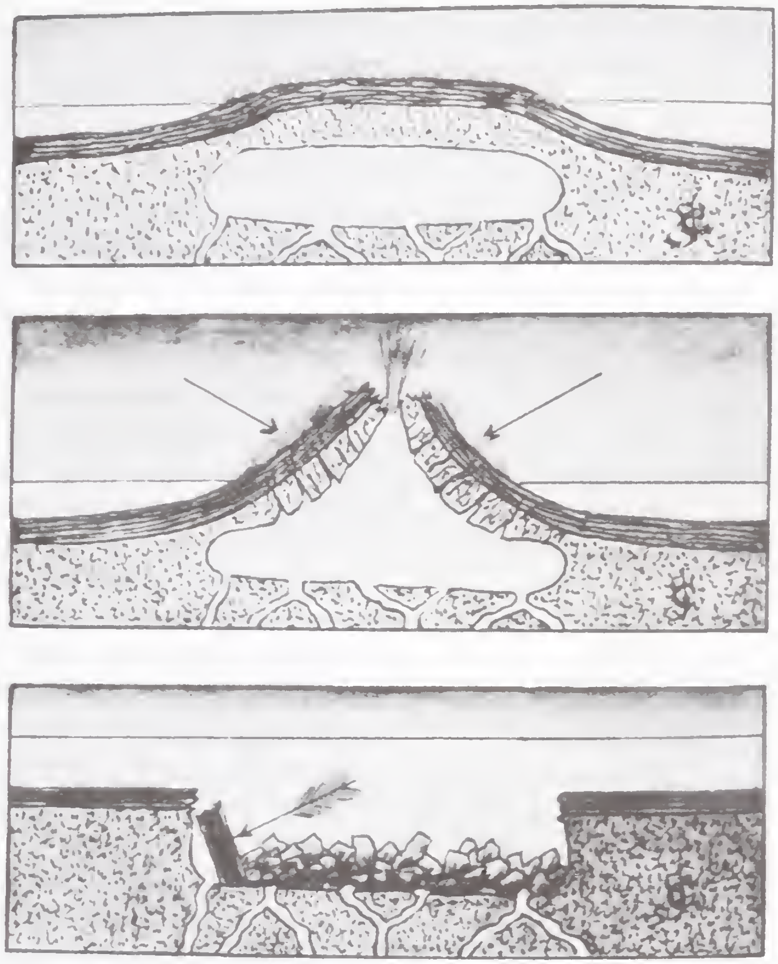
The principal symbol of the tablets was the sun—a monotheistic or collective symbol of the Creator; later it was given many attributes, each of which was also symbolized, though it was stressed that these attributes were only powers of the One Supreme.



According to Churchward's interpretation of the tablets, two cosmic forces were required for creation; thereafter, the first four gods were the four primary forces which evolved law and order out of chaos, creators of all that is physical throughout the universe—or what in the Christian and Moslem worlds would be termed the four archangels. Churchward adds that Pythagoras taught that the number four referred to the Great Creative Forces. In Steinerian or anthroposophical terms, these forces could manifest as the force fields behind hydrogen, oxygen, nitrogen, and carbon.

Later in the history of man, according to Churchward's analysis, the disembodied souls of men were added to the list

The raising and collapsing of mountains by the action of great subterranean gas belts, which, according to Churchward, occurred in more recent times than geologists are ready to accept.



Churchward's depiction of a mountain rising from a plain.

of gods. The formulator of this theology, says Churchward, knew that man at his creation was given cosmic forces under the control of the soul, and that when the soul leaves the material body it carries the cosmic forces with it, eventually back to the originating power.

Churchward claims the symbols of Mu reveal an origin of Freemasonry far older than in Egypt 5000 years ago. He also claims the sacred writings of the Naacals, which contain many Masonic symbols, evidently going back to Mu, perhaps as far back as 70,000 years, constitute the first known religious teachings, of which the present Masonic doctrines are but fragments outlining a monotheistic religion of All-in-One, with love for the Creator as Heavenly Father, and love for mankind as brothers, handed down from generation to generation since the collapse of Mu 12,000 years ago. Ever since, says Churchward, man has lived many lives in many places, not always of this world, with between each life a veil of darkness breached only in some daydream or casual thought of previous circumstances, all of which in the end will be revealed.

Churchward's most improbable explanation for the evident tidal wave which swept across the Valley of Mexico, a mere 5000 feet above the sea, is to suggest that the valley was once at sea level and that vast mountain ranges were pushed up by the explosion of subterranean gases in a relatively recent period, not more than 12,000 years ago. He suggests a similar explanation for the abundant evidence indicating that Tiahuanaco in the Bolivian Andes, now at 9000 feet, was also once at sea level, ignoring H. S. Bellamy's theory that the waters of the oceans once reached up to these levels when held by the attracting force of earth satellites which preceded our moon and which caused cataclysmic tidal waves when these satellites disintegrated onto the earth, releasing enormous girdles of water accumulated around the equator. Though each suggestion seems farfetched, either, and especially Bellamy's, is at least an attempt to explain remarkable evidence for which geologists cannot provide explanations.

This story of Mu does give a background to the influx of peoples to Central America and fill some gaps in a rational way, but as no one other than Churchward appears to have reported on the Naacal tablets, and as he produces

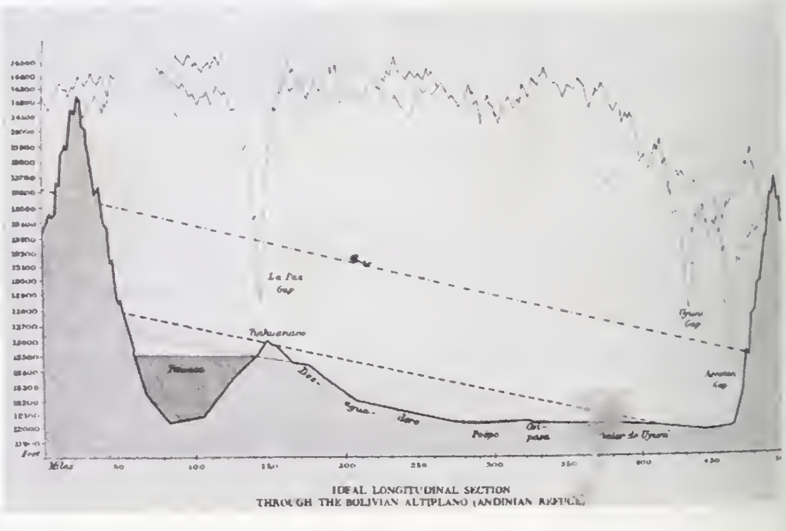


Illustration from H. S. Bellamy showing level of oceans on Andean Altiplano as held by his postulated satellite predecessor of Luna.

illustrations of only very few—and none of these in photographs—his word can only be taken by those who wish to believe him.

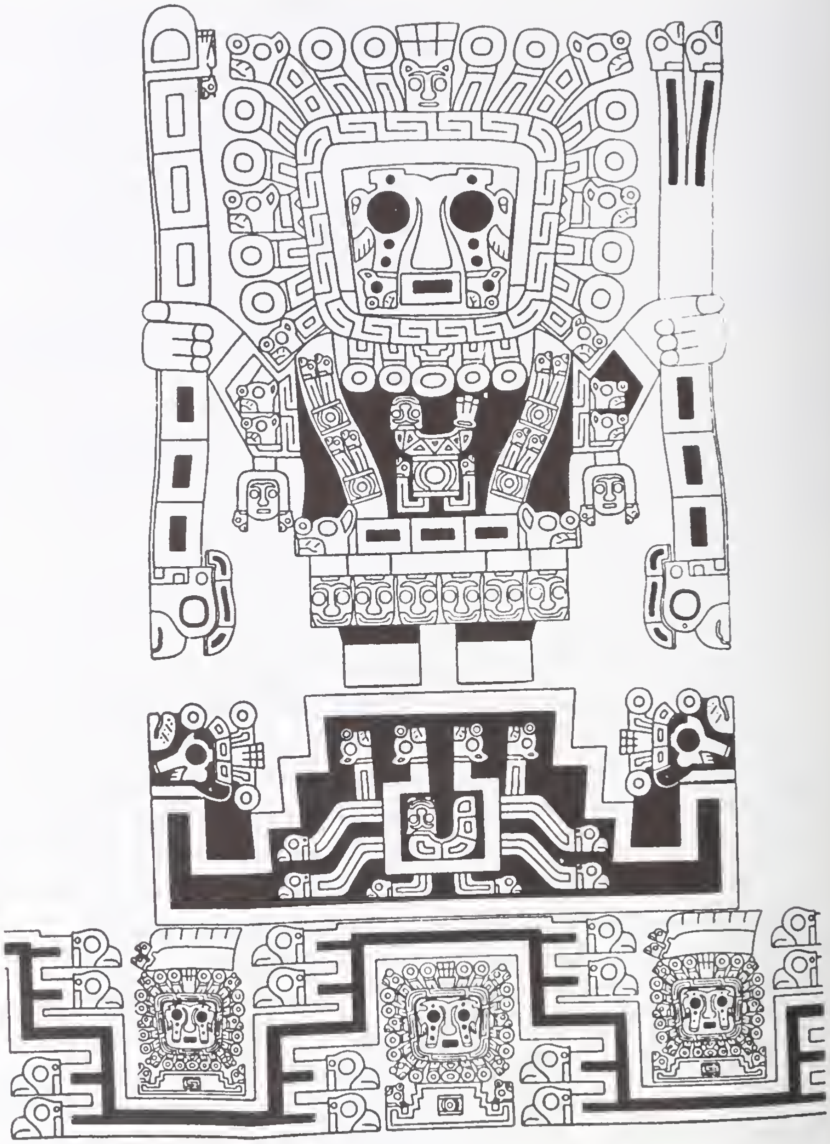
It might therefore seem foolhardy to dwell on the geological possibilities of a sunken continent in the Pacific were it not for a great deal of solid data recently put forward by a group of Soviet academicians. Soviet author N. F. Zhirov, who lucidly marshaled the data in his scholarly *Atlantis,* fully subscribes to the opinion of V. V. Belousov, who writes in *The Geological Structure of Oceans:* "It may be asserted that very recently, partially even in the age of man, the Pacific Ocean grew considerably at the expense of great chunks of continents which, together with their young ranges of mountains, were inundated by it. The summits of these mountains are to be seen in the island garlands of East Asia."

Zhirov also quotes from an interesting paper read by George H. Cronwell at the 10th World Pacific Congress on the discovery of coal on Rapa Island (Rapaiti, southwest of Mangareva Island) which "provides irrefutable testimony of the fact that there was a continent on that part of the ocean." The flora on the island likewise dates back to remote antiquity. On the basis of these discoveries, which, Zhirov says, passed virtually unnoticed, Cronwell assumed the existence of a vast submerged land area in and south of the region of Polynesia.

A comparison of island and continental lava led R. Furon to surmise in *Sur des trilobites dragnés à 4255 de profondeu par le "Talisman"* that the Hawaiian Islands were once part of a Pacific continent. "We believe," says Zhirov, "that in the not very distant past the submarine Hawaiian ridge was a large land area—Hawaiis; perhaps the sinking of its remains was witnessed by man—let us recall the Polynesian legend of a happy motherland named Hawaiki about whose location there are the most diverse guesses." Zhirov adds that at one time Hawaiis may have been a chain of islands or even a large land mass over which man (possibly Mesolithic and Neolithic pre-Ainu and Mongoloid tribes) migrated from Asia to America and southward to Polynesia.

North of New Guinea there is also the vast submarine Carolina plateau, over which are islands of the same name. This region is the home of an enigmatic Megalithic culture about whose origin and people there is little trustworthy data. The cradle of this culture, says Zhirov, was on Ponape with its remains of a huge mysterious port carved into basalt cliffs, Nanmatal, sometimes called the Venice of the Pacific. This port of the western Pacific is now virtually

Solar-year part of the great calendar at Tiahuanaco, Bolivia, from H. S. Bellamy.



inaccessible to archeological and oceanographic investigation because of U.S. naval and air bases—possibly the cause of such detailed interest by the Soviets in a lost continent of Mu.

Edgar Cayce (1877–1945), America's "Sleeping Prophet" was a medical diagnostician by clairvoyance whose 30,000 "readings" while entranced gave detailed medical and spiritual advice to thousands of individuals, often thousands of miles away from Cayce's office. The stenographic records of these "readings" are now at the Association of Research and Enlightenment in Virginia Beach, Va., along with hundreds of affidavits from satisfied patients and physicians who followed Edgar Cayce's prescriptions.
As a psychic observer, Cayce also described geological changes in the remote past of this planet, and calmly prophesied catastrophes for the future, believing, as he did, in endless cycles of life in which spiritual entities occupy one body after another.
From Cayce's description of the "past lives" of his patients, going back several millenia, it has been possible to create or recreate a picture, sometimes hodge-podge, sometimes lucidly rational, of what might have occured on this planet, for which there is little historical data but for which recent geological and archaeological research has adduced some startling verification.

27. Cayce's Mesoamerica

There is one strange source corroborating Mu. In the voluminous "readings" given by America's foremost psychic, Edgar Cayce, over a period of a quarter of a century, he describes in broad strokes and fine lines the same sinking of two great continents, Mu in the Pacific, Atlantis in the Atlantic; he also outlines an inspired religion very similar to that exhumed by Churchward from the Mexican tablets of Niven.

Cayce's data is extracted from "past life" readings of several hundred individuals whose incarnations in Atlantis, Mu, and their various colonies he describes in such fascinating detail that, as the Italians say, *"se non è vero è ben trovato."*

Mu, which Cayce calls short for Lemuria, he describes as a continent covering a large area of the southern Pacific which sank beneath the sea even before the end of Atlantis. The arrival of fleeing Lemurians to the Yucatan peninsula, says Cayce, had its part in changing the civilization already established there by the Atlanteans, though it was the Atlantean civilization which was the most powerful influence in shaping the earliest culture in Yucatan. According to Cayce, at the time of the final destruction of Atlantis much of the land area of Yucatan also sank and was covered by the sea so that the land assumed its present outline.

Again it might seem idle to pursue such tenuous leads as the psychic readings of Cayce were it not that many of the same eminent Soviet geologists quoted by N. F. Zhirov support the thesis that a large continental body sank into the Atlantic in relatively recent times. Furthermore, the University of Miami's top geologist, Cesare Emiliani, is categoric, on the basis of corings in the Gulf of Mexico, in his description of the flooding of Yucatan about 12,000 years ago. He says that at the end of the last great ice age a flood of icy water poured down the valley of the Mississippi to raise the waters of the Gulf of Mexico some 130 feet. Pointing to Antillia on the map, he is quite specific: "That's where the last of Plato's Atlantis could have been submerged."

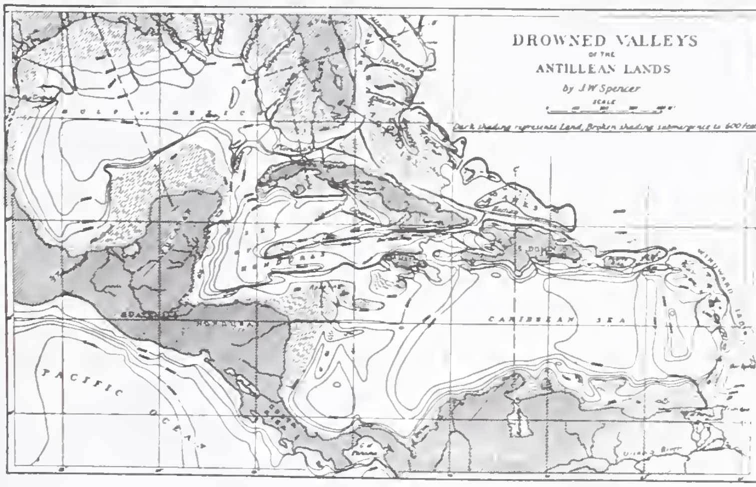
The lost continent of Atlantis, which Cayce places just about where Plato placed it in the Atlantic, went down, says Cayce, in three successive disasters. The readings claim that many lands have risen from or collapsed into the seas in a series of cataclysms over hundreds of thousands of years, shifting the poles repeatedly, causing tropical areas to freeze while frozen ones became warm and fertile.

Antillia (B) and Atlantis (A).

No definite date is mentioned for the first destruction of Atlantis, though 50,722 B.C. is given as the time of a meeting held to discuss how to rid the earth of a menacing horde of prehistoric beasts; the first destruction is presumed to have occurred not too long thereafter.

The readings tell of a few Atlanteans leaving before the first destruction, going to South and Central America, Egypt, and to what are now Spain and Portugal as places of refuge.

Cayce describes a struggle on Atlantis between two main groups, the "Sons of the Law of One," who believed their bodies to be a temple to the living God, with whom they could communicate by meditation, and the "Sons of Belial," who opposed the Law of One, using their creative forces for self-aggrandizement and the control of others. Cayce attributes the



J. W. Spencer's map showing coastal areas of the Caribbean islands, Florida, and Yucatan that were above water before the flooding of the Mississippi, estimated by geologists to have occurred at the end of the last ice age about 12,000 years ago.

catastrophes which overcame Atlantis partly to the noxious thought forms of the Sons of Belial and partly to misjudgment by the others in the use of power.

In the first destruction of Atlantis, a large portion of the area of the Sargasso Sea is said to have gone under, inundating a huge land mass that "would be considered a large continent." The breakup apparently produced large islands "with intervening canals, ravines, gulfs, bays and streams."

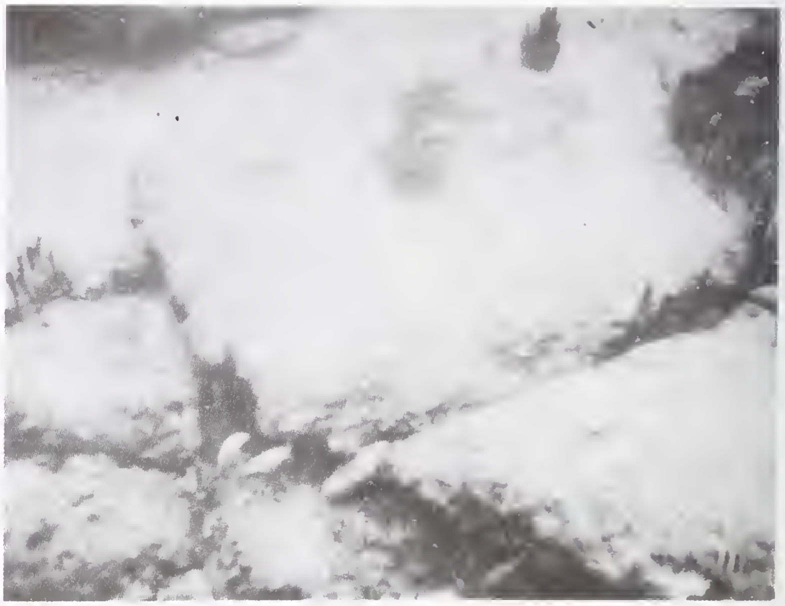
Prior to the breakup, Cayce speaks of the earth's rotation about the sun being different, revolving around Arcturus and the Pleiades. As the earth's axis shifted, people rose up and there were great movements toward the south during which the enormous animals which threatened to overrun the earth were fortuitously destroyed by the changing of the poles.

The second period of disturbance is given by Cayce as "some twenty-eight thousand years before Christ." In this catastrophe he tells how representatives of Atlantis fled the land and settled in what is now Yucatan. According to the readings, they fled in airships as well as water craft.

Elsewhere Cayce describes aircraft "lifted by gases," and pleasure vehicles "that pass along close to the earth," as well as craft that traveled on and under the water.

To power these craft at a distance, Cayce describes a mysterious cylindrical glasslike stone placed in an oval building where it could be activated by the sun's rays to produce phenomenal energy, which the Atlanteans had apparently learned to broadcast.

Cayce says that knowledge of how to construct such a "mighty firestone" was taken to Yucatan, where it was preserved, the records of the manner of the construction of the stone being secreted in three places in the earth: "in the sunken portion of Atlantis, or Poseidia, where a portion of the temples may yet be discovered, under the slime of ages of the sea water—near what is known as Bimini . . . And in the

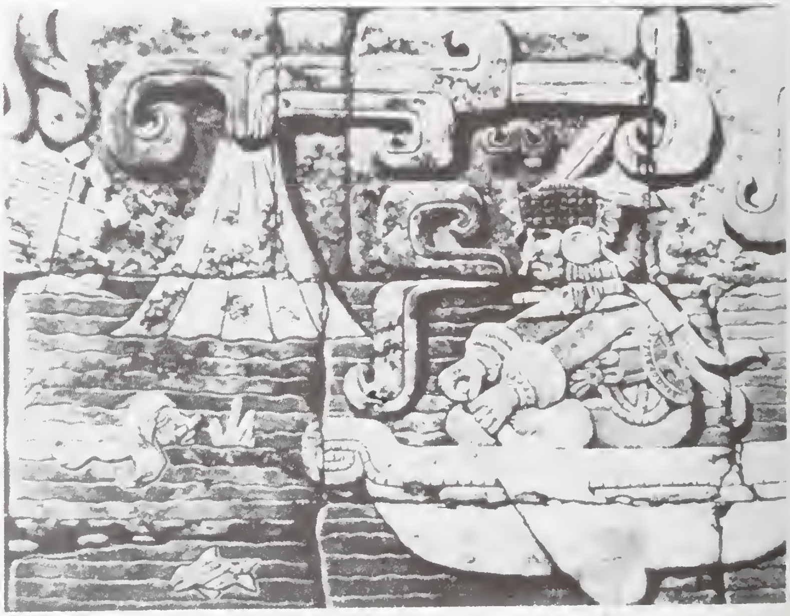


Controversial part of the so-called Bimini Wall believed by some first-rank European geologists to be a man-moved megalithic structure, but which Florida geologists believe to be a natural formation of beach-rock. Now in about eighteen feet of water, it appears from recent corings by geologists to have been above water some eight thousand years ago.

temple records that were in Egypt . . . Also the records that were carried to what is now Yucatan."

Much of Cayce's evidence is either corroborated or complemented by the research of Robert B. Stacy-Judd, who belives that the people of the Cro-Magnon invasion of Europe in 23,000 B.C. were also Atlanteans, and that another large wave came about 14,000 B.C. He says the Cro-Magnons were a tall well-built people with long skulls, fine foreheads, of light brown or red complexion, "one of the finest peoples, mentally and physically, that the world has ever known."

According to Stacy-Judd, the Cro-Magnons brought with them to Europe a mixed bag of assets, including the art of pyramid building, witchcraft, the cult of the phallus, and wor-



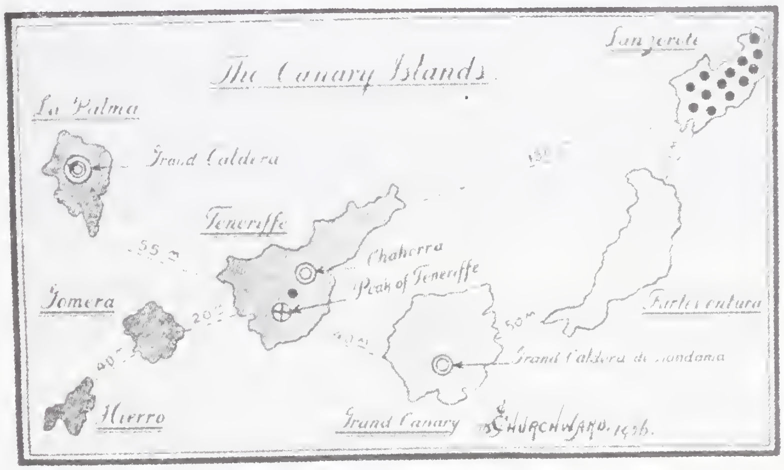
Teobert Maler obtained this depiction of an Atlantean cataclysm from a bas-relief in a remote and, at that time, unknown spot deep in the jungle of Yucatan. The relief shows a volcano erupting, a pyramidal temple crumbling, land sinking, men drowning, and a survivor fleeing by boat. The original of the photograph is in the possession of Robert B. Stacy-Judd, who suggests that when, between 200 and 500 B.C., the last of a great Atlantean empire vanished beneath the waves of the Atlantic Ocean, the remnant of her highly cultured people, last of the root Atlanteans, fled hurriedly to Yucatan and Central America, bringing with them—among numerous other expressions of a great civilization—the highly developed art of symmetrical pyramid building, and were thereafter known as the Maya.

ship of Osiris. He says that all the ancient races of Europe, with the exception of the Negro, claim that their ancestors arrived in boats from a land which sank beneath the waters toward the setting sun or west, and that with each successive subsidence of the disintegrating Atlantis, escaping hordes invaded the shores of the Mediterranean, slowly pushing their way eastward toward the fertile lands of Egypt, already settled by colonists of their own mother country.

To Cayce, the escape from Atlantis was not a random scattering but an organized movement to colonize lands that were carefully chosen. Several readings indicate there were already inhabitants in the Yucatan area when the Atlanteans first arrived, though these were less developed than the newcomers.

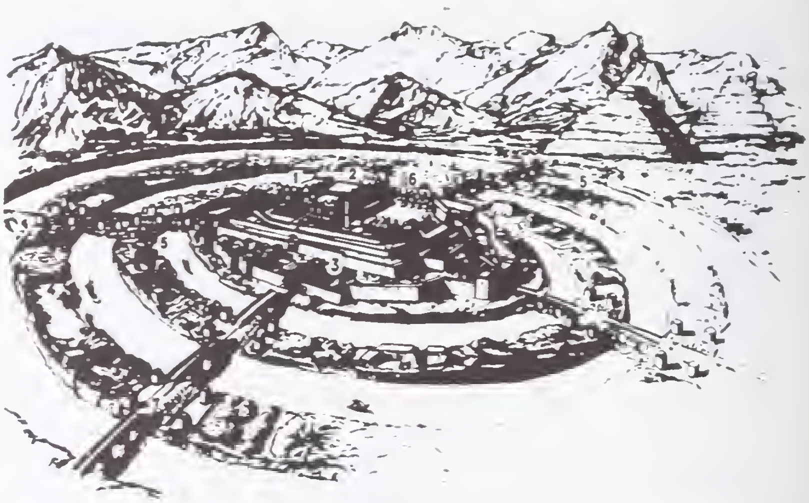
Cayce refers to considerable temple activity in Yucatan by the refugee Atlanteans, with temples set up to propagate the original faith and to preserve the "knowledge that would make for a unifying of the understandings as to the relationships of man to the creative forces." From Cayce's readings it appears that the Atlantean civilization was well advanced and that their art reappeared in Yucatan as a full-blown accomplishment.

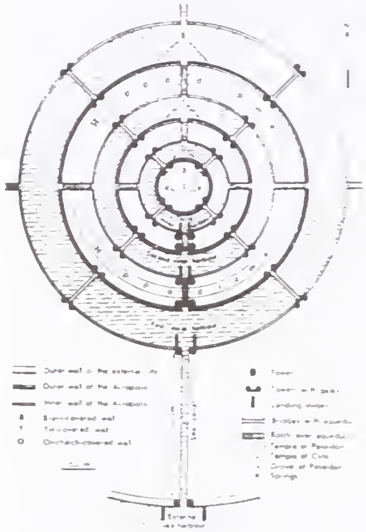
The Canary Islands as depicted by Churchward.



Stacy-Judd believes that fleeing Atlanteans became the Cro-Magnons who settled on the Canary Islands. Humboldt and Bonpland searched for remains of ancient Atlantis among the extinct volcanoes of the Canaries.

Plato described the capital of Atlantis as being divided into alternate zones of land and water.





Plan of the Atlantean capital as it appears in Soviet geologist N. F. Zhirov's book *Atlantis*.

Cayce tells of a leader named Iltar with a group of followers, "members of the worship of the One," who came westward and entered what is now a portion of Yucatan to develop their civilization as it had been on Atlantis. He says the first temples that were erected by Iltar and his followers were destroyed at the period of the final collapse of Atlantis, when there were great physical changes also in the contours of Yucatan. In one of his readings he adds that these temples built by the Atlanteans in Yucatan were being rediscovered in the 1930s, saying that many of the second and third civilizations may never be discovered because to do so "would destroy the present civilization in Mexico."

Corroborating Le Plongeon, Cayce says that ruins of temples still stand in Yucatan which contain secrets pertaining to the occult. As for the temple of Iltar, he says it is located on a portion of the land that now rests beneath the waters, but may yet rise again.

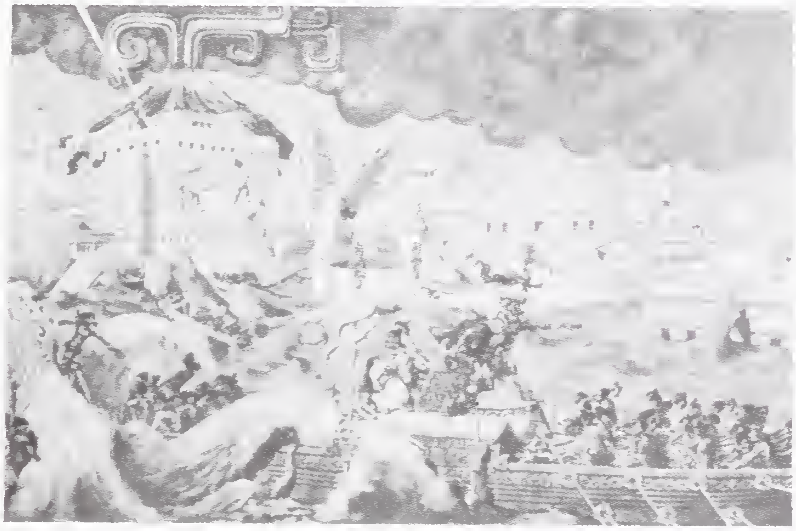
Cayce categorized the two types of remains from Atlantis as "stones that were circular" and "altars upon which there were the cleanings of the bodies of individuals." The readings state that the altars were not for human sacrifice. Instead, the bodies of those to be "cleansed" were placed on the altars so that such undesirable qualities as hate, malice, and self-indulgence could be removed "through the rise of initiates from the sources of the light."

The altars apparently served as focal points for spiritual forces brought from "the source of light," the cleansing being accomplished through a sort of spiritual healing.

Partly corroborating Le Plongeon, Cayce says small numbers of Egyptians also came to Yucatan, where they prepared "The Temple Beautiful" in which song and music were used to make "for losing even the association with the body" except for the body's vibrations which "make for light, then become color, then become tone, then become activity . . ."

With the music, there was dance which "enabled those with the disturbing forces and influences to become more erect, upright in body, in thought, in activity . . . being in the world, yet not of the world . . ."

Cayce says the "children of the Law of One" could concentrate their thoughts for the use of the universal forces, with the guidance of what today would be called the saints. Through concentration of the group mind, they were able to reach a higher level of consciousness which brought them into a fourth-dimensional consciousness, an out-of-body experience.



Stacy-Judd's romanticized version of the collapse of Atlantis. And Edgar Cayce's description of the events told in the strangely archaic language which issued from him when he fell into a trance.

The records in Egypt, says Cayce, contain "A record of Atlantis from the beginnings of those periods when the Spirit took form or began the encasements in that land, and the development of the peoples throughout their sojourn, with the record of the first destruction and the changes that took place in the land, with the record of the sojournings of peoples to the varied activities in other lands, and a record of the meetings of all the nations or lands for the activities in the destructions that became necessary with the final destruction of Atlantis and the buildings of the pyramids of initiation." According to Cayce, the Great Pyramid of Gizeh in Egypt was completed around 10,000 B.C. to be used as a temple of initiation for the White Brotherhood.

He speaks of the Atlanteans being able to transpose "those materials that did not pertain to themselves bodily, by that ability lying within each to be transposed in thought and body." He suggests that Atlanteans were not only able to move matter about the universe, but could move themselves in consciousness beyond the earth plane.

He speaks of the "full consciousness of the ability to communicate with or to be aware of the relationships of the Creative Forces and the uses of same in material environs," adding that during the age of Atlantis and Lemuria (or Mu) this brought destruction to man because of selfish use.

As for the Lost Tribes of Israel, Cayce confirms that a portion of them came into the southernmost portion of the United States, mixing with the refugees from Mu, then moved on to Mexico and Yucatan, but mostly to the central part near what is now Mexico City. He says they came much later than settlers from Atantis or Mu, but did add their influence, as rerecorded by the Mormons, to the cultural melange that had been gathering in Central America for thousands of years. He says they too came by boat, setting sail during those periods

Barbiero's Atlantis in Antarctica, with shifted pole.

By some ardent fan, Atlantis has been placed almost everywhere on the globe. It has even been placed in Antarctica in the area bathed by the Weddell Sea. In the book *Una Civiltà sotto Ghiaccio,* Italian author Flavio Barbiero maintains—with some cogent evidence—that the earth was struck by an asteroid or comet about 12,000 years ago, just about when Plato said that Atlantis sank. The ensuing cataclysm, says Barbiero, shifted the poles and caused Antarctica to be shrouded in a mile-thick mantle of ice. The same event, says Barbiero, caused the melting of the great Wisconsin icecap and the melting of the icecaps over parts of Scandinavia, Russia, Germany, Britain, and the Alps.

Taking as historic fact Plato's description of the sinking of Atlantis in a single night under the action of earthquakes and tidal waves, and as scientific evidence the carcasses of mammoths congealed with springtime food in their stomachs, Barbiero suggests that the cataclysm would have had to be sudden.

Barbiero postulates that a vast civilization with a high technology and a fleet of great trading ships flourished in Antarctica before the catastrophe; he believes the survivors from this civilization got away in ships to create colonies elsewhere. According to Barbiero, neolithic culture was not a civilized advance but a regression of Atlantean survivors who landed in various areas, gradually losing their original know-how. Barbiero believes that sophisticated Atlantean artifacts will be found beneath the icecap of Antarctica.

A preface to Barbiero's book by the director of the Italian Polar Geographic Institute, Silvio Zavatti, attests to the seriousness with which the thesis was received.

when there was the breaking up of the Tribes of Israel, and while "the rest were enslaved in the Persian land."

Several tests of the veracity of Cayce's prophecies have already turned in his favor. His prophecy about the recovery of the Quamran papers is quite breathtaking.

Though all of this is highly speculative material, hardly the makings of history, the data adduced by Churchward, Niven, and Cayce makes so much more sense and resolves so many apparent incongruities in what passes for history and prehistory that it should perhaps be pigeonholed rather than discarded a priori.

More tests are in the making. Between now and 1998, Cayce envisages another shifting of the poles with great upheavals. The earth, says Cayce, will be broken in many places, which he lists for the benefit of those who wish to listen to his

Barbiero's ancient Atlantean Continent.

Barbiero maintains that 15,000 years ago the seas were 130 meters lower and that the missing water was heaped up on what is now Europe and the northern part of the United States in the form of 80 million cubic kilometers of ice.

He rests his thesis primarily on the evidence of geologists that a large celestial body precipitated into the North Atlantic 10 to 12,000 years ago, and quotes Austrian geologist Otto H. Much to the effect that the body which weighed 2 billion tons landed near Florida, breaking into two large fragments. According to Much, this event occurred on June 5 of 8496 B.C. at 2000 hours local time.

Barbiero further maintains that because of the pull of the moon, the earth cannot maintain its axis of rotation constant to the ecliptic. He says the moon's pull makes the earth's tilt vary from 15 to 20 degrees over a period of about 20,000 years, causing more or less ice on the poles and glaciations that occur in cycles. Ten to twelve thousand years ago, says Barbiero, the earth was tilted no more than 4 to 5 degrees from the ecliptic.

Professor Cesare Emiliani, head of the Department of Geology at the University of Miami, has worked out a graph from deep-sea core samplings taken in the Gulf of Mexico which indicate glaciation and deglaciation in cycles of about 20,000 years over the past 700,000 years, with the last major deglaciation occurring in 11,600 B.C. when ice water pouring down the Mississippi Valley from the melting Wisconsin icecap caused the waters of the Caribbean to rise about 130 feet, at precisely the date given by Plato. Emiliani postulates that the ensuing flooding of low-lying coastal areas, many of which were inhabited by man, gave rise to the deluge stories common to many traditions.

warnings. If any more of the events he has predicted come to pass, a closer look may be given to Cayce's descriptions of events purported to have occurred on this planet in remote antiquity. And an even closer look may be given to his descriptions of the spiritual religion of the Atlanteans, remnants of which were passed on to Yucatan and Central America for the avowed purpose of finding a better way to handle man's affairs upon this planet.

28. Therapeutic Theater

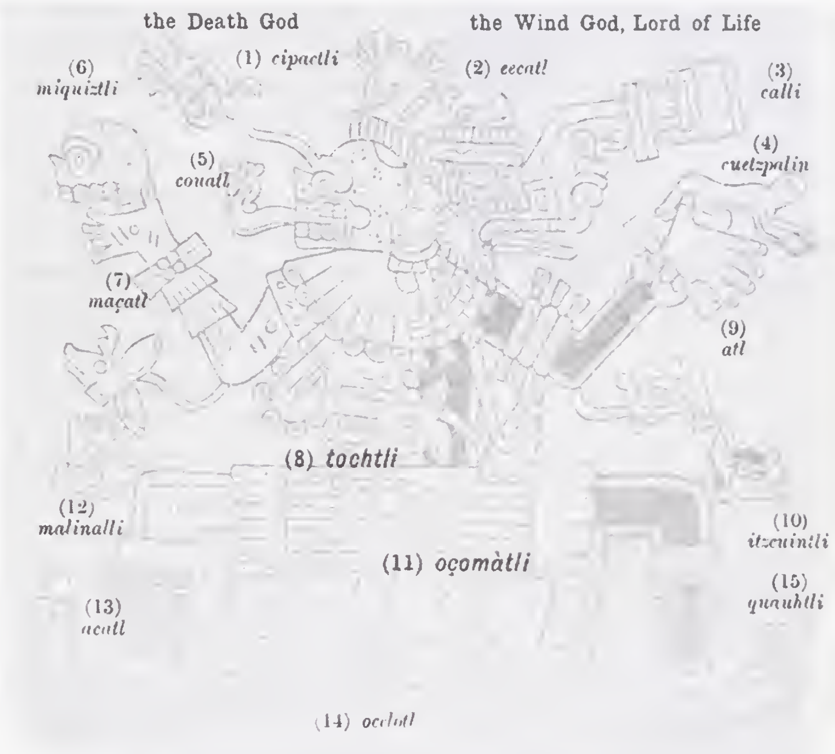
From the first reports of the Spaniards in Mexico it was evident that the stepped pyramids they encountered had been used for religious rituals but had long since degenerated into monuments of senseless slaughter. The Spaniards also found that the stadiumlike ball courts of the Indians appeared to have once had astronomical and cosmic overtones.

Edmond Bordeaux Szekely, philosopher, psychologist, and author of many books on ancient cultures, whose brilliantly intuitive work on Mexico is described in the prestigious *Handbook of Latin American Studies* as a "compendium of misinformation with unsubstantiated conclusions to explain Toltec, Aztec, and Maya cosmology," has, in fact, delved deep into the philosophy of ancient Mexico to produce a convincing analysis of the pyramid and ball-court rituals which indicates they were originally designed by initiate priests for religious dramas to convey to large audiences religious truths of cosmic import.


Edmond Bordeaux Szekely.

A Sanskrit and Aramaic philologist, whose Transylvanian forefather, Csoma de Körös, compiled the first grammar of the Tibetan language, Szekely claims to have deciphered the hermetic symbolism of the ancient Mesoamericans to show that their pictographs incorporate a philosophy of life similar to the world picture of the Sumerians and Persians, which interpreted the realities of the universe and gave expression to the strange forces within and surrounding man.

The predecessors of the Aztecs, says Szekely, believed that everything in the cosmos, including life and human consciousness, was brought about by a struggle between the two cosmic principles of Life and Death: a system similar to that of Zoroaster, or Zarathustra, in which Ormuzd, or Ahura Mazda, The Life and Death sides of a single deity as they appear in an Aztec codex, with the symbols for the Aztec days of the month.



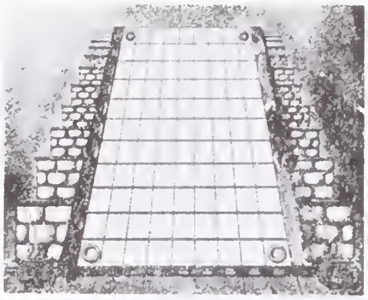
the holy spirit of Light, and Ahriman, the evil spirit of Darkness, waged war for man's soul—a war that constituted the history of the world.

In Mesoamerica, says Szekely, the spirit of Light and Life was symbolized by the plumed serpent Quetzalcoatl; his opponent, the spirit of Darkness and Death, by the jaguar or tiger called Tezcatlipoca.

At the center of this struggle, man, created free, could partake of either Life or Death, could make himself accessible to the influences of either good or evil. By his actions man could render service to, and thus strengthen, one or the other protagonist.

Aztec Tezcatlipoca.

Aztec depiction of Quetzalcoatl.



Ball Courts.

Both Brinton and Troncoso observed that the game of ball was intended by the Mesoamericans to represent the idea of the perpetual motion of the heavenly bodies. Tezcatlipoca, Lord of the Shining Mirror, Lord of the Nocturnal Heaven, was reflected in a myriad of mirrors each night throughout Mesoamerica. His priests, who called themselves "sons of the night," were associated with the divination of human destiny, which was linked with the movement of the stars.

Nuttall draws attention to the fact that the courts were called *tlach-tli,* which literally means "the looking place" or observatory, and the *tezca-tlachtli* is the obsidian mirror-observatory. The double tau-shaped courtyard or enclosure surrounded by a high wall with battlements, which at night was employed for observation, was employed by day for the national game of ball by figures depicted with obsidian mirrors.

Mexican astronomers extensively used black obsidian mirrors as an aid to astronomical observation by means of reflection. Nuttall says that besides mirrors on the summits of temples and mountains, the codices depict square columns, placed on an elevation, faced with a broad band of polished obsidian. The latter, says Nuttall, if properly oriented, would have served as an admirable means of registering the periodic return of

To dramatize the struggle for man's soul between the forces of "good" and "evil," the ancient Mesoamerican priests, according to Szękely, devised a religious ritual to be enacted on the steps of the great pyramids, a ritual that was not mere pageant, but combined a knowledge of the science of the time, of astronomy, philosophy, psychology, and of social organization.

All the pyramids in Mesoamerica so far discovered, says Szekely, contain symbols of the two cosmic principles of Life and Death: in Mexico, Yucatan, Guatemala, and Honduras all the stepped pyramids leading to the sky contain representations of the plumed serpent and of the jaguar.

Later the ritual was transferred to the flat surface of a ball court, gradually degenerating into a mere display of athletic prowess or bloody sacrifice. As Szekely reconstructs the original ritual, largely on the basis of the extant codices, the pyramids were divided into eleven horizontal levels and nine vertical ones, which produced ninety-nine squares. Larger pyramids consisted of multiples of this basic system, a pattern which was then transferred to the flat ball courts.

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·‖					a					11
‖				c		b				10
····|			f		e		d			9
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A. Grass – Malinalli – Life
B. Feathered Serpent-Quetzalcoatl-Creator
C. Adobe House – Calli – Preserver
D. Flower – Xochitl – Joy
E. Dog – Itzcuintli – Love
F. Deer – Mazatl – Peace
G. Sun – Ollin – Movement and Power
H. Lizard – Cuetzpallin – Fertility
J. Eagle – Cuauhtli – Air and Wisdom
K. Water – Atl – Source of Life
M. Man

a. Skull – Miquiztli – Death
b. Crocodile – Cipactli – Idleness
c. Vulture – Cozcaquautli – Spoiler
d. Reed – Acatl – Emptiness
e. Jaguar – Ocelotl – Hatred
f. Monkey – Ozomatli – Inferior Man
g. Rabbit – Tochtli – Weakness
h. Flint – Tecpatl – Barrenness
j. Windstorm – Ehecatl – Violence and Ignorance
k. Rainstorm – Quiahuitl – Violence and Destruction

planets, stars and constellations to certain positions; they would have been reflected on the polished surface, as in a frame. Thus the obsidian mirror became the symbol of Mexican Star Cult adherents. Small mirrors of polished pyrite—used to concentrate rays of the sun to light sacred fires at noon on the days of the vernal equinox and summer solstice—were the symbol of the Sun Cult.

TLA  MAN

Father Duran's depiction of various masks and costumes worn by Mexican dancers for rituals, the original purpose of which was lost.

(Facing page)
Szekely's arrangement of players on the pyramid steps.

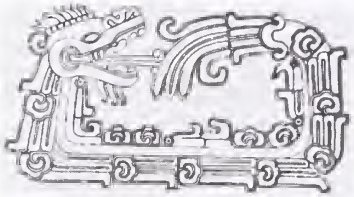
As with Protagoras, who proclaimed that man was the measure of all things, so in ancient Mexico man stood at the center of the pyramid (on the sixth horizontal and fifth vertical position) represented by a priest wearing a human mask. Szekely shows that in the codices the numbers representing the rising steps were written horizontally and those representing the squares were written vertically. On the various squares stood the twenty basic characters of the religious drama, ten representing the forces of Life, ten representing the forces of Death, each wearing an appropriate mask symbolizing the force or power represented. Szekely says the masks, which are still worn by dancers at festivals in central and south Mexico, are survivals of these ancient pyramid rites, whose original significance has long been lost.

The object of the drama, in which actions had deep symbolic meaning, similar to the rituals of Freemasonry, was for man, at the center of the stage, to rise toward the summit of the pyramid, aided by the forces of Life embattled against the forces of Death, which tended to drive him down and off the bottom rung of the pyramid.

If man could triumph over the forces of Death and destruction so as to reach the summit of the pyramid, the spiritual part of him could then triumph over the force of gravity and he would become transfigured into the light of Quetzalcoatl, the evening star.

The pyramids, says Szekely, were invariably designed in such a way as to have a level which formed an angle with the motions of Venus. In this game, man's ceasing to be subject to planetary gravity meant a true return to the stars, a reunion with the cosmic ocean of life.

According to Laurette Sejourné, when the internal war in the human heart was resolved by reconciliation of the two opposite forces symbolized by water and fire, man "could bud and flower" from fleshly matter into spirit, finally freeing himself from duality—a shedding of man's earthly clothing to free his spirit from his mortal body.



To Sejourné, Teotihuacan was the place where the serpent learned miraculously to fly, that is, "where the individual, through inner-growth, attained the category of a celestial being."

From the scant remains of two palaces within the Citadel area, recently excavated and measured by Drucker, he suggests that there may have been two rulers at Teotihuacan, one the head of the rite of the feathered serpent, or Quetzalcoatl, who lived in one palace, and a second ruler, presumably identified with Tezcatlipoca, who lived in what Drucker euphemistically calls the "other" palace.

In Szekely's analysis, if man were brought downscale and forced off the bottom of the pyramid, he would be devoured by jaguars and disintegrated, losing his individuality and having to start another cosmic cycle.

Like the Persians, says Szekely, the Mesoamericans believed that at death a body disintegrated and returned to "the reign of gravity"—the entropy of modern science. But each birth of an individual or organism was considered by the Persians to be a triumph of Life over Death. In Mesoamerica, Quetzalcoatl was considered the germ, the cause of germination in a seed, of the birth of an animal or a child, of the production of ever more abundant life. He was the Attis, Adonis, Thammuz, Bacchus, Dionysus, Osiris, and quite possibly the Pan of the Western World.

Quetzalcoatl was also seen as a unifying symbol which could achieve the union of opposites: of heaven and earth, morning and evening star, matter and spirit, light and darkness, male and female, good and evil, which, in their separate forms were Quetzalcoatl and Tezcatlipoca. The conflict between them, says Indianist Frank Waters, and their reconciliation, were what gave movement and life to man and the universe.

Out of the interplay of these opposing forces rose the world of being, change, and movement, conceived as the continuous transformation of one force into the other.

In Szekely's reconstruction of the ritual on the Mexican pyramids, a priest, wearing the mask of man, or *tla,* as the Aztecs called him, would go up or down the steps, depending on whether his thoughts and actions supported the forces of Life or Death. If his thoughts and actions had favored Tezcatlipoca, he would go downscale; if they had favored Quetzalcoatl, he would move upscale. On the face of the pyramid, man could only move slantwise, like the rays of the sun, because it was believed that Ollin, the sun, was the source of all movement, and thus of the power behind both Quetzalcoatl and Tezcatlipoca.

According to Szekely's reconstruction, the deathly priests of Tezcatlipoca occupied the higher steps of the pyramid, attempting to force man down, whereas the life-giving forces of Quetzalcoatl occupied the lower steps, hoping to raise man higher.

Coatl, the serpent, represented energy moving in spirals—the Kundalini of the Tantras or the wavelengths of modern science, which views the entire universe, from the smallest vibration in the atom to the longest wavelength in the super-galaxies, as fluctuating within a gamut of a mere 144–151 octaves.

Moving and undulant, the serpent in Mesoamerica symbolized life, power, planets, suns, solar systems, galaxies, ultragalaxies, and infinite cosmic space. The plumes, says Szekely, were an added symbol of the levity with which birds can overcome gravity better than other creatures. When the plumes were depicted folded within the circle formed by the snake's body, they signified matter in its latent form, potential, as it was before the creation of stars and solar systems. If the plumes were fanned out from the serpent, they represented the universe in manifestation, with all its created worlds, each plume symbolizing a basic element in the strength of nature—fire, earth, water, air.

Depicted with its tail in its mouth, the serpent represented infinity, eternity, no beginning, and no end. The symbolism was comparable to that of the Hindu cosmic cycles of Brahma. When Brahma sleeps the material universe is nonexistent. When Brahma wakes, all of creation comes into existence. When, after eons, Brahma sleeps again, the planets, solar systems, and all the energies of the cosmos revert to nothing.

The power of gravity and disintegration was represented by the jaguar Tezcatlipoca, who brought everything back to the kingdom of Death.

As with Goethe, the ideal of the Mesoamericans was the triumph of levity over gravity. The pyramids were the symbols of this triumph, of the ascension of man from the kingdom of Tezcatlipoca in dark caves under the earth, step by step, up to the light and wisdom of Quetzalcoatl, high above the earth.

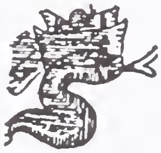
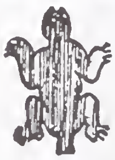
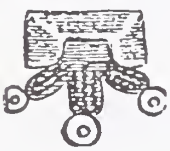
In a ritual which expressed the cosmic life of man living in a universe governed by the absolute laws of Karma, every good move tended to free man from the slavery of gravity, leading him to levity, from which the jaguar could no longer hold him back.

To Irene Nicholson it was clear that the bloody ritual sacrifices of the Aztecs were a distortion of what must have once been an extraordinary vision of the place of man and of organic life in the universe.

She sees Quetzalcoatl as the wind god representing spirit freed from matter, yet in his totality as a composite figure

The lively world of Quetzalcoatl in Szekely's interpretation of ten of the Aztec day-signs.

THE WORLD OF QUETZALCOATL

SYMBOL	AZTEC NAME	ENGLISH NAME	SYMBOLIC MEANING
	MALINALLI	GRASS	LIFE
	COATL	FEATHERED SERPENT	CREATOR
	CALLI	HOUSE	PRESERVER
	XOCHITL	FLOWER	JOY
	ITZCUINTLI	DOG	LOVE
	MAZATL	DEER	PEACE
	OLLIN	SUN	POWER
	CUETZPALLIN	LIZARD	FERTILITY
	CUAUHTLI	EAGLE	AIR
	ATL	RAIN	WATER

"describing the many orders of matter in creation; a kind of ladder with man at the center, but extending downward into animal, water and mineral, and upward to the planets, the life-giving sun, and the god creators."

On the lowest rung of the pyramid, the first Quetzalcoatl supporter of man, according to Szekely, was what the Aztecs called *malinalli,* or grass, because grass grows on the surface of the earth where the basic life-giving elements of air, water, earth and sun are united. Grass also revives perennially, so it was considered the source of renewed vitality, a giver of sustenance to all creatures, which permitted them to take the first step in the conquest of gravity.

In opposition to grass, on the top level of the pyramid stood a skull or death's-head, representing disintegration and the return to gravity. Man was depicted as seesawing between these parameters.

The second negative or downward force was represented by the crocodile, known to the Aztecs as *cipactli,* a creature which lounges in the sun, creating nothing. On the other hand, because life has both the aspects of creation and preservation, a small adobe house, known as *calli* to the Aztecs, represented the values of conservation, of planting, of watering gardens, of painting pictures, of building new things, of preventing deterioration, deterioration being symbolized by a vulture, quick to spot death and corruption.

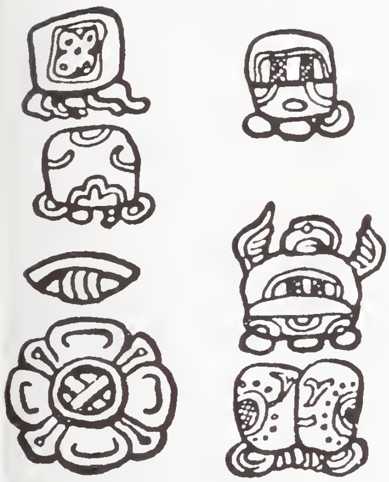
A stylized flower, *xochitl,* was considered gaily positive: its color, shape, fragrance, and the lovely effect it had on humans, representing joy. Its reverse was the cane, representing vacuity.

Disinterested love and devoted affection were symbolized by the dog, *itzcuintli.* In Mexico, where there were few domestic animals before the arrival of the Spaniards—no cows, horses, donkeys, or mules—the dog was man's most constant companion, the only possession which accompanied a Toltec to the next world.

In opposition to the dog was *ocelotl,* the meanest of killers, enemy to all animals, obliged to make a kill every day to survive.

To symbolize peace, the Mesoamericans had *mazatl,* the deer, an animal which eats only plants and vegetation, never attacks other animals, is pacific, inoffensive, and the ideal of a tranquil life.

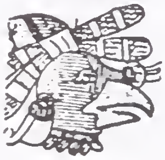
For inferior humanity the symbol was a monkey, for weakness a rabbit, for fertility a lizard or newt, because it was also considered alchemically close to the basic elements of earth, water, air, fire. For sterility the Aztecs chose the flintstone; for wisdom, because of its high point of view and its airiness —Quetzalcoatl's favorite element—Mesoamericans chose



As Frank Waters put it: "The tonalamatl may thus be seen as a four-sided pyramidal structure of twenty day-signs arranged in five terraces of four steps each, symbolically showing the process of creation—the birth of spirit in matter, death to the world of forms, and the ascent of the spirit to a higher plane as was exemplified by Quetzalcoatl."
An interpretation of the Mayan procession of days as symbolizing man's cycle of birth, death, and resurrection is also given in Irene Nicholson's *Mexican and Central American Mythology.*

The ten Aztec day-signs of the deadly world of Tezcatlipoca, according to Szekely.

THE WORLD OF TEZCATLIPOCA

SYMBOL	AZTEC NAME	ENGLISH NAME	SYMBOLIC MEANING
	MIQUIZTLI	SKULL	DEATH
	CIPACTLI	CROCODILE	IDLENESS
	COZCAQUAUHTLI	VULTURE	SPOILER
	ACATL	CANE	EMPTINESS
	OCELOTL	JAGUAR	HATRED
	OZOMATLI	MONKEY	INFERIOR MAN
	TOCHTLI	RABBIT	WEAKNESS
	TECPATL	FLINT	STERILITY
	EHECATL	WINDSTORM	VIOLENCE
	QUIAHUITL	RAINSTORM	EMOTION

the eagle. Violence and ignorance were symbolized by the pointlessly destructive force of *ehecatl,* the hurricane. Water, considered the font of life, was symbolized by three drops of water; its opposite, a devastating torrential rain, by *quiahuitl,* the monsoon. Such is Szekely's interpretation of the ancient symbols. With just ten positive ones the Mesoamericans were able to represent the Life powers of vitality, creativity, conservation, gaiety, love, peace, power, fertility, wisdom, and eternal life; on the negative side stood the ten deadly forces of sloth, corruption, vacuity, hatred, inferiority, weakness, sterility, violence, and ignorant destructiveness.

The purpose of each ritual on the pyramid steps was to drum into the audience what was considered an essential moral: the fact that as man faces each and every problem in life, the result depends entirely on his own thoughts and actions; it is up to him whether he rises toward the stars or slips to the underworld. The audience was shown that with freedom of choice man has responsibility for his own actions, that a man's past actions affect his future, and that man, subject to the inviolable laws of the universe, determines his destiny by his thoughts and actions, by his positive or negative output. Man can create more abundance, or more destruction, he can be full of appreciative joy, or empty as a reed. He can love or hate. He can have fertility, wisdom, and the font of life, or sloth, corruption, and death.

Szekely reconstructs the ritual in which a high priest, positioned on a platform on the summit of the pyramid, announced to the accompaniment of drumbeats to the crowd below the movement of each character from square to square on the pyramid steps, drums and voice being loud enough for an audience a mile away to participate in the ritual. Zelia Nuttall describes two kinds of drums: a large *huehuetl,* which emitted a loud, deep tone heard for miles, and a smaller portable drum suspended from the neck, which emitted a shrill piercing note employed as a signal.

At the opening of the drama, man would be in the center of the field; his object was to rise to the eleventh level and to avoid being pushed below the first. The ritual, says Szekely, was an actual trial of man for his good and evil deeds. Whereas today a man is judged for a crime by a judge and jury according to a labyrinthine code of laws, in Mesoamerica man was judged by the sum of his past deeds, good or evil, as searched out by two high priests, one looking for his deeds in support of Quetzalcoatl, the other for his deeds in support of Tezcatlipoca. If a man had watered a tree, mended a wall, or saved a bird, he got points for the Quetzalcoatl team; if he had killed, maimed, or hated, he got points for Tezcatlipoca.

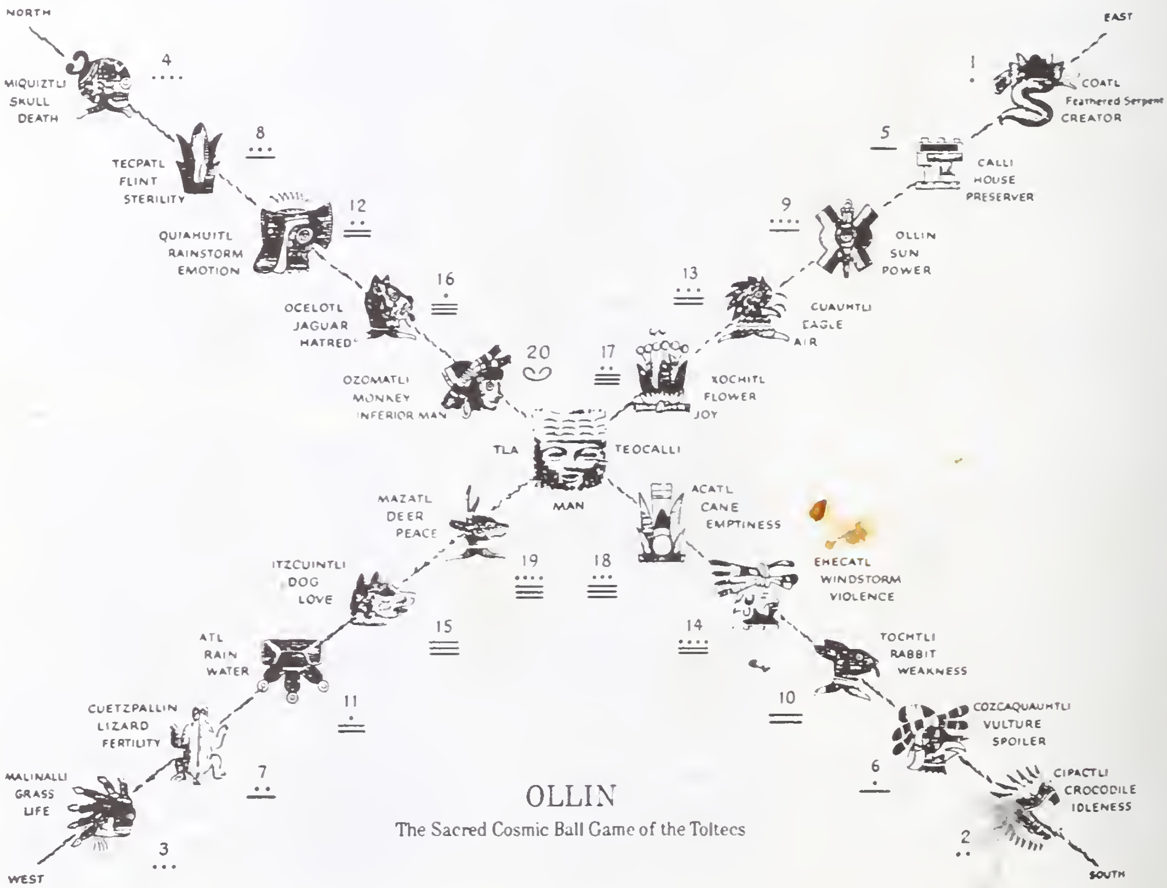
For each point, a man was entitled to a small round object, or *pelota,* originally made of stone and then of rubber, with a hole in the center so it could be strung on a thong. The *pelotas* were given to the players on the team with which he had cooperated.

In the ritual, when a masked player was reduced to a single ball he would have to retire from the game and could no longer help man either up or down. If a man had cooperated very little with the forces of Tezcatlipoca, that team would have few *pelotas* and would be forced to disappear from the stage, allowing the man to rise rapidly to the top.

With such a clear-cut world picture of Karmic law, it was easy for a man to harmonize his acts. Szekely says that during every moment of his experience the early Aztec, Toltec, Mayan, and presumably Teotihuacano would ask himself if what he was doing was in harmony with the positive, constructive principles of Quetzalcoatl or with the negative, destructive principles of Tezcatlipoca.

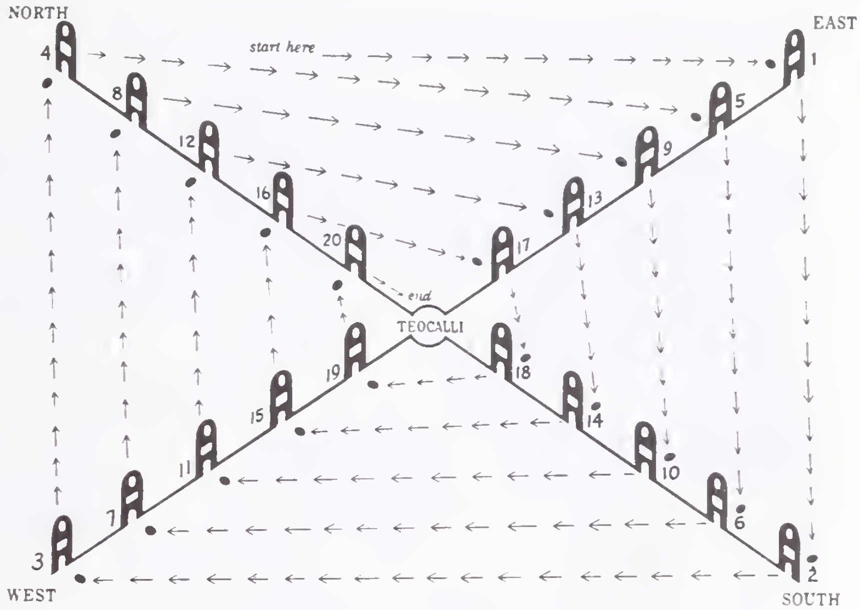
With just twenty symbols, says Szekely, it was easier for the priests of Mesoamerica to instill a moral code into society than it is for a modern judge to handle contemporary man with thousands of volumes of codified law.

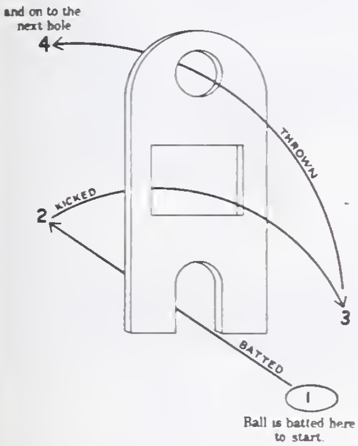
Szekely's depiction of the horizontal ball game of King Netzahualcoyotl.



OLLIN
The Sacred Cosmic Ball Game of the Toltecs

Order in which the ball had to be moved to the winning goal at the center of the horizontal ball game, according to Szekely.





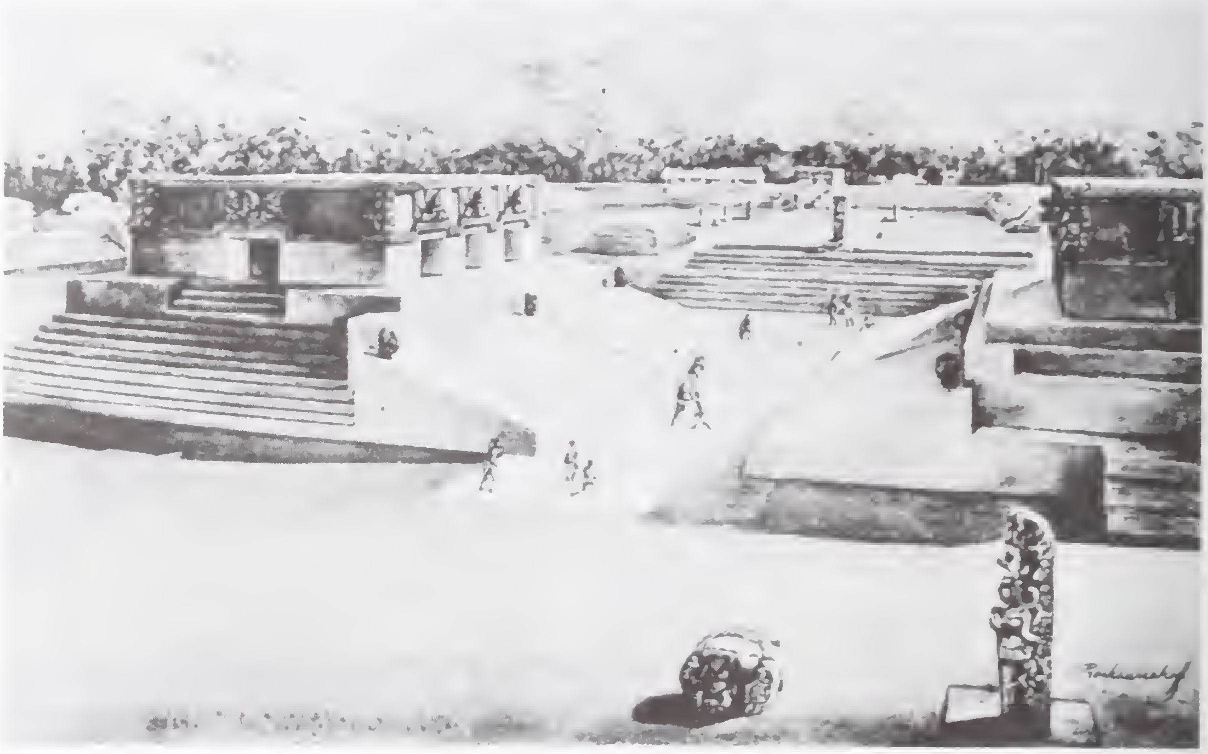
In Szekely's reconstruction of the game, the player had to bat, kick, and throw the ball through the apertures in a stone marker.

In due course the pyramid ritual was transferred to a level court that retained the pyramid format only when seen from a bird's-eye view: a cross with a central point, symbolizing the rays of the sun. In this ritual man still stood in the central position, symbolizing his fundamental unity with the creator. Here man was like a pawn on a checkerboard moved backward or forward by the force of his own past actions.

In different areas the ritual varied, says Szekely, until King Netzahualcoyotl, poet, philosopher, and lawgiver, compared by Szekely to King Solomon, synthesized the four games of Teotihuacan, Monte Alban, Tula, and Tenayuca into a single new game. In Netzahualcoyotl's game the twenty classical symbols were erected on the ball court in the form of stone stelae with three separate holes through which a ball had to be batted, kicked, and thrown.

Played with a rubber ball, the game was the evident prototype of several of our modern games, a mixture of croquet, baseball, soccer, and basketball, with scoring similar to golf, depending on the number of strokes it took to finish. This game, says Szekely, constituted "one of the most advanced judicial systems in the history of man." It took into account not simply the crime committed, but the entire past history of the person accused.

Whenever a person violated the law, a priest would go to his home and neighborhood, talk to his friends, neighbors, and family, and objectively collect accounts of his good and bad deeds. With sixty holes in the game to contend with, sixty good deeds could get the accused to the center of the field safely into the *teocalli,* "home of the gods." Anything less would bring him punishment, no matter how well he played.



Ball court in Copan as it is estimated by archeologist Proskouriakoff to have existed in A.D. 600.

The beauty of the game, as described by Szekely, is the emphasis placed by law on the pursuit of good deeds rather than the punishment of evil, with an extra incentive for keeping physically fit in case of a trial.

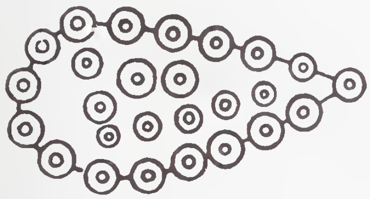
Eventually the game degenerated into a spectacle, with professional ballplayers touring the country to give exhibitions of their skills and engender a fever for gambling.

Sometime earlier it may have been an even more sensational exhibition of paraphysical prowess.

Stephan Schwartz, author of *Psychic Archeology,* and Dr. Lindsay Jacob, a psychiatrist in Pittsburgh, both students of the Cayce readings as well as of the archeology of Mayaland, surmise from the reliefs on the walls of Chichen Itza that there may have been more to the game of Tlachtali than described by conventional archeologists. They suggest that the original ball in play may have been of a substance more subtle than rubber, a sort of plasma on the order of a static electric thunderball, or orgone, requiring a high degree of initiation to move around the court and pass through a ring high on the wall, possibly by means of such developed talents as those described by Carlos Castañeda in his quatrilogy on the metaphysical feats of the Yaqui bruja. Failure to control such a fireball could have resulted in an out-of-body experience, which, carried to excess, might have left the body fulminated.

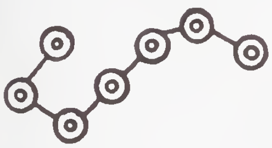
Archeologists concur that the game had deadly implications and that the losers could forfeit their lives as easily as they did on the pyramids. This too could have been a corruption of the original sport.

Several researchers have linked the ball courts with maps of the heavens. According to Livio Stecchini, the great ball court at Chichen Itza displays on its walls a cylindrical mercator projection of the path of the planets around the zodiac, a 14-degree swath 7 degrees above and below tne ecliptic along which the planets move, a sort of ball court for the gods, in which to dribble the planets.



Aztec depiction of the Pleiades according to Sahagun.

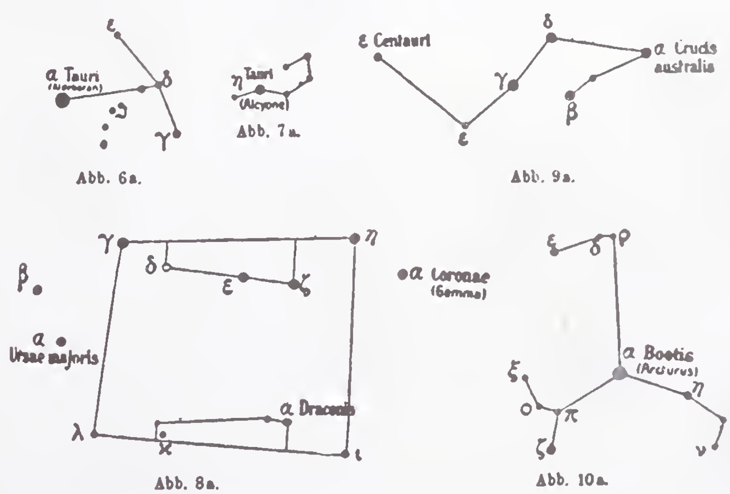
Other researchers have suggested the ball courts dramatize a bigger game, the game of life in the entire universe, symbolizing the various levels at which spirit creates and handles matter. They suggest that the ring through which the ball must pass may have represented the spot in the heavens whence travelers came to this planet from their previous cosmic home.



The big dipper in an Aztec codex.

Whereas the pyramid ritual appears to have been a dramatization of man's earthly struggle between the poles of spirituality and materiality, between gravity and levity, the ball-court games may have dramatized the space adventures described by modern science-fiction writers—the exploits of spirits operating bodies, robots, and spacecraft to and from planets orbiting various stars in various galaxies—exploits which appear less fictional since man has landed on the moon, and since UFOs have been validated by tenured academics.

L. Ron Hubbard, originator of Dianetics and Scientology, produced fine data on such "space games" by regressing individuals in reverie back on the time track to remote periods during which they described invasions of this planet by extraterrestrials. Hubbard added to this data from his own out-of-body exploration of the universe and from his own travel along the track of time. In the early 1950s



Ball-game arenas among the constellations, according to Szekely.

he used the electropsychometer—a galvanometer refined by Olin Mathieson—much like the standard lie detector, only more sensitive, and calibrated for longer trips, to probe the Jungian memories of the race going back thousands and thousands of years.

Delicate movements of the electropsychometer's needle subtly and fleetingly reflect the thought patterns of the subject, enabling the questioner to probe for memories heavily charged with emotion. These, when contacted and reviewed by the subject, appear to run in almost endless chains, revealing three-dimensional dramatic scenarios with full color, sound, and sensation, set in the most exotic surroundings, scattered through time and space. By this technique, any subject can become a potential Edgar Cayce, capable of projecting his point of view throughout the cosmos, a technique which enabled Hubbard to produce one of his more unorthodox but startling books: *A History of Man.*

In the "space opera" of the twilight world between science and fiction there is said to flourish a group of extraterrestrials known as the Brotherhood of the Serpent, familiar in terms of Mayan history. They are described as members of a Great White Brotherhood who arrived on earth from bases they had established on Mars and the moon during the Atlantean and Lemurian periods to set up mystery schools to teach humans how to free themselves from mortal coils. These Serpent People are described as a pro-evolutionary group, on whose instructions the original pyramids in Egypt and Central America are said to have been built.

G. I. Gurdjieff in his *Beelzebub's Tales to His Grandson* claims that the beings responsible for the occult school in which he was instructed in Central Asia—the ones who developed the Sufi movement—also had a base on Mars.

Psychics have described certain temples in Atlantis as being used by priests to encase spirits in human bodies so they might better learn to care for them, a process which apparently degenerated into a state of identification with the body in which they forgot who they were: a condition only to be remedied by other initiate priests who could get them out of their bodies to recognize the game—through initiation.

From the accumulated data on the rites of initiation in the mystery schools, it is clear that the initiate was led to see and be and know without a body, facing certain out-of-body terrors as illusions that could be handled by postulate and will. Initiation was a rebirth to the world of levity and the realization that no harm can befall a spirit other than that which it does to itself, mostly by willing harm to others, or by restricting, for the perverse enjoyment of the sensation, its own unlimited powers. Once initiated, a person could be in this world but no longer of it, see it as an entrancing game in which a player can be trapped by believing he is a body, or by agreeing he must hurt when the body hurts, or die when the body dies, despite the fact that such a notion is easily disproved by a hypnotist in twenty minutes, when pain can be seen to be a subjective imposition on the body, and that one can be and see without the bonds of space and time.

Any Indian taking peyote can tell you that all are one, and each is but a point of view. Out of body, anyone can see, and be, like Edgar Cayce, a thousand or a million miles away.

Frank Waters, in his *The Book of the Hopi,* says the Hopis still claim that the Maya were helped by extraterrestrials or intersteilar people. He says the Cochines also claim to have come from outer space and to have helped the Maya.

Dogon tribesmen in central west Africa have reported contact with blue-skinned men, purportedly extraterrestrials from Sirius—a fascinating subject dealt with in great detail by Robert K. G. Temple in his *The Sirius Mystery.* All over the world and throughout history there have been reports of blue-skinned men who are somehow related to the star Sirius. There were blue-skinned gods in the Vedas, blue-skinned men of northern Japan and the Marianas, blue-skinned men of Wales.

Sirius is a blue-white star, bigger and hotter than our sun, thirty-four times as bright, with eight times the mass. In occult literature, it is said to act as a cosmic throat center for this area of the galaxy, whereas the Pleiades act as the heart.

Lao Russell, wife of the extraordinary mystic writer Walter Russell (described as a modern Leonardo da Vinci), says she was in touch with a group who said that Sirians had come to Atlantis about 20,000 years ago and left important records which, with the sinking of Atlantis, were entrusted to Phoenicians who took them to Brazil, where they remained sealed in a cave in the cliffs marked by great Phoenician petroglyphs.

Sensitives say the Serpent People are due to return to earth in 2011 to help create a world government. But all is not so simple. In opposition to the Brotherhood of the Serpents, the grand opera of space has its heavies: members of the "Marcab Confederation." Marcab, or Markab, is a star in the constellation Pegasus. It is located in the same general direction as the stars belonging to the group reconstructed in a three-dimensional model by Marjory Fish from Betty Hill's hypnotically described star maps of the area seen while aboard a space ship.

Those spacemen are said to be monitoring this planet preparatory to manifesting themselves en masse, and to be sending ahead scouts in human bodies to prepare the way.

Some individuals, when regressed or out of body, describe the Marcabs as having been in existence some 200,000 years, operating meat bodies and androids, or robots modeled to look like human beings, but who have lost the power to crawl out of their present condition. In this semi-degenerate state they can apparently only try to control others and drag them to their level.

Subscribers to the Marcab-Serpent People theory envisage a struggle between extraterrestrials for the souls, minds, and bodies of terrestrials, with the Marcabs using control methods to keep humans ignorant and enslaved while the Serpent People use initiatory methods to help humans recover the knowledge of their true spiritual identity.

Identity with a body can lead to easy blackmail by a controller who wishes to enslave an individual simply by guaranteeing the requirements of shelter, food, sex, and security. Hence the various attempted routes of escape via fasting, abstinence, free love, and vagabondage. Hubbard's remedy is to recover the certainty of one's spiritual essence and and learn to operate, successfully and at will, with or without a body.

Ball, hole, and body games seem to predominate in this particular corner of the universe.

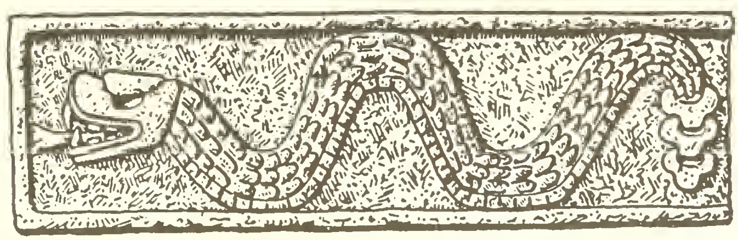
Much of the violent history and pre-history of this planet could rationally be accounted for by such a hypothetical conflict between the Marcab-type "controllers" and the Serpent People "liberators," or the roles could be reversed.

For those who find it hard to postulate the existence, even in space, of friend and foe on the Quetzalcoatl and Tezcatlipoca order, it is suggested that a cosmic game, just like any earthly game, requires levels of "friend" and "foe," stacked in alternating harmonics, otherwise the layers will coalesce until eventually everyone will be on one side—and the game will end.

As Hubbard points out, to have a game you must have barriers and delimitations—arbitrary limits. One can hardly kick a goal where there are no goalposts. To have surprise and variety, there must be something one does not know, or temporarily hides from oneself. To have a contest there must be opponents. To have a winner, someone must suffer defeat. Thus games can lead to falls, and harder falls to forgetting it's a game and who invented it.

If all this sounds grossly farfetched, far from the point of a pyramid, it is no further than the substance of all myth and of most organized religion: it is the perennial subject of great art and literature; it is as much the source of *The Magic Flute* as of *A Midsummer Night's Dream*.

But whereas in Renaissance England the Ancient Wisdom was still preserved hermetically in the Temple and the Inns of Court to be dramatized for the Globe in Shakespeare's plays, elsewhere on the planet the prospect was less brilliant. In Spain and New Spain, with rack and pillar and stake, the Holy Office cast itself to eradicate the vestiges of wisdom, and those reflections of the game of life still dramatized upon the local temples—on the pyramids and ball courts of Mexico and Mesoamerica.



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In *Mysteries of the Mexican Pyramids,* bestselling author Peter Tompkins probes the history, origin, and purpose of the pyramids in the Valley of Mexico, the Yucatan, and Central America, with emphasis on the Pyramid of the Sun and the Pyramid of the Moon near Mexico City. He recounts the history of these structures from their first sighting by Cortes as rubble-covered mounds through four centuries of efforts to solve the mystery of their existence. He follows the adventures of Humboldt, Stephens, Brasseur de Bourbourg, and other explorers and scholars. He shows what theories have been advanced concerning the design and dimensions of the pyramids as mathematical computers, astronomical observatories, and foci for cosmic and telluric forces. He also speculates on why and how the Mayan and the Mexican pyramids were built and what links there may have been between their builders and other historic and prehistoric societies, like that of the lost continent of Atlantis.

Peter Tompkins has visited the complex of ruins at Teotihuacán and other Central American pyramids on numerous occasions and has spent half a dozen years gathering and analyzing information from scientists and archaeologists and studying hundreds of published and unpublished documents on early Mexican civilizations. He has selected more than 500 illustrations from rare books and other sources and obtained special drawings from Hugh Harleston, Jr., René Millon, and Edmond Bordeaux Szekely. In addition to this book's companion volume, *Secrets of the Great Pyramid,* on the Great Pyramid of Cheops, he is the coauthor of *The Secret Life of Plants* and several works of history and biography.

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