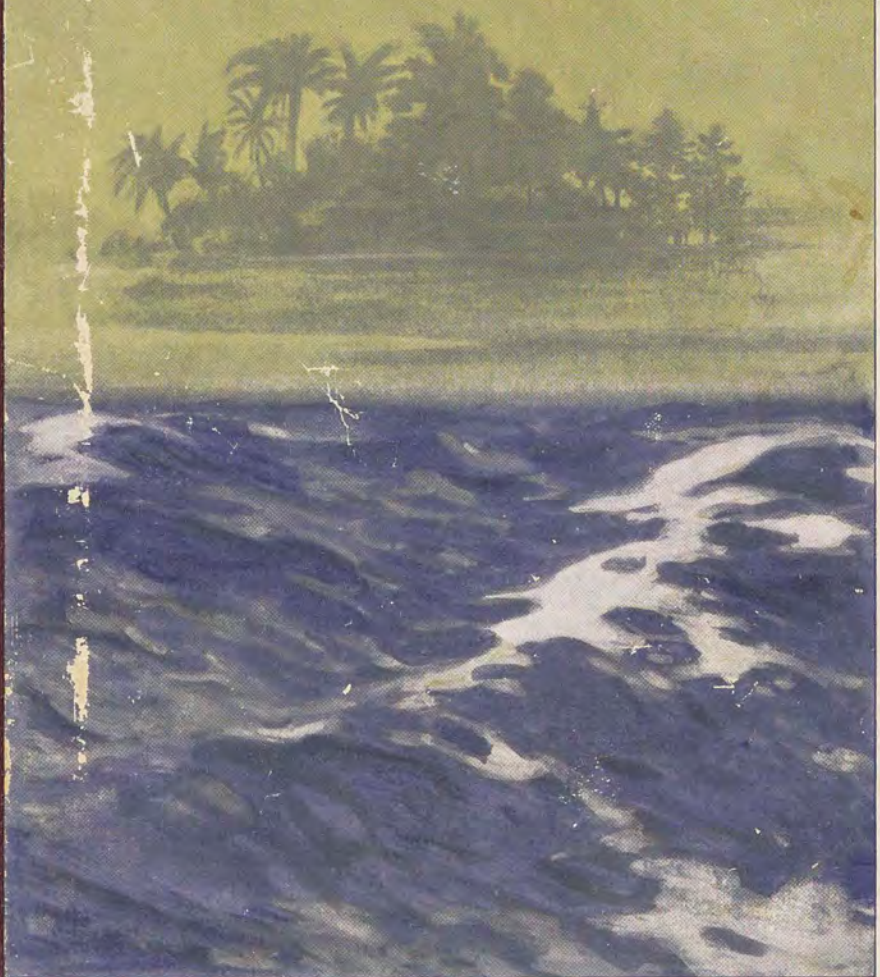
WILHELM BOELSCHE

THE AMBER-FOREST PRIMEVAL



FRANCKH'SCHE VERLAGSHANDLUNG, STUTTGART

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BY

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ILLUSTRATED

FRANCKH'SCHE VERLAGSHANDLUNG, STUTTGART

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Jung & Sohn, Printers, Stuttgart

"Out into your shades, ye swaying crowns
Of ancient, sacred, thick-leafed groves . . ."
Iphigenia

The histories of many peoples, not least among them the German history, begin in the forest.

For a while popular reminiscence still perceives active human life, powerful individual figures; then, like a wall, appears the forest.

The primeval, mysterious forest.

The aspect is like the one which, like a blue wall, so often bars the horizon from the view of those living in level lowlands. I spent my youth in the valley of the lower Rhine where a poplar or a lonely windmill, would look like something gigantic; but when a rare patch of coppice happened to interpose itself to the view even there, it loomed from afar like a mountain range supporting the clouds. And with this magic forest, which for a long time remained inaccessible to the child, I at once associated the figures of the fairy-tales. There, I fancied, unheard of sweet-smelling flowers were growing, there the dwellings of the dwarfs must be, and the haunts of wild animals speaking in the human tongue.

This charm of the unapproachable last wonder in the forest has never failed me. Much later in life I once more enjoyed it to the full, when from the complete level of the Russian plain, all of a sudden like the tangled hedge around the sleeping beauty, there rose before me the forest of Bialovice, which at that time still sheltered bisons and elks like those that had been in the swampy wilderness of ancient Europe.

Of such a "primeval forest", in the true sense of the term, I want to tell you here.

So old it is, indeed, that even the last true horizon of the whole human race fails to encompass it.

Yet, ever and anon, it would thus rise again before the view of thinking humanity.

Like a multi-coloured Fata Morgana which sometimes appeared high in the sky and then again seemed to sink low down into the waters — like the apparition of a ghost condemned to find no rest.

In certain moods it would seem to be right within our grasp, its green foliage growing somewhere near to us.

Waves would seem to roll toward us, washing up strange golden treasure from its soil — so near that we fancied we could lay our hands on it.

But then it would be lost again, sinking into the abyss of aeons of time, like the mythical Castle of the Holy Grail, toward which a rider may be trotting any length of time without ever getting nearer to it than to the rainbow.

Until, here too, the calm survey of the scientific searcher reduced the fleeting appearances to steadiness, stopping the ghost and compelling him to answer his questions. Which broke the spell and solved the riddle — as far as human perspicuity will ever be able to solve a mystery of Nature . . . .

It was about eighteen hundred years ago.

At the time when the vast Roman Empire was in the zenith of its power and cultural significance.

The time of the Roman Caesars has very commonly been described as an evil epoch of decay. Habits of crazy luxury, it is stated, had weakened the vitality of the peoples, poisoning their morals and irresistibly leading them to ruin. In reality, it was a greater period of increasing cultural development of the world than has ever before or after been passed through by the human race. A uniform law and jurisdiction extended over nearly all the civilized nations then sharing in the work of cultural development. Through centuries of almost complete peace throughout the world all the civic forces of these nations were working hand in hand instead of tearing each other to pieces. For the first time all the countries then known were covered with a network of splendid highways. A world postal service was organized and regular transportation lines of the Imperial fleet were opened from Ceylon and Zanzibar to as far as Ireland and Jutland. Uniform coins were used from central Asia up to Spain. Instead of what is wrongly said to have been economic decay, a truly international commerce was developed for the first time, free from any important customs barriers, and carried on with truly international means of transportation.

It sounds like a story but is nevertheless scientifically established that the Roman Empire at that time carried on a regular commerce even with China. Occidental metals, rugs, glassware, made up the exports while Chinese silk was bought in exchange. Chinese chronicles report about the merchants of "An-Tun" (in reality the Caesar Marcus

Aurelius Antoninus), who were received at the Chinese court, and make mention of the Roman military roads, posts and glass factories. Musicians and jugglers from the Roman Empire appeared as stars in the performances at that court.

No wonder that with such universal peace and extended exchange of commodities throughout the world, prosperity increased everywhere at home and with it the appreciation of more varied and mundane habits of life. People grew fond of the silk gowns from China and liked to possess glittering gems, even though the emeralds they might fancy had to be bartered for in the remote Ural or Altai mountains, and endless sea voyages or transports over high and snow-capped mountain passes had to be undertaken to provide the ornaments wanted by beautiful prospective wearers.

And there, in those active days of high cultural development when the conception of "humanity" was actually coined for the first time (at first in a legal and economic, later also in an ethical sense) we hear of amber also.

If, say toward the end of the first century A.D. we had walked into one of the numerous jewelry stores on the Via Sacra (Holy Street), the Forum (Market Place) or the Campus Martius (Camp of Mars), upon request we should have been shown such amber practically everywhere, either crude or fashioned into artistic shapes. A pretty, translucent, decorative stone, mostly yellow or of a yellow-tinted red colour, with the characteristic superficial qualities of a semi-precious stone, chemically resistant, burning away at high temperatures with a pleasant smell, while in its normal hardened state it could be mechanically cut and polished, and, if faceted to the best advantage, emitting a brilliant sparkle which made it a gem of the very first order. We should have been shown both cheaper and more expensive qualities, the lower ones being so moderately priced that even a plain country lass from the province could afford a string of beads around her bronzed little neck. For quite recently, it would have been explained, the imports had been very ample.

There were some mysterious special properties with which it was credited. Thus, if rubbed, it was said to attract to itself small bits of stuff; yet at that time no one ever suspected what a tremendous power of nature was to be revealed in the future through this very property.

Of course, when asking for it we should not have called for "amber", the term by which it is now known; but there were very good Greek and Latin names for it.

For, like the whole jewellers' craft, the art of handling amber was one of venerable age.

More than a thousand years even before that time the mythical kings of Mycenae in ancient Greece had put the finest amber chains into the tombs of their wives, every one of the beads being pierced and arranged on a string. In the Odyssey (15th song, verses 114 et seq.) we are told of artful Phoenicians appearing in the home country of the "divine swineherd", haggling with the people for everything and offering in exchange gold trinkets, "studded with precious amber" (as Voss translates it). This passage is slightly disputed, since the Greek word "electron", which already appears here, could originally mean also a silver alloy of gold itself; but the very fact that the far-travelled Phoenicians are mentioned as the bargainers may safely be considered as sufficient evidence that amber is the substance here referred to.

Had we asked our Roman jeweller, say under the reign of the excellent Caesar Trajan, what was then known about the nature and origin of this glittering golden stone, he, who even at that early period was probably an educated man, might have referred us to the near-by library in the Temple of Augustus. There, we might have been told, we should ask for the great work of the slightly earlier contemporary P l i n y, which was a sort of handbook of the entire natural science of that time, amber being a subject treated at length in the 37th book.

Well, we now praise the discretion of the mice and the bad luck of the vicious iconoclasts following them. For, this truly monumental work of Pliny has been preserved to us through all the vicissitudes of adverse times and can still be referred to by people who can read Latin.

Pliny himself was a rather choleric Roman military man who would have been best pleased to have all his countrymen brought back to the simple life of the good old time, looking as he did even upon an asparagus bed or the little string of amber beads upon the neck of a beautiful girl as an extravagance — and, in fact, he with his railing did a good deal to give his whole age its evil reputation. But he died great as an investigator at the destruction of Pompeii, in the fumes of Vesuvius, and truly gigantic and an

almost inexhaustible source of information for us is his encyclopaedic work, which was compiled by him at the time with the punctilious methods of an unlimited card catalogue from hundreds of cuttings from original works, most of which are lost to us.

And there, we can still read about amber — probably all or nearly all that the antique world had learned about it by that time — truth and fiction, as Pliny himself says, which had to be sifted very critically.

First — his very rambling card case has to be rearranged somewhat to be more clear for my purpose — we learn a few amusing details bearing upon that contemporaneous amber trade itself. The finest grade, he tells us, must have the colour of the noble Falernian wine — well, we know that brand even today. With the Roman demimonde, he goes on, it had become the fashion to wear amber-coloured hair (they dyed their hair as we do!). That faculty of attraction, we are told, was noticeable even in spindle-whorls of amber, which would draw the fringes of fabrics toward themselves.

For hygienic purposes, too, it he states was used. Thus, for instance, farmers' wives in parts of the country with bad water (today we call it water deficient in iodine) wore amber jewelry around their necks as a remedy against swellings (goitre?).

But now as to the question of origin — first, from a purely geographical point of view. Some authors say, it was dug from the earth — we shall see later that this is an interesting statement — but others had long since connected it with the water. Though it to be alluvial, maybe washed up from the sea. But that too had been narrowed down early to the n o r t h e r n ocean, up where the Germans bordered on the sea. The reader gets interested when that is first stated. Somewhere up in that region, he goes on, Pytheas assumed a vast estuary (shallow water at orifice); thereabouts the Goths were settled, and upon their shores amber was thrown each spring by the tidal wave, the people there using part of it as fuel and bartering another part to the Teutons. This Pytheas is a significant figure for us, being, after a fashion, the first explorer of the North pole. In the days of the Great Alexander he was sent out by merchants of the Greek town of Massilia — the present Marseilles — to make a mercantile study of the original home of tin, which was then used in bronze

casting, and, being an astronomer, he took advantage of this chance to make exploring trips into the land of the midnight sun. He advanced as far as Jutland and Norway, and in the course of these trips he must have somehow become acquainted with those undoubtedly German tribes. So, in a measure, he was the discoverer of Germany as well. Some believe that "estuary" was one of our "Haffs", but that question is not cleared up.

Meantime, according to Pliny, that vague rumor itself had become obsolete, the Romans having since carried on their great Germanic wars, pushing their war-fleets through the North Sea and receiving a number of official reports about those foggy coasts as well. Pliny himself had been stationed for some time in the occupied part of Germany as a colonel of the Roman cavalry. And thus, he says, it was quite certain that at least the amber for sale at Rome actually came from that northern ocean. Another kind might occur in India (perhaps he simply mixes it up with our copal), but that in the Mediterranean traffic was of Germanic origin. In which connection we can confirm from our present chemical knowledge that even those ancient amber beads of Mycenae are proved to be northern amber by their high percentage of succinic acid, which is lacking in all similar substances. With the tide, he says, it was still being thrown upon the shore, easily moved as it was by the water (as a matter of fact, amber is nearly buoyant). And there the officer from his first-hand knowledge for the first time communicates to us a native Germanic name for it: They called it there "glesum", a word which was generally used by the Roman soldiers also, during the campaign, and probably containing the earliest root of our present word "glass". To the combustibility, then, there is added the other conspicuous quality of translucent brilliancy. The same designation is found in the slightly later writings of the historian Tacitus.

The traffic with this washed-up sea-glass, Pliny says, had long since been carried on not only with the neighbouring tribes but right through the whole continent and "up to us", i. e. to the cultural centres on the Mediterranean. That via Austria it entered the Empire, its terminal emporia being on the Adriatic Sea, near (what are now) Trieste and Venice. This route — most instructive to us — unmistakably points to the eastern part of the Germanic coast line. And, for that matter, the numerous inland

A landscape of the Baltic amber coast (nearly Palmnicken, Samland)

findings of Roman coins and Roman goods (metal and glass vessels, arms, dress-pins, glass beads) are sufficient evidence of the intensity with which this northern trade must have been carried on for a time. Cattle, goose feathers, furs, also well-built slaves, were bartered next to amber. On which subject Pliny then proceeds to treat us to a particularly pretty little contemporaneous episode.

Under Nero (that is, quite recently), he relates, a Roman knight had been specially sent to the source itself, by Julianus, the supreme stage manager of the Imperial gladiatorial shows, to make wholesale purchases of amber, then the latest fashion, at first hand. The man was still alive and could tell. The man had made the round of all the northern trading places and coasts and had brought back a vast quantity of amber, in fact so much that on the next festival day all the nettings protecting the state boxes from the wild animals could be tied with amber pieces and the gladiatorial implements were all paid for from the proceeds. (That must have been a glorious glittering, indeed, from the German sea-gold). The largest piece had weighed thirteen pounds (which does not exceed the largest pieces now exhibited in our museums). There follows a more detailed account of the route taken, it went via Carnuntum, the present Petronell, east of Vienna, then a famous station of the Roman Danube fleet. The good Caesar Marcus Aurelius, the same who was praised by the Chinese, later wrote his philosophic monologues at that place. From the map we conjecture that the knight, who up to that point had travelled over what may be called civilized ground, had thence proceeded up the river March and down the Vistula. The magic password of the time: "I am a Roman citizen" may be supposed to have still proved a fair protection to him. As the crow flies, it took him another six hundred Roman miles, according to Pliny — which is again a very important statement.

After the question of origin he then proceeds to that of its natural history. Granting it to be thrown upon the shore by the northern ocean, how and in what shape did it get into that northern ocean? When walking along such a shore and finding sea-weeds and shells cast on it, we know that they are specimens of indigenous ocean flora and fauna. Was, then, the amber any such product of the sea itself? Here again Pliny first leads us through a number of abstruse propositions. The Greeks (whom as a hundred

per cent Roman colonel he rather disliked anyway) were lying profusely, he comments.

Hardened lynx urine it was represented to be, which, of course, was a silly mistake. At least what the ancient Pytheas had had in mind was a sort of real condensed sea scum or (this passage is not clear) some impure matter which was secreted when the water otherwise coagulated into clear ice. Which others of a more poetical turn had changed into a veritable sun-foam, in accordance with the customary derivation of the Greek word electron from elector, the sun-glare. But even in the early Phaeton myth the poor sisters of the driver of the sun-chariot who came to grief were metamorphosed into poplars, the latter since dropping their arboreal tears into the water as amber. And in this manner we are gradually led up to what Mr. Pliny considers to be the only possible explanation.

The good old Latin term for amber, succinum, that is the sapstone, he argues, clearly indicated the right track. For in point of fact, it was nothing else than coagulated vegetable juice, a r e s i n which had once been a liquid. Like the gum from our cherry trees or the resin of our pine-trees, this sap too had fallen in drops from pine-like coniferous trees and had only subsequently hardened. This, he says, was proved in two ways: First, because, when rubbed, amber smelled like pines and burned off like resinous wood. And again by certain i n c l u s i o n s which sometimes could be clearly recognized in its transparent substance, such as ants, gnats, and various other little insects, which necessarily must have got stuck and been enveloped in the substance while it was still dripping soft, to be then preserved by it, forever after it had become rigid. For all his denunciation of the Greeks an inference which had been drawn long before by his illustrious fellow scientist Aristoteles and, after him, was to be drawn again by his great successor Tacitus. It seemed hard, indeed, to prefer anything against it.

And so there only remained the last question, viz., how such large quantities of that arboreal resin could have got just into the northern ocean.

Right here Pliny's account reaches its culmination in an imposing picture which immediately impresses itself upon the reader, never to be forgotten again, even though he himself barely outlines it. In full detail it was drawn only by Tacitus.

If this amber resin had been cast upon the Germanic shores since time out of mind without ever being exhausted, and if the substance itself was thus produced by trees, with inclusions of land fauna and no marine fauna: Then the probabilities are that opposite that coast, far out beyond the sea, there must be a v a s t f o r e s t, from which this wealth of resin continuously drops into the waves and in its hardened state is carried by them to the opposite shores.

While Pliny fails to express himself quite clearly, compelling comparison with other passages in his work, it seems that he too thought of vast islands as the original home, which would be met with if the northern sea was boldly crossed. One of them is designated as Scandinavia and it is said to extend into the unknown — into another sphere of the earth, as it were.

And, indeed, it would take a forest of truly fabulous dimensions to have filled the sea breaking on its shores, so widely and ever since the days of Homer, with its tears of golden resin, in which its insects travelled as in minute ships. The thought may have made Pliny reminiscent of incidents from his own past experience in the Germanic forests: Of oak trees torn from the ground and threatening a whole Roman fleet, or a gnarled tangle of roots under which a troop of cavalry could pass. Why shouldn't there be similarly gigantic pine-trees? Tacitus has the oriental woods of balm and spice trees repeated once more up in those regions. An earlier source referred to by Pliny mentions cedar woods like those of the wonders of Lebanon. Maybe it was even a genuine magic forest which, according to the myths of the time, was still haunted by the hippopodes, the men with legs of horses, or the long-eared ones, who could wrap up the whole of their naked bodies in their ears.

Even to the proud Roman, for that matter, this was the limit of the world's geographical outline. There, as the last veil, descended the dim mists which people were so apt to think of as covering everything in the North.

And in them the vast amber forest at first remained indistinct, standing there like a vague shade. All we had was what may be said to be the circumstantial evidence of a few glittering little necklaces — that we had to be content with. And the antique world was content with it. Like

the closing prospect of the first act of all amber lore this unexplored forest looms at the limits of the world — truth and fiction.

Trading with the Mediterranean countries continued until towards the migration of the German tribes. About Theodoric the Great, under whom the Goths of Pytheas had captured Rome we have a report stating that envoys coming from the boundaries of the ocean waited upon him, carrying yellow amber. Here mention is made once more of the forest on the islands of that ocean. After that the last rumour of the misty forest is lost in the mists of the turbulent times.

We pass over a space of about a thousand years.

The aspect of cultured humanity has grown more steady, thanks to an immense amount of work done and especially from the fact that the peoples in Central Europe have settled down again.

Reversing previous evolution, a great part of the area illumined by that culture has moved up to the North of ancient Germany and casts a strong light on the seashore there.

As the curtain rises again on the second act of the history of amber, the latter no longer presents itself as a half mythical product in the streets of Rome, but is shown in its true home which is just about to form a prominent part of that general history.

Six hundred Roman miles, according to Pliny, was said to be the distance from the Danube near Vienna to that home. A calculation of it, straight as the crow flies, arrives almost exactly at what is now S a m l a n d in East Prussia.

The Germanic Ocean of the antique world has by that time been divided into the North Sea and the Baltic. On the Baltic Sea Prussia borders, its coast making a grand sweep. Streching across that curve, in a straighter line like the string of a bow, the "Nehrungen", narrow tongues of land, separate the shallow waters of the two "Haffs" from the sea. Between the two haffs, however, this Samland juts out into the sea like a block with two steep sides.

If its oblong area is figured to extend as far as the river Deime, which, geographically speaking, now connects the river Pregel with the Kurische Haff as a so-called bifurcation, it may almost be designated as an island barely held to the mainland in an incomplete manner by the weak arms of the „Nehrungen".

A pleasant scenery with wooded areas, a range of moraine hills in the interior, and, added thereto, everywhere the view beyond the edge on the blue sea make comparison with the Island of Rugen rather appropriate, although there the border slopes stand out in white, being carved out of the ancient cretaceous bottom layer itself, whilst here they reveal a multi-coloured variety of geologically younger strata which, however, are still very interesting.

Here too the slightly rounded extreme end is marked by a lighthouse, a cliff jutting out into the sea below indicating the gradual destruction wrought upon this last sturdy rampart by the insatiate billows breaking upon it. A dreadful work of destruction, which especially in more recent years has again been threatening this whole beautiful shore. An "Association for Samland Shore Protection" is now most creditably trying to fight the evil and save what can still be saved — one of the most pressing tasks of general German Home and Nature Preservation.

It is to the border zone of this Samland that the certainty of the "Amber Coast" has been narrowed down by the time the curtain rises again.

While amber is cast up on other German shores as well, this is the only one where it is done so bountifully and regularly, yielding such a continuous and rich harvest that the inhabitants of the coast could make a "profession" of gathering it.

A thousand and some years after Pliny and Tacitus we find it at the very source, but it is called neither "succinum" nor "electron"; nor has that native word which sounded somewhat like "glass" survived. Instead its (German) designation is now actually "bern"-stone, but still spoken and written in the language of that time — about 1200 and 1300 A. D. — with the old German modification of the vowel as "burn"-stone, which at once suggests the origin of the term as a sort of operation viz., the burning stone. Quite remotely in this, we fancy, we hear the voice of Pytheas once more.

The manner of obtaining it is the same that was probably seen by that daring knight under Nero and which can still be seen today in what we may call its perpetuated primitive form, though limited by circumstances to be related later.

The stones, easily floating on the surge, are carried toward the shore and the poor fishermen come down from their

cottages along the beach to gather them. There being practically no tides in the Baltic, they are of no importance. Most welcome, however, are a stiff north-westerly gale, thoroughly stirring the bottom of the sea with the wrack accumulated there, and the abating wind following it, known as the "amber wind", before which great masses of these marine plants (the "amber weeds") are carried to the shore in the broad swell of the sea. For, with the sea-weed

Little Map of the Samland. Scale: 1 : 600,000
Distribution of the succinic "Blue Earth" in the present Samland (after A. Jentzsch from Tornquist)

comes the "sea-stone". At such times the sturdy fishermen may still be seen walking far out into the shallow water to meet the floating seaweed fields as they alternately surge forward and back again. With special long-handled netted bags (spoon-nets) they scoop up the briny weeds, picking out the larger ones among the floating stones right there and throwing the wrack with the rest of its amber cargo to their wives and children on the beach to gather the smaller nodules. Or else (a practice that has now rather fallen into disuse), when the sea is calm, the shingly ground is artifically dug up and the hidden stone transiently floated. And, of course, on the pebbled beach itself the people gather whatever may have been left there and overlooked.

So it is now and so it probably was then — with all the bounty of Nature still hard, wearisome work, dependant on the luck of the hour, whose whims, however, may even yet offer an occasional chance like Peter's miraculous draught of fishes. Thus in one single lucky night 2000 kg of amber was yielded in 1862 near Palmnicken, and at least 868 kg at Rauschen after the great tidal wave of January 1914.

And in connection with this simple original operation there was to be a chain of the most remarkable external developments in future, extending over a space of several centuries.

What was won from the sea by the little Samland colony of poor fishermen had first to be properly appreciated by wide strata of the civilized world. But for that purpose it now needs no longer travel as far as Mycenae or Rome, for by that time mechanical craft, too, had moved nearer to the spot.

At Bruges and Lubeck since about the year 1300 special guilds of amber turners had been formed, their members making a business of properly fashioning and improving the material that had been sold to them. The creed has changed meantime and, accordingly, the amber beads are now preferably arranged as rosaries — paternosters was the designation widely used for them at that time, and paternoster-makers was what the members of those guilds called themselves.

But as the demand is gradually growing again, rising political powers in the neighbourhood begin to cast covetous glances on the Samland coast itself. The Teutonic order has come into that part of the country. Its great historical mission is well known. Tired of the purposeless of oriental crusades, it was conducting a narrower cultural crusade here in the borderlands of Prussia. Nowhere has this been described more beautifully that in the "Ahnen" (Ancestors) by Gustav Freytag. But the first Grand-Masters of the order are not only firm believers but (which is perhaps the very root of their political vigour) men of a very practical turn of mind in worldly affairs. Holding the government of the country in their mailed fists, they are not slow to realize what a mint of money is secretly coined by the dwarfs down there below the Samland cliffs. What had probably since the time of Pytheas been undisturbed private property (though, of course, we do not know that for certain) is now converted into a stringent seigniorial privilege. The

shore people are enjoined to deliver the greatest possible quantities to the order in return for the most meagre working wages, the order at once starting a very extensive intermediate trade with those rising guilds. Tons and tons of amber, well packed and sorted, are now coming to the Grand-Marshal of the order at Königsberg and leaving him as his gold. A wail rises from the poor people whose every attempt to do a little trade of their own on the side is severely punished as "smuggling"; but it is no use, some-

Harvesting sea-amber by "culling up" on the Samland beach

thing of Alberic's curse of gold weighs heavily on them for centuries thereafter, no matter whether the gold came from the bowels of the earth or from the turbulent sea. Much later, when the times had improved again, people would still tell about the rows of gallows on the strand, and the story goes that up to this day the evil wreck-master haunts the beach in a stormy night, crying: "Oh, my good God, amber illicit!"

But the matter of doing a trade for their own account does not prove quite so easy, after all, as it looked to the knights of the order, whose haughty arrogance increased from year to year. The Reformation comes, and beneficial as its spiritual influence is to the order, it nevertheless proves to be a disturbing economic obstacle to the sale of the rosaries. Nor are matters helped by the expedient

of paying no cash wages to the real producers and instead allowing them only a pittance of salt, which is likewise subject to a government monopoly. For a long time every means had been used, for fear of smuggling, in opposing the formation of a local guild in the country itself, to take over the raw material. Now one has actually been organized at Dantzick under the protection of the Poles, and finally there is nothing left to the order but to re-sublet — at third hand, as it were — the intermediate trade carried on by it to the citizens of Dantzick, represented by the great merchants' family Koehn von Jaski, the contract providing that this firm shall take over practically the entire selling privilege, thus relieving the Grand-Master, who had just become a secular Prussian duke, of the risk of trading for his own account, the consideration being a definite cash security and the payment of an annual guaranty.

Thenceforth the Jaski family for about a century has the actual monopoly of the foreign trade with amber, showing great enterprise in extending it into the Far East. But when the imports of Peruvian silver in the latter part of the 16th century start something like an inflation of the money market, that arrangement about a pure cash rent led to another crisis. Vigorous efforts are made by the Prussian Government, which meantime has been slowly gravitating toward the province of Brandenburg, to get rid of the Dantzick people, and finally the Great Elector succeeds in accomplishing this by the payment of 40 000 Reichstalers in cash, whereby he gets the free selling privilege back into his own hands.

Again there follow a century and a half of continuous direct government monopoly, still much to the sorrow of the poor people on the beach. A special "amber court" is established as a protection against smuggling; every fisherman is compelled to take the "shore oath" once in three years, enjoining him to turn informer even against his nearest relatives, the penalties still ranging up to death — we know the dreadful methods of administering justice at that time, even in the best states. Even the parsons of the neighbouring parishes must take that oath.

But the gold curse continues to work both ways. The more miserably the people are paid, the better does smuggling thrive notwithstanding all measures taken against it, and, besides, the small souls are morally impaired by that state of affairs. The Department of Public Revenue (the

Prussian "Fiskus"), while compelled to maintain an apparatus of control comprising a vast number of officials, in selling directly to the national guild of amber turners has to put up with the lowest prices, which at last are no longer sufficient to meet the expenses. To this political difficulties and military occupation during war are added. Thus matters are going from bad to worse all through the 18th century. It is the period of most splendid rise of the Prussian State, which on the whole is admittedly a wonderful economic organization, and yet that period closes with what proves to be, for the time being, an almost complete bankruptcy of the State amber monopoly.

Again we turn a leaf and look at the parallel scientific developments in the matter during this time.

In that strict Prussian amber law even harmless scientists were not allowed to be on the Samland beach except by special permit. Nevertheless the scientific world would not be kept from thinking about amber.

The antique world had been closed with the northern forest dropping the mysterious golden resin into the ocean. The authority of the ancients still remained supreme. Professors liked to write in Latin, to prove their profound erudition. They spoke of "succinum" and "electron" and possibly would even translate the good German word "Börnstein" (burnstone) back into the Latin "lapis ardens", to make it sound "more scientific". It was the time when the physicists too again seized upon the word "electron" to designate their first rudimentary knowledge of "electricity", which was just dawning upon them, — even though the further development of that knowledge had hardly anything to do with amber.

But, strange to say: What had become of the amber forest?

This question could not be avoided in the long run by any scientist familiar with the classic sources.

The mists had vanished. Where, then, under the blue sky lay those "islands" which Pliny and Tacitus had visualized, with their sky-high pines and cedars?

Over beyond the sea, opposite the amber coast, there was now Sweden, no island. That country, too, had for some time past been in the bright light of history. In these centuries occurred the great Swedish invasions into Germany and the battles of Lutzen and Fehrbellin. Gustavus Adolphus and his successors were no more legendary fig-

ures than the Great Elector himself. And what was true of the kings, was true of the trees, after all.

Here again, however, what is indubitable.

There could hardly be anything that fitted this prototype of an enchanted giant forest less than the really beautiful scenery of southern Sweden. Now that the country was seen, it looked like nonsense to assume that the whole Baltic Sea had been impregnated with resin from it. That might have been ascribed to the few pine-trees on the steep edge of the Samland coast just as well — or rather, just as little. A remote Italian botanist of the latter Reformation, who was more familiar with Aristoteles than with his own time, might possibly have believed it for a moment. But Athanasius Kircher, the Jesuit wit, already ridicules the idea. If amber grew on the trees over there, he says, why didn't the people harvest it and thus kill the whole Prussian trade that had just cost the Elector such a bag of money? It refused to grow on the trees, however. The whole magic forest of the classics seemed to have been dissolved in the vanishing mists — sunk into the sea, as it were, between the two now familiar shores, like the legendary town of Vineta in the year one thousand which had never been heard of again except for an occasional sound of its bells coming up from the depths of the sea.

But was not the true depth merely a learned error this time?

Out of this state of mind we see opinions grow at that time — between the 15th and 18th centuries — according to which the entire classic resin theory had to be dropped again. Here too I omit what seems extravagantly fantastic and give a summary of the essentials.

Beginning with the 16th century (as far back as Paracelsus and Agricola) the petroleum theory is in vogue.

Amber was said to be a purely mineral product — simple bitumen, as it is termed, of the group comprising naphtha, asphaltum, mineral wax.

Such substances, according to that theory, were formed in the bowels of the earth and occasionally pushed forth to the surface. In the last analysis petroleum itself was nothing more than liquid amber, and the stone was a mouldy kind of petroleum which had in some way become solid. The tiny bubbles which often made it look cloudy, were remaining genuine petroleum droplets. In its solid state it could be washed out by the sea from strongly

impregnated oil shale, but besides, springs of native oil might open directly at the bottom of the sea. Let us imagine such a spring of petroleum at the bottom of the Baltic, not far from the Samland. For centuries in the past it has been gushing forth an oily liquid which rises to the surface, floating there and gradually becoming solid, like the famous asphalt crumbs of the Dead Sea where the legendary towns of Sodom and Gomorrah are said to have been destroyed. Completely hardened drops get tangled in the seawrack and along with it are carried to the shore. We may, indeed, recall the coagulated sea scum of the ancient Pytheas, if we want to.

Of course, the animal inclusions remained a certain difficulty with this theory. In harmony with the mentality of that time, they could have been pronounced to be nothing more than delusive natural freaks — a proceeding much affected at that time in the case of fossil shells and leaf impressions in the rocks — but, at a stretch, real gnats and spiders might have been caught and glued in the oil skin floating on the surface of the waves or rotting on the beach; land animals, for instance, driven upon the sea by the wind — a favourite idea of the above-mentioned Jesuit Kircher. But if it was asked why no marine animals had ever perpetuated themselves in that manner, such for instance, as unwary small fishes, then a helping hand was lent by a fake industry which still thrives today. Its adepts had a knack of deftly inserting such small fishes in holes between two parts of amber pieces which had first been cut and then glued together again, to provide the scientists with pretty specimens. Owing to that practice, all collections were for a long time believed to contain such „amber fishes", whereas in reality no genuine fish has ever been found included in amber.

At any rate, the theory proved and remained attractive to quite a number of consecutive generations of scientists, and as late as in 1784 we find it still advocated by Buffon, then far advanced in years, although he already had his doubts about those inclusions. And through the genius of this man an interpretation was to be put on it, which contained an element of progress in itself.

In the opinion of Buffon all those petrolic and asphaltic mineral fats were themselves of living organic origin, being due to the disintegration and chemical transformation of locally accumulated remnants of animal and vegetable fats.

According to him, even today such a fatty stratum is constantly being formed and renewed at the bottom of the oceans, but in many places it had been formed in past geological periods and is only now becoming operative through the naphtha springs of the depths. Fundamentally an interpretation which comes very close to the one advanced by Engler and Potonié and now generally accepted. One cannot help admiring this great man for the advanced ideas he entertained.

If this was correct, however, it had a new and very important bearing on amber as well. Not only was the latter thus indirectly reinstated as an organic product, but it could now be properly assumed to have come down to us from a remote period of the past — to be a geologic evidence of the p r i m e v a l w o r l d.

Now, Buffon again, in his time, drew a very rich picture of that primeval world. He described the fern woods of the carboniferous age, imagined ancient changes in the land and water areas, the coming and going of animal and plant species. It was a great hour with him, the hour of the awakening of these things in the human mind. And among all these things amber could now find a place — in some way.

Now, ideas which are logically consistent to the extreme, invariably tend, in their last conclusions, to lead out of their own circuit.

What if we turned back the last conclusion in this case? If amber was assumed to be a coagulated primeval fat, why not, after all, a p r i m e v a l r e s i n?

Only a few years before (in 1767), at Königsberg, that is quite near the source, there appeared a book of small size but most interesting contents, entitled "Attempt of a Brief Natural History of the Prussian Amber", by Friedrich Samuel Bock. The author, having taken good advantage of living on the spot, had become an uncommonly expert judge of special conditions in the Samland and was thus enabled to anticipate many things that became a truly scientific possession only a hundred years later. As to the general nature of amber, however, he supported the resin theory and in this respect was in agreement with several other contemporaneous German and Russian scientists of great repute.

In brief substance his argument is as follows: That story (he says) about the Baltic's gushing forth petroleum

is, after all, grossly improbable. Never have those floating oil skins been found, and what has been told of amber cast on shore in soft, tar-like condition, let alone the stories about entire oil ducts in the hills along the Samland coast, would only be laughed at by any expert living on the spot. Any unprejudiced analysis invariably leads to resin, and this is the only substance that tallies with the overwhelming number of typical forest insects in the inclusions. Now, while it is true that today there are no forests either in the Samland itself or, say, in the Swedish province of Schonen, which could produce such large quantities of resin, yet there can hardly be much objection to the assumption that such a forest may have been there at some earlier period. It is well known that even in historic time the land and water areas have undergone many changes (Bock's description of them is very attractive), to say nothing of what lay back in the legendary days of the great flood. Why, then, should not sections of land, islands, with forests of resiniferous trees have been right here in the Baltic at some time in the past? Which may later have been actually engulfed by the sea, like Vineta, only at an earlier period, most of them probably in the dim days of the ancient Atlantis? And in that deluge the giant trees, a thousand and more years old, with all their resin and the resinous soil around the roots, would, of course, have gone down to what is now the bottom of the sea; whence the resin is now occasionally washed up by the waves, just as wreckage and timbers from villages swallowed up by the sea are cast up elsewhere. That the Samland coast of all others gets such a large share with each storm is probably due to the fact that there whole mounds with closely packed masses of amber openly exposed can be found in shallow depths.

A pretty and novel picture it was that the clever man of Königsberg outlined in his book: A veritable Vineta-forest, its phantom tree-trunks and leafless branches perhaps still towering deep down there, petrified into a sort of coral grove in the dumb world of wracks and fish, only the stormy waves ever and anon plucking off some of its golden fruit grown on a northern Atlantis, and throwing it to man. Maybe the ancient trunks, every now and then cast up along with the amber, came from that very spot.

As a result of publications like this and a few similar ones (by Lomonossoff, Struve, a. o.) and the compelling

force of their arguments, the resin theory was reinstated as the dominant one about that time, within the 18th century and shortly after its close, and this re-establishment was to prove permanent. That wondrous petroleum hole in the good old Baltic was no longer heard from in after years.

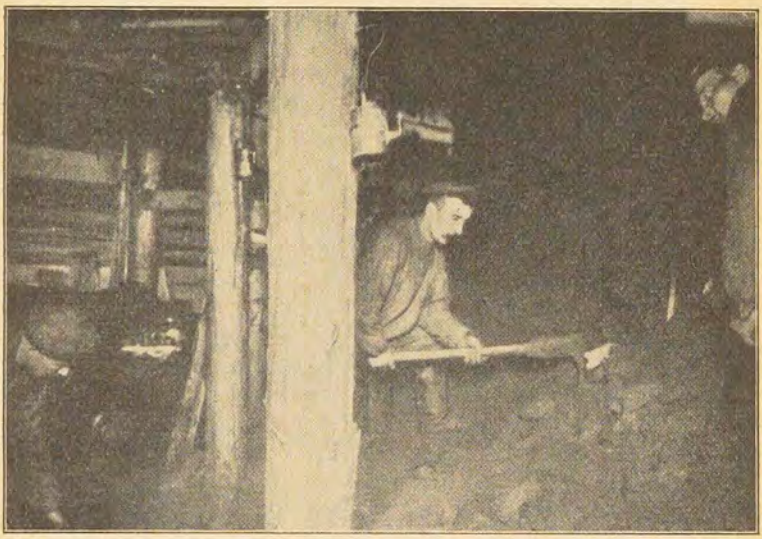
But how about combining Buffon and Bock nevertheless, at least to a certain extent, by the assumption that amber is a fossil (primeval) resin? In that event Bock's sunken forest could be placed back into any earlier period of the past beyond Pytheas and Atlantis — in fact, even into those remote eras of the primordial world that were just then re-appearing before our mental view. Maybe it had been a patch of the carboniferous forest itself, or it came down from the age of the ferocious, uncouth saurians, long before the mythical great deluge. Probably a geological stratum of some such formation was deposited down there at the bottom of the Baltic, and there the fossil amber resin was loosened and washed up by the gnawing waves, just as up in the mountains on the surface of the earth the rushing whirl of a swollen torrent may occasionally unearth the skeleton of some primeval animal, whose giant bones we then take to a museum — a mammoth's tusk perhaps or the skull of an ichthyosaurus.

Some of the first to look upon this new and dazzling far view, like seers in a complete trance, drew to themselves mental pictures of fabulous palm groves which, they thought, had grown on that primeval Atlantis of the Baltic under a tropical sun, even the tiny gnats in the golden flow belonging to primordial species which had since entirely disappeared from the world. To which some of the cooler heads took exception, insisting that the resin must, after all, be from firs or pines, even though they might now be conceded to have been primeval firs. As far as I can see, it is Wrede who clearly expressed this idea for the first time in the "Königsberger Archiv für Naturgeschichte", issue 1811.

There could be no doubt: If this was correct, then here the greatest turning point in the whole science of amber since Pliny was ushered in. The ancient magic forest, after mysteriously vanishing in the depths and being degraded to a petroleum spring, was rising again, but now projected into another dimension, as it were, — into time, the past aeons of the primordial world.

In this picture there was but one feature that looked awkward at first.

The geological formation from which our amber was said to have come was buried as a stratum in the deep sea, inaccessible to the spade, which is otherwise applied to such a layer. Only the amber itself rose occasionally, because it happened to be buoyant.



Underground mining of (land) amber from the "blue earth". Miners breaking up the layer with pickaxes. Trackman loading mined material into the truck

It could not even be proved that the wooden fragments, cast on shore along with it, had actually belonged to the amber forest; in point of fact, this flotsam might be material from much younger periods, having likewise accumulated down there.

But would it ever be possible still to determine the age and geological formation of that layer itself from the amber alone — the lion from the paw?

That seemed to be rather improbable!

And yet this proved to be one of the many instances where different things operate toward the same end. The solution of that very problem was to be materially advanced by a technical progress in the methods of obtaining the amber, which had very quietly developed in the Sam-

land and now passed into the sphere of modern geology.

In the very same year 1811 when Wrede proclaimed the "primeval amber" that Prussian monopoly predicament had come to a climax. The State monopoly, once redeemed at such an enormous sacrifice, had definitely reached the end of its resources.

This becomes plain in the Napoleonic time when extreme demands are made on all financial resources, and so it is again found necessary to cast about for some expedient to save at least a fraction of the gain. Two modern ways present themselves:

Either another lease to some commercial group, the shore people, however, to be now subordinated to the lessees on the basis of a free labour contract. Or else — a truly novel idea — to lease the privilege to the shore people themselves, the latter, after a fashion, purchasing their release from the State monopoly by a regular impost to be paid by themselves. Both ideas were undoubtedly favoured by the humane tendencies of the time, trying to have ancient wrongs redressed in some way at that late date. It is a pleasure to read the expert opinions rendered on the matter by Prussian officials of that time, as contained in Tesdorpf's excellent collection of State documents.

While originally only the first named measure was adopted by the Prussian Public Revenue authorities, even that meant a great relief to the poor fishermen, since it did away with the ugly "shore oath" and the compulsory gathering for the Government. The lease itself, however, is rapidly passing into one hand again, as had been the case with the Jaski family. This time it is the Douglas family.

But about twenty-five years later the second scheme prevails: There is immense jubilation and rejoicing in the fishing villages when the king confers upon them the privilege of individual leases of their respective shores. And with that measure (since 1837) a truly ideal state of affairs seems to be attained. Those small people are now thriving, smuggling ceases (since they would only cheat themselves) and the State itself receives a reasonable rent, while at the same time, the beach now being open, the seasonal bathing business at seaside resorts begins to boom.

Only, in the long run another hitch became apparent in the matter.

So far, I have given an account of the external developments, but meantime internal changes had been taking place in the methods of getting the amber, both greatly benefitting and unfavourable, depending on the different view one chose to take of them.

It was a matter that had been coming for centuries, but now it was rapidly getting more important and bound to become almost decisive.

As early as in the ancient Pliny account voices were dimly heard, stating that occasionally amber could be dug out of the ground.

That statement there refers to different localities and may partly be due to some confusion, but no sooner has the true Samland amber coast passed into the light of history than this strange idea begins to concentrate upon it.

Right at the beginning we find a wily bishop in that part of the country negotiating with the people of the Teutonic Order about the regional right to such dug-up "burn-stone". And later the downright fact is asserted time and again on the spot.

The regular supply of amber, it was claimed, was of course cast up by the sea, but it could be found also, in packs and nests as it were, in the sandy walls of the steep coast itself. And there people are searching for it in a desultory way, and rejoicing in an occasional find. Even the strand-riders in the hard times of the past had been instructed to keep an eye on such doings in their leisure hours.

When in the last years of "Old Fritz" (Frederick the Great) the yield of the sea is exceedingly poor, a wide awake minister of state together with a few good mining experts even conceives the idea of real amber mining. Some eighty feet back of the high edge of the coast a vertical shaft is driven down, with horizontal galleries at its bottom, pushing into the sands, and a ventilating and hauling shaft even piercing the slope toward the sea at a height of 30 feet above its level. For a while fair amounts of nodules are found in there, but later it is abandoned, having proved unprofitable and too troublesome. This, as we shall see later on, was due to the fact that the vertical shaft had not been driven down far enough to reach the right level.

For, since early in the days of Bock there is a vague rumour about a dark secret in this respect as well.

To this day people like to talk of amber as the "gold of the North." A pretty and very recent publication by Brühl (of the Institute of Marine Science) still bears that title. But wherever there is a gold treasure there are treasure tales as well.

Thus the rumour of the occasional findings on land had gradually consolidated into the story of a vast hidden amber hoard. Those small nests occasionally found in the sands, and for which that shaft had been driven down, were said to be but stray ducats from it, as it were; but down, deep down, there was the true and inconceivably rich treasure layer itself, containing infinitely more amber than all the sea could ever yield.

If a hole was dug into the earth, so it was rumoured, all through the steep mountain range along the coast, down to its very bottom, there would be found a mysterious "b l u e e a r t h", which is the popular designation first coined by the treasure tale — like the little blue flames above treasure in other tales. In a most awkward place this treasure (like all others in folk-lore) was said to be hidden — close to the sea-level or mostly even below it — where the effect of the water was felt and the roof of wet sand was likely to cave in and bury the bold treasure-seeker. All legendary treasures are subject to some such vicious spell, lest it prove too easy a job for the seekers to find them.

Sometimes the rumour was quite mysterious — like that of the famous virgin soil, for which the alchemists were searching to convert it into genuine gold. Just as if the yellow stone, like the gold there, had been growing for thousands of years right from its blue mother soil.

Well, in the 19th century (our narrative having by this time progressed well into it) people did no longer entertain such legendary notions in this respect either.

All things considered, it was not so very difficult to get at the true "blue lime" (as Bock had called it). And in point of fact, it looked far more promising indeed than all the "fishing".

Now that the shore had passed back into the hands of the fishermen, they themselves very generally began to destroy the slopes along the coast. In a haphazard way they pushed on toward the treasure layer; removed the masses of sand on the top, dug deep open pits into the ground, barely protecting them against the entering water by an improvised timber lining; until here and there

they seemed to have cut into a bit of what looked like a uniform layer of mineral amber. This they then proceeded to dig out in sheets, following no system whatever, until sterile ground was met again.

The shore, of course, was anything but improved by this activity. As early as in 1790 (i. e. still under the former Government monopoly) it is reported that not far from Kraxtepellen this destructive exploitation resulted in the collapse of a large part of the slope, lowering the height of the edge by forty feet. What was already dangerously threatened by Nature itself was now further destroyed by man. Home protection was as yet unknown, although at that very time a new source of income to the shore people was developing from the visits of strangers who were attracted by the beautiful landscape of that shore.

But the small people themselves were soon threatened by economic dangers. The unexpected riches yielded by the land produced some of the characteristic phenomena of gold mine districts. The good old morals were deteriorating; the money won somewhat like prizes in a lottery was spent for drinks. Suspicious characters were attracted. And added to this, the fishermen needed funds for such mine-digging, crude as it was at first, and that, in turn, made them more or less dependent on city merchants.

In the long run the Government, too, could not fail to take notice of this new departure. If that large treasure deposit really existed, it could certainly be developed into an incalculable new source of revenue for the State, provided it was worked systematically.

On the other hand, it could be taken for granted that the desultory digging by the shore people was in no way equal to such operation on a large scale.

In the good old time underground treasures had been conjured up, the modern time calls for that purpose upon mining experts who have graduated from a State mining academy. Weighty voices were heard, demanding that at least the digging privilege should be taken away from the shore people and placed in the hands of trained miners. There was still some hesitation when a contracting genius, who had proved his worth before in other enterprises, made a bid for this one. It was in 1867. The contracts with the fishing communities were just expiring about that time. It was plain that a new crisis of the entire amber work was imminent.

In accordance with the changed trend of the time, however, it seemed impossible to reach any radical decision on a question involving technical mining unless geologists had first been consulted. Once the scientist had been banned from the beach, being suspected of smuggling; now he was the first to be asked for an opinion as to the existence and the prospects of the mysterious amber deposit on land. But this, in turn, produced the new element now entering into the scientific amber question itself. What did this unforeseen land deposit of amber in the Samland mean to the theory?

A first sceptical explanation strongly suggested itself to the investigator. For thousands of years the sea had been casting up its marine gold on this coast, probably unheeded for a long time, and still much longer before man existed to heed it. It looked therefore quite possible that time and again some amber had got into the sands on the shore and later the dunes had been piled on it. And in this way entire deposits might have been accumulated there at last, some of them possibly as a result of great tidal waves. In fact, we witnessed a very recent instance of this process after the storm of 1914, when veritable little ramparts of amber were found on the shore.

Well, for isolated "nests" of amber this theory might be true. But the great depth in which the treasure was supposed to lie (at some places many metres below the sea-level) and the fabulous dimensions claimed for it, together with its concentration in a single underground layer, were as many evidences against the assumption. Moreover, a mere glance shows that the true many-coloured slopes abruptly terminating the Samland plateau as a whole, are no dunes but cuts of the mainland itself. Yet that was the very spot where the treasure was hidden.

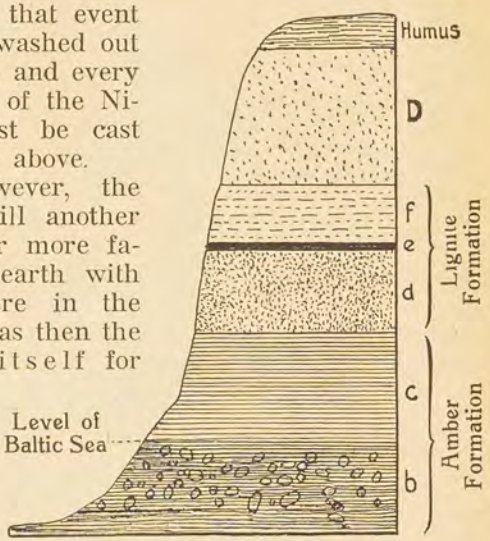
There could be no doubt: Here was a phenomenon of far more fundamental nature, and one which made entirely new demands upon the theory. There were two possibilities:

Did the old bottom of the sea, which was still well stuffed with amber, extend here into the firm land below the whole length of the shore? In that event the mysterious "blue earth" could be an extension of the geologic stratum which concealed also the puzzle of the amber forest.

There was, however, another idea which is already hinted at in Bock's old booklet. What if it was the other way and

the whole yield of sea amber came from the treasure on land? For that supposition it was only necessary that, reversely, the treasure layer should extend for some little distance from the land below the sea, being laid open below the water as the sea grew deeper. In that event it was bound to be washed out by the stormy waves, and every now and then parts of the Nibelungen hoard must be cast back upon the shore above.

In that light, however, the situation assumed still another aspect, and grew far more favourable: The blue earth with its amber right here in the depths of the land was then the geological stratum itself for which we were looking. Right here in the Samland the verdant amber forest had once grown. No longer need it be assumed to have sunk into the ocean. Only its silvan soil, well filled, to this day, with the golden resin which had gradually been buried, in the course of geological periods; lying mountain-deep below all that had been subsequently deposited on the same spot; presumably later layers of sands and more recent wooded grounds; just as even in historic times many a marble floor was buried under more recent layers of rubbish, and just as well preserved for the man who would dig it out again with youthful vision.



Approximate outline sketch, illustrating the stratification of the complete successive layers in the Samland steep coast. Above (D) are aggradations of the diluvial time, topped by modern humus. Under them, at (d), (e), (f) there follow deposits of the preceding tertiary period, first those of a somewhat more recent section of that time (so-called lignite formation, presumably miocene). The black line (e) between the striped and other sands (d), (f), is meant to indicate a seam of lignite, remaining inserted here as an evidence of former tertiary forest soil. Still lower, at (b) and (c) there are layers from a still older division of that tertiary era, being former marine sediments with remains of marine fauna and being included in the s. c. oligocene within the tertiary era. Only with these layers we reach what may be properly called the amber formation, its decisive layer being the s. c. blue earth (b). It is seen that this blue earth, which is fairly stuffed with amber, lies either at or below the level of what is now the Baltic Sea, washing the steep coast, and therefore any parts of this layer protruding below the water are exposed to the action of the waves, which may wash out pieces of amber. (After Runge)

Wonderful how much the problem seemed to be simplified both in its physical and technical aspects. What the good shore people thought they had been harvesting from the sea had, in reality, never been more than crumbled parts of land treasure. And in this land treasure thenceforth both the technical and the whole decisive geological tasks were centred.

What was this "blue earth" in the history of the earth? What was its kin and time? And is it in its blue ghostly light that the amber forest was to rise once more before us?

There it was, the beautiful high coastal wall of the Samland, which had so often impressed itself upon the minds of numberless people in a way never to be forgotten.

To the geologist first hearing of the wonderful blue earth in it very likely a similar idea would suggest itself as to the weighing modern technical man of large calibre.

If we could remove all this far into the country, levelling it down to the very treasure deep at the bottom, removing all that was later deposited on it, all the strata, layer after layer, until at last the blue earth reappeared as the original level so that one could actually walk on it! Thus in our days the nine towns were levelled and removed from the wonder-hill of Troy by Schliemann. In that event, would not the whole situation be cleared up, as by a ghostly light, from the present time back to the ancient amber forest? That would indeed be the highest technical goal to the thoroughly practical treasure-hunter, and at once the last scientific one. If it could not as yet be done with the spade, perhaps it might be visualized for the time being.

I once more summarize on the summit what in its modest beginnings dates back to about 1811 and reached its first high spot exactly on that date in 1867.

Few other sections of our own German country have been opened up, scientifically as well, with equal self-sacrificing devotion, through parochial work of the highest and noblest kind. Ever since the beginning of the sixties the highly deserving Society for Physical Economy at Königsberg had set itself the task of completing a comprehensive survey of the Samland coast on modern lines. The result which is decisive for our purposes was published in that year by E. G. Zaddach in the society's own papers. A masterpiece remaining fundamental to this day and worth reading, aside from its substantial scientific contents, on account of the attractive descriptions of landscape appearing in

many places of the text. In monumental style — veritable "general staff strokes" — it unfolds for the first time the complete history of Nature's tremendous campaign which passed also over this beautiful spot in our own native country, building and burying, sowing, piling up, and destroying.

The history of at least six million years of earth evolution, conservatively figured.

The following is a concise outline of it, including only a few later supplements.

But for small, recent, and transient sand drifts thrown against it, our steep coast, as stated before, is no dune but a cut of land. Whereby the stratifications of that land up to a certain vertical limit are laid open on one side, like the wall of a quarry or a sand-pit. The highest elevation of the ridge amounts to a little over 60 metres, and from this point it declines on either side.

Even those who look upon it with the eye of refined connoisseurs of landscape cannot fail to note some variations in this stratification: Rather solid parts of stone-like consistence, and again such of looser and more granular structure, in different colours. On the whole certainly a picture suggesting violent destruction and a fissure which is constantly widened both by Nature and man. A piece of mineral bowels laid open, comparable on a smaller scale to those many-coloured giant pictures of American canyons with romantic ravines, torn off rocky pillars, and sheer precipices. Yet among its detail features, besides drift-fillings of more wildly irregular structure and arrangement, there are many layers and beds which are still horizontally arranged upon one another in beautiful sequence, as if they were of most steady and ancient formation. Though these too look as if they had been locally covered, pierced, and subsequently destroyed by others. And thus down to the present variable shoreline, beyond which a continuation is hinted into invisible depths, and only at the beginning of these, or even still deeper down, the mysterious "blue earth".

It is, however, essentially on such sequences of different strata that modern geology since about the beginning of this century has built up its geological periods as they must have succeeded one another in infinite spaces of time. The Carboniferous, Jurassic, Cretaceous eras, for instance, to name but a few from the bottom up. Theoretic-

ally, all these strata must still lie upon one another like sliced bread, if we imagined a cross section made through the crust of the earth, which of course is merely a theoretical conception. At the same time, however, on a small scale each profile, including the one here considered, more or less closely resembles such a cross-section through the earth.

The only question is to what depth it extends on our steep walls here.

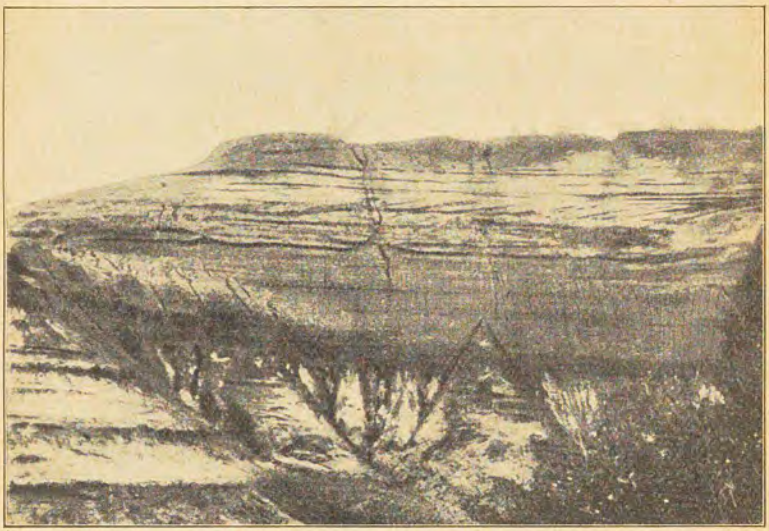
Now, first as to the depth, we have something to go by in the fact that strata of Cretaceous formation are underlying the whole Samland. These Cretaceous strata, it is true, are not actually visible either within the profile cut into the Samland coast or anywhere else, but from borings they are known to be the bedlayers at the bottom. All that is above them, including the whole profile and far down into the bottom layer itself, must be of more recent formation than Cretaceous. Thereby, however, the Jurassic, Carboniferous and all the older periods are at once excluded, and on the other hand, our steep wall being a deposit even above the Cretaceous, only two periods of our geological system are left for it, namely, in the order from top to bottom, the D i l u v i a l and what is termed the T e r t i a r y period.

The name Diluvial is derived from the popular myths of the great flood. The Tertiary (or the tertiary period) was inserted as an intermediate space of geologic time in about that year 1811, designating, strictly speaking, a whole geologic system as the third principal era, although it really comprises only a single period of the earth's history, and a short one at that in comparison with the preceding ones.

Deposits of these two periods are still possible in our Samland profile, and they are indeed both present there. The trained eye of the geologist detects diluvial fillings in certain strata, especially the very irregular ones above referred to.

This Diluvium (or the diluvial period) is very recent — in fact, man existed in it. But a great part even of this very recent time passed through violent disturbances. We know that better now than Zaddach himself could in his time. The vast fields of glaciers of the ice-age within that period covered the Samland as well, since at that time they extended from Sweden down to the country in front of the Giant Mountains in Silesia. And wherever they passed, they

left the crude detrital loam of the moraine at their bottom, stuffed with loose boulders, in addition to the more nearly stratified sands and gravels from the streams of the melting ice. And thus it was here. Often what was left is itself deformed by the pressure of the ice, or the boulders washed out are loosely dispersed along the beach. In most places this diluvial material forms the top layer in the profile, below the humus; in others however it penetrates deep



View of the strata of lignite formation, laid open, (cf. the profile on p. 33) on the Samland coast in the s. c. Kadolling gorge near Rauschen, photographed on the spot in October, 1903. Below, sands with thin clay insertions; above them a lignite seam, on that, clay, and still higher mica and coal sands. (After Schellwien's beautiful "Geologic Pictures of the Samland Coast")

into the gaps of the lower strata. One is left with the impression that the tremendous crush of the ice had subsequently broken up and ground down those older strata, carrying part of them along and filling up the faults with its own detritus. It is almost a wonder that anything at all was left, and probably there are many other places where everything was completely annihilated.

But certainly this ice-age was no likely place for our amber forest. Early investigators indeed had notions to that effect, because now and then amber occurred in this diluvial detritus. But we are justified in the assumption that it got there only indirectly through some such upsetting

action as is above referred to. As a matter of fact, amber has been thus carried all over northern Germany, like some pieces of cretaceous formations and Swedish granite, the latter even from a much farther place. In fact, such an isolated golden guest, weighing 3 kg, who had gone astray, was, years ago, secured from the river Oder near Breslau. But in these upper regions, it appears, there is nothing to be found that bears upon what we are really looking for.

More interesting, however, are the lower strata, or so much of them as has survived the ill-usage they were subjected to. We said before that their sides are all visible, their position being fairly horizontal, evidently just as they had been peaceably deposited long before that awful cataclysm of the ice-age passed over them. And here again there is no doubt that what has been preserved of them is the only formation that could be in this position according to the theoretical schedule, viz: T e r t i a r y.

Fate has not been cruel, after all.

Passing on below the ridge and through its gorges, we note that this Tertiary deposit, in some places many metres high, is completely laid open to the view within the profile — still open to this day, but not scraped clean, revealing its own natural colours and varying layers.

The geologist, however, here calls to mind that in his schedule this Tertiary, while not one of the larger periods of the earth's past history, still is divided into several sub-divisions, to any one or all of which its remaining deposits may belong. These sub-divisions were first named by the old scientist Lyell, the designations given them all pivoting upon the Greek word "kainos" (new) with slight modifications indicating either more or less new, all of them, however, now mere figuring marks. Four of them are commonly in use, being (from the bottom up): Eocene, Oligocene, Miocene, and Pliocene.

A number of details are known to us about this Tertiary, especially its middle and last sub-divisions, whereas the earliest one borders on the realm of myth. It was no longer the age of the colossal saurians. Instead, vast paradises flourished, containing a great variety of mammals. Until towards the middle of the period the European climate was conspicuously warm. There were vast forests, which left to us no longer hard coal but lignite. Perhaps man first appeared in them. The respective areas of continents and

oceans varied in many places from what they are now; our highest mountains were completed only during that period.

No doubt whatever that this comes much nearer to an "amber forest setting." And quite in keeping, too, with the fact that undoubtedly the treasure layer must be looked for in this Tertiary part of the profile.

But Zaddach himself already noticed that this portion of the profile was once more divided in itself, as if layers from t w o of the above-mentioned sub-divisions were placed upon each other — not sharply separated, however, but as if they had most peaceably succeeded each other. Yet there were two of them, one being m o r e r e c e n t, the other a good deal o l d e r. With great acumen Zaddach at once determined the exact location of the dividing line.

The upper layer, within itself, passes through a rich variety of white and brown sands and clays. And lo! Here, as an insertion between the thin sheets of clay, for the most part still clearly marked, there is indeed one of those characteristic lignite deposits, unmistakably pointing to the existence of Tertiary boggy forest soil in the Samland of that time. Retaining our drastic simile of the sandwich, it lies there like the relish between two slices of pumpernickel. Not a very big seam (or seams), but big enough, at any rate, to have furnished the fishermen with sufficient fuel to heat their stoves with occasionally, and even large enough to explain the notion, once entertained, that it might be worth the expense of systematic mining.

No question whatever but that here we plainly look upon a primeval forest on the very spot. In fact, we fairly seem to grasp the trunks and branches of its trees in those dark fossile prints on the sheets of clay near Rauschen, the marks left by the leaves being particularly beautiful. Heer, the excellent Swiss botanist, has first determined them. Next to poplars and alder-trees, there were sequoyas and taxodias, which seems strange enough, at least for modern Europe. The sequoyas are those immense mammoth trees, of which a small surviving remnant is still in the Californian Sierra Nevada, some of these trees being as tall as our highest cathedral towers. Among the taxodias (cypresses of the swamps), now growing in Virginia and Mexico, there are trees with trunks, 12 metres in diameter, their ages being up to 3000 years and more. A most impressive view, there is no denying it!

Undoubtedly the climate must have still been rather warm; Heer estimates the mean temperature during the year at probably 16°. An even more closely approximate mental view of the situation at that time can be attained. Evidently a continent extended right up to here, but probably from the north, across what is now the Baltic. As stated before, the relative positions of firm land and oceans were then different in many places from what it is now. But throughout this whole Tertiary period there has invariably prevailed a tendency of firm land pushing forward south from Scandinavia, whereas the ocean came from the south through Europe. Right here where the lignite rot was deposited, that land may have opened towards marshes or a haff with water that was no longer briny, a river emptying into it from the north. Strange how much a naturalist may read off even from such a few brown strips which the tourist passes by indifferently!

The time, however, may have been about the so-called Miocene (according to Lyell's nomenclature), that is, about the middle sub-division of the Tertiary in that classification. At least that is the time when most lignite deposits are supposed to have been formed by their respective forests. Four million years, more or less, may separate us from it. The period itself, however, may have extended over a goodly space of time. And all through it, probably, the trees of this forest had continued to grow, their foliage rustling in the breeze. A very strange fauna may have lived in it. Those were the days when the big animals that are now natives of Africa and India were still wont to roam all over Germany as well. Whoever wants to make his mental picture of that paradise complete may people it with prehistoric man, walking about under the sky-high sequoyas, together with gorillas and elephants.

Unconsciously we allow the book to drop for a moment. Was that the amber forest itself? Again some demonic power seems to face us in that dark hatched pattern on a terrace wall of our mountain profile. Have we got the genuine forest?

Alas! Again it proves elusive. What our paradise still lacks to be complete in this respect is — that mysterious earth.

Had this once been the amber forest, then the treasure itself must lie here. A few isolated amber nests are found indeed in these closely related mica-sands, which are com-

monly called "striped sands" because of their varying white and brown colours. They are those straggling bits of treasure that were once mined at the time of "Old Fritz" and are not despised even now. But this is not the "blue earth". That is hidden far below at the very b o t t o m of all layers, in the deposits of another, earlier section of the Tertiary. When the trees of that Miocene forest first struck their roots into the soil, these earlier strata had long since been buried far below and, hidden in them, the treasure itself. That is clearly apparent from the present situation. It is quite possible that these small Miocene nests, too, were subsequently dug up from the lower strata, although not in so violent a manner as later by the Diluvial glaciers. Perhaps it was done quite peaceably by a river which had scraped off a bit from what was then already a mystery of the depth, thereby becoming another gold-yielding Pactolus river — the "gold" it carried having grown in a forest of a much earlier time.

Again our glance embraces the steep slope with its plainly marked "sandwiches", our eye resting on a particularly complete spot — not unlike the scholar endeavouring to decipher the cuneiform characters of an ancient cultural document — say on the "Zipfelberg" (Hooded Mountain) near Großkuhren, which has been often reproduced in pictures and, unfortunately, is now gradually decaying. For a long time the Diluvial detrital loam and the lower Miocene sands with their lignite seams were exposed in the "hood" as plainly as could be desired. And only below them appeared what presented itself as a long wall of sand and sandstone of that earlier Tertiary formation which Zaddach already had so clearly separated from the Miocene one. It disappears into the underlying bottom below the surface, and there the treasure layer lies near the "Zipfelberg" about one or two metres below the level of the sea. Which leaves another wide margin of at least an equal length of time backward.

The geologist is apt to find recurrences of many kinds: The same sequence of successive layers recurring time and again in the same locality, as well as a recurrence of similar settings but earlier by many thousands of years. On those early Tertiary "sandwiches", as we found before, the Miocene forest had grown. Why should not a second, earlier forest have once existed in that early Tertiary time itself, its traces being hidden in this lower wall, similarly

as those of the younger forest were found in the upper wall? This forest having existed a long time (i. e. geological time) before and leaving both the location and remains on which the younger one could subsequently grow?

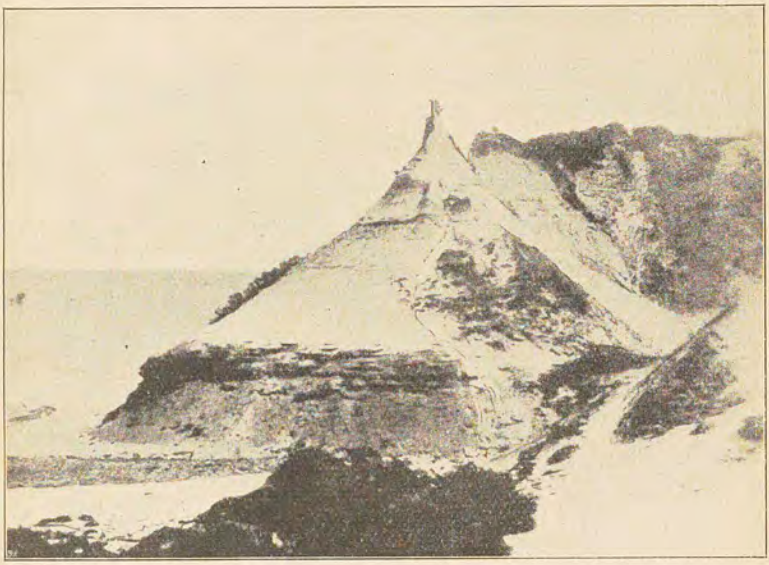
This, as mentioned before, is still a strong Tertiary sequence, composed of many different layers. But by this time we are eagerly watching the geologist to see what further conclusions he may be able to draw. We feel like the playing children, when they call out: "Hot, it's hot." There is no mistaking it: We are getting close now to the very level of the treasure or, to use Schliemann's expression, the "golden horizon." One effect of this near approach is a willingness on our part to dispense with the learned terms. The old and new treasure-seekers too were "hot" on the trail at this stage, and so they themselves early gave honest German names to the last layers that had still to be pierced.

At an early stage, however, Zaddach with the eye of the genius perceived a mineral element common to all of these lower strata and externally expressing itself in a definite colouring. This is a steadily increasing admixture of very minute grains of a rather pronounced green or green-tinted blue substance in these lower sands and clays. From the Greek term "glaucos" for green its mineralogical name is glauconite.

Wherever the green substance prevails undisturbed, it produces what may be called completely green sands and earths, and thus in the lower part of the profile we first find a covering layer of quartz sands, commonly designated as "green sand" or the "green wall". On the other hand, where by the action of hydrated peroxide of iron the sands in the lower layers have been more or less completely cemented into a solid sandstone, they are popularly referred to as "Krant". In the case of the Zipfelberg this "krant" forms the protruding foot of the mountain, which is of fairly rock-like consistence. Immediately above the concealed treasure there follows what the people call "drift-sand." It is not sharply separated geologically and since time out of mind has been dreaded by all treasure-seekers, since as a true quicksand it holds the entering water and is liable at any time to collapse and drop right on the heads of the adventurous human moles digging for amber underneath. Through this too we dig and lo! We are face to face with the innermost shrine of sacred mystery, the relatively

short layer which, geologically as well, was the goal our hearts had so yearningly longed for. Below that, the common people only know what they call "wild earth", which however marks the beginning of the sterile soil — the bottom of the treasure-box, as it were.

Dropping all mystery, from a purely geological point of view, this widely heralded "blue earth" or "stone earth" is fundamentally just a layer like the others. Only its



The so-called Zipfelberg (Hooded Mountain), large parts of which are now destroyed, near Großkuhren on the Samland steep coast, after a photograph taken in 1880 by Gottheil and Son at Königsberg. The hood proper, which was then still intact, was composed of drift marl of the Diluvial period. Below it the sands of the lignite formation with the seams inclosed in them, and still deeper, the upper layers of the Oligocene age (cf. the profile on p. 33) are cut and laid open. Of the latter what is popularly known as "Krant" forms the solid bottom protruding like a rock, and only below that in the invisible depth is the location of the blue earth

situation is inconvenient, this part of the profile extending below the surface and being invisible throughout.

This layer too is made up of very fine-grained glauconitic sands with abundant admixtures of clay and mica.

The colour disappoints, as do many other terms originating in fairy-tales. Zaddach says it is a greenish grey, when dry, and black in wet condition. Blue, as it is called by most shore-people, he says it had never looked to him, at least not in its normal state. In some collector's spe-

cimens one may with a right good will perceive the shadow of a greenish blue tint.

It can hardly be doubted that this stratum, on account of its deep situation with respect to the sea-level, extends under the sea in many places. At any rate, it is the underlying bottom layer of the entire land profile for a considerable distance both on the northern and western coasts of the Samland block and may at once extend more or less far into the interior of that land.

All this does not look particularly exciting at first glance. But the wonder begins when we look upon this "earth" in the light of its second native name, "stone earth" — when we realize, in fact, that heaps and heaps of amber are imbedded in this layer throughout its whole length, not everywhere at the same rate, of course, yet in the aggregate amounting to almost inconceivably large quantities, the yield being so consistent and abundant that we may justly speak of an actual amber deposit and a geological amber stratum. While individual nests of amber occur in the "krant" and even in the "wild earth", they are merely what Zaddach calls harbingers and stragglers respectively of the principal layer. The size of the individual pieces varies all the way from the smallest dust to pieces weighing several kilogrammes. The biggest one so far found weighed nearly 7 kg, while individual pieces weighing 1 kg occur time and again in the yield of a layer. To form an idea of the aggregate quantity contained in the whole layer is more than the most exuberant imagination is equal to. Göppert refers to an early calculation where the blue earth layer is estimated to be ten (German) miles long and only two (German) miles wide, an area of 20 (German) square miles. Estimating the contents of amber at the very modest rate of one-twelfth of a pound per cubic foot, we arrive at the high figure of about 96 million hundredweights of amber in the entire treasure layer. Such figures, of course, are not necessarily exact, but nevertheless sufficiently so to convey at least a remote idea of the quantity involved. At any rate, on this basis, there is no prospect of exhausting the hoard by systematic mining within a measurable time; nor does it seem possible, from a physical point of view, that these wholesale accumulations should be merely accidental. Above all others this seems to be the spot where we are close to the very origin of amber. And following up that ori-

ginal assumption of ours, we ask ourselves: Can this be the genuine ancient soil of the amber forest with the resin accumulated in it?

But geology, too, has a mischievous "object-devil" of its own.

Whereas above, the wooded swamp of the Miocene betrayed itself as unmistakably as could be desired, here no vestige of such soil appears. If above we had the forest without the treasure, we now face the treasure but no forest.

No indication this time of fossil ligneous vegetable mould or leaf prints. But instead something of an entirely different nature is noticeable throughout the blue layer and the sands immediately surrounding it. Fundamentally, these glauconitic sands look much more like a marine sediment. The position of the amber seems to indicate that it was even then deposited by the sea and washed into a main level. The pieces all slightly rounded, like rolled. Conclusive proof, however, is furnished by certain fossil animal remains next to and above it. As in the resin itself only land insects are included, so the deposits externally enveloping and surrounding it exclusively contain pronounced sea-fauna.

As early an investigator as Bock knew that in the blue earth there were oyster-shells, which at that early time could hardly have been left there by some gormandizer. Later, Beyrich was the first to determine a genuine oyster of the latter Tertiary from the ocean of that period. By the time Zaddach commenced his investigations, Mayer had established practically a whole fauna pertaining to it. Aside from whole oyster-banks, we now know all sorts of sea-crawlers, heart-shells, sea-urchins, a very frequent large crab; added thereto, the teeth of sharks, whose grand evolution in the Tertiary ocean is otherwise known as well. As throughout the blue earth, so this sea-fauna enters also into the "krant", often whole nests of them accumulated in individual lumps of clay. The presence of oysters indicates that even then it was no ocean of fathomless depth. Probably not far from some continent; yet an ocean that must have covered all of this particular locality.

From the animal remains we can draw a fairly reliable conclusion as to the exact time and the particular subdivision of the earlier Tertiary to which it belonged. At

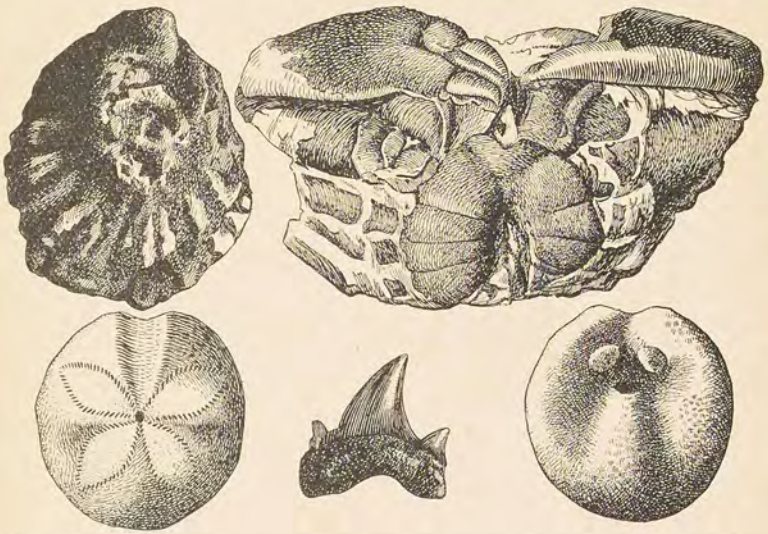
an early stage Beyrich determined upon Eo-Oligocene, which means some length of time prior to the Miocene and rather near to the somewhat mythical Eocene. The name Oligocene can be translated into "Not yet much new" (though that's immaterial). That the ocean at that time reached up to here cannot be astonishing in itself. Later in the Miocene it had already been crowded out by the land. At that earlier period, however, it still entered here on a broad front, undoubtedly also from the south, coming from what was then a big Mediterranean, which in the earliest Tertiary made an archipelago of the whole of central Europe, similar to the present South Sea. It was still the time of active changes being wrought in the map of the world. As later the lignite forest deposited its seam here, so at this earlier time the ocean precipitated its mud banks with their oysters and sharks' teeth on the Samland spot.

But this primeval ocean of the early Oligocene did not only bury shells and teeth at the time: It must have contained amber at that early time. In fact, almost inconceivably large quantities of it at times. Which it then carried over here, allowing them slowly to settle. In a fine-grained mud on the bottom of the sea, which we have just got used to calling blue earth. In Zaddach's beautiful description of 1867 this situation also has been presented with complete clearness. But let us see what it really means.

We saw the amber as it is now being cast up by the sea. Pliny and Tacitus had thus seen it in their time. The question arose as to whence it had got into the present sea. From far off islands of this sea, perhaps from islands now submerged. Later the question was simplified: The amber was merely washed out from the coast and then cast-up on the shore again by the sea. The mystery was condensed to the geological origin of this coastal formation, and now it is revealed. This coastal formation is itself a sediment of an infinitely older primeval ocean of so and so many millions of years ago. Which existed here when neither the Baltic Sea nor the Samland coast itself existed. That primeval ocean had contained amber in its time and had deposited large quantities of it. Where did the amber in it come from? This time not from the Samland itself, since that did not exist as yet. Well, from whence?

We see: At bottom, it is the same old question again, only now dated back to a remote past of the primordial world.

And, quite consistently, the same old explanation is re-introduced by Zaddach and those succeeding him, only with a suitable modification. Somewhere that Oligocene primeval ocean must have destroyed and washed out a still older coast, island, formation, where at that early time heaps of amber had been accumulated as a land-product. Where the amber forest had originally left it. From which place it had been carried off — at that early time — and



Specimens evidencing that the blue earth together with the layers closely pertaining to it in the lower part of the Samland steep coast (cf. the profile p. 33) are a sediment of a primeval ocean: Preserved remains of primeval sea-fauna of the earlier Oligocene age. Upper left hand: An oyster (Ostrea ventilabrum); right hand: A crab (Coeloma balticum). Lower right and left hand: A sea-urchin (Sea-bun, Laevipatagus bigibbus), seen from above and below. In the middle: A shark's tooth (Carcharodon obliquus), the species being still represented by the whale-shark (Carcharodon rondeleti), which is up to 10 m long. (Combined from Tornquist and Schellwien)

finally deposited again by the sea — at that early time — at its bottom as a foreign element. Of that sea-bottom a few little strips happen to have been preserved to us right here in the Samland, whilst the rest of it may have been lost by subsequent re-destruction. Hence the amber here; but not indigenous.

There may be many indications that this mysterious primeval land of first origin had likewise been situated north of here. Where it had in due course been flooded and destroyed by the Oligocene ocean coming from the

south, the amber deposits thus being released. A portion of primeval pre-Scandinavia. It could not have been very far from us, otherwise the amber nodules would have been worn off more smoothly than they were during their ocean travel to our coast; nor would such vast numbers of them have been deposited on the same spot. As to the time, the days of its splendor, when the trees of its forest were still rising straight toward the sky, may have been farther back by many aeons. One would be inclined to think of the very earliest Tertiary — in fact, back into that mythical E o c e n e itself. The amber forest would have been a genuine Eocene forest. As the word "Eocene" (from the Greek "eos" = dawn) suggests the dawning of the new, so this would have been the forest of the dawning Tertiary, its first roots probably reaching back into the still older Cretaceous formation. At least, most of the investigators after Zaddach looked at it that way, whilst others hesitated to go back into such remote geological periods. When the Oligocene floods swallowed up that land, they are not likely to have found the trees of that forest still standing upright. All they found was the ground where it had been still replete with its amber-resin, which they then destroyed.

It was the last, the farthest view that thus appeared, and substantially it has remained our last scientific one to this day — conclusive to us as that grey, misty forest had once been to the antique world. Instantly however, looked at in this light, it led up to a conclusion which seemed unavoidable. Consistent like the closing view itself, and at once full of resignation.

Which they then destroyed! In order that the treasure layer of the present Samland might form, it was necessary that on the t r u e site of the amber forest all the ground should have been radically d e s t r o y e d at that early time. There was no prospect of our ever re-discovering it. Its sands had been washed away, its humus was dissolved, its tree-trunks, perhaps still imbedded in the old decaying soil, had been carried away by the waves and were lost. And the only thing saved to us from the general destruction, though now resting in a strange place, was the amber. This now being definitely re-established as the l a s t d o c u m e n t.

The problem had now completed a circuit of immeasurable length. From the present time through the primeval

world to the half-mythical Eocene. Only to terminate invariably at the few golden pieces of resin, now lying in the hand of the geologist as they had once lain in the hand of the Roman jeweller. Would it be possible — for the last time the question arose — for some modern sorcerer eventually to convert these little pieces themselves into a magic mirror, once more reflecting the image of the forest lost to us forever? Or did their empty golden sheen reflect nothing but the eternal negation of the "Ignorabimus" — we shall never know? It could not be denied that apparently the scientific prospect around that memorable year 1867 had been reduced once more to the lowest minimum imaginable.

While, reversely, all the benefit resulting from this definitely established geological fact seemed to go to technical and economic progress — those quarters where the amber treasure, not the amber forest, was looked for.

In the same Königsberg periodical and almost in the same year when Zaddach's fundamental work appeared, another geological investigator, G. Berendt, addressed a sort of memorial to the Government, calling upon it in flaming words to begin at last with the exploitation of the now well established blue earth by real mining. The attempt made in the 18th century, he argued, had failed only because of the insufficient geological knowledge at that time, but now the chances were most favourable.

This publication may well be said to have introduced the last period of the economic and technical exploitation of amber, which continues to this day. In every respect the greatest and most fruitful.

It is not within the scope of this work to treat it at length like the preceding ones. For while it resulted more than all the others from the new scientific basis, still it did no longer bear more than a rather loose relation to the last phase of amber science, which is to be described later, while its purely economic importance grew beyond all limits and established world-wide commercial relations which cannot be adequately described except in a comprehensive history of international economic development.

Up to a certain stage of that period, one of its features which in itself renders it interesting is the organizing work done by an economic genius of large calibre, the merchant bearing the second name appearing in the firm of

Stantien & Becker. It was, in a measure, the personal element, the human side of the new local prosperity. Once the way had been paved by this man, the Government was able to pick the ripe fruit.

The relations of the firm to amber date back to a number of years before 1867, which is so significant to us. In those earlier years amber had been brought to light near Schwarzort in the course of dredging work done for the Government in the Kurische Haff. At that time it was believed that a remote layer of blue earth had been cut, which was a geological error. Probably what was then found was merely an old nest, washed out from the Samland itself and carried across the "Nehrung", which while now a narrow tongue of land, was once a strip of shallow water. The firm, however, gets interested and acts quickly. In consideration of taking over the dredging work, and an additional cash payment, it secures the local privilege of exploitation, which for many years proves a veritable gold mine until the nest is exhausted. During the year 1883 alone 75,546 kg of amber were dug-up at that place. The whole transaction certainly an evidence of excellent business judgment.

Meantime, in renewing the leases, the Government in 1867 had actually taken the digging privilege away from the Samland shore-people. (Incidentally, the leasing system was entirely dropped in the end and is now replaced by parties making purchases of amber from the Government in each individual case). At about the same time the subsidiary privilege of raising amber by divers off shore became vacant and was acquired by the firm, its exploitation proving fairly successful. But the decisive point in the development is reached in 1870, when Stantien & Becker apply for the digging privilege itself and (after the failure of an intermediate attempt by the Government) secure the local privilege. Intuitively, the contractors now immediately conceive the plan of real mining operation after the pattern of the lignite mines in the central part of Germany.

There were two ways of doing it on a large scale: Either by open digging, after actually removing all the covering layers; or by underground mining with vertical shafts and horizontal drifts where miners in waterproof cloths are working with the pick-axe in the light of lanterns. After some experimenting, the latter method is selected (in the neighbourhood of Palmnicken), and while at first it does

not prove by any means ideal, still an abundant wealth of amber soon pours forth, richer, indeed, than had been thought possible by the boldest day-dreamer. During the next years the customary Samland yield of a paltry few thousand kilograms swells to several hundred thousands, and the State revenue from the yearly lease from 20,000 or 30,000 Marks of former good years to as much as 800,000 Marks.

And as the unbounded stream of these new riches pours in, the ingenious contractors are continually improving and extending the selling possibilities. Through the application of equally new methods, the weathered crust of the raw material is peeled off and the commercial sorting done right on the spot, to facilitate close examination. But above all, the foreign trade is systematically organized, including own factories even in most remote countries. From Vienna especially the manufacture of amber mouthpieces for smokers' utensils is developed. But far beyond that, the near and far East, China, Africa, the North American markets are conquered, the old plans of the Jaskis far surpassed.

Even a dangerous incidental adventure is skillfully warded off. A problem which had already occupied the attention of the old chemist Kunckel von Löwenstern, had first been solved in independent quarters (in 1879). It is a process of artificially combining clear and well cleaned but otherwise useless small pieces of amber into big ones by the application of heat and strong hydraulic pressure. Since this so-called "pressed amber" (ambroid) did not lose any of the characteristics of genuine amber, it proved a suitable material for amber-turners; and besides, it could be shaped in moulds (e. g. for cigar-holders) and furnished in any desired tint by minute admixtures. This competing product, which threatens the large-sized natural material of the firm, is at first vigorously opposed by the latter as imitation amber, but later absorbed by the monopoly, which itself takes up the manufacture of pressed amber.

I refrain from going into further detail. In the long run the exclusive control exercised by a single firm over the whole raw material and the excessive foreign trade could not fail to prove more or less unsatisfactory. I will not discuss or express an opinion on this phase of the question; at any rate, the outcome was that toward the end of the nineties this whole exploitation of amber by underground

mining was taken over by the Government for its own account, and in 1899 the whole stock-in-trade and real estate, with the commercial and factory buildings of the firm, were likewise acquired at the price of 10 million marks, a capital which within a few years was fully amortized by the immense current income.

On the whole, the clever work done so far had certainly accomplished its purpose, and all the Government has since had to do was to proceed on the same general lines. Only the underground mining of the firm, which was moist and not completely thorough in the long run, was gradually replaced by open digging operations on a vast scale with up-to-date excavators. What I referred to above in the geological description as a theoretical proposition is here, in a measure, practically demonstrated every day: The levelling of the entire superimposed covering mountain range with all its strata down to the very treasure.

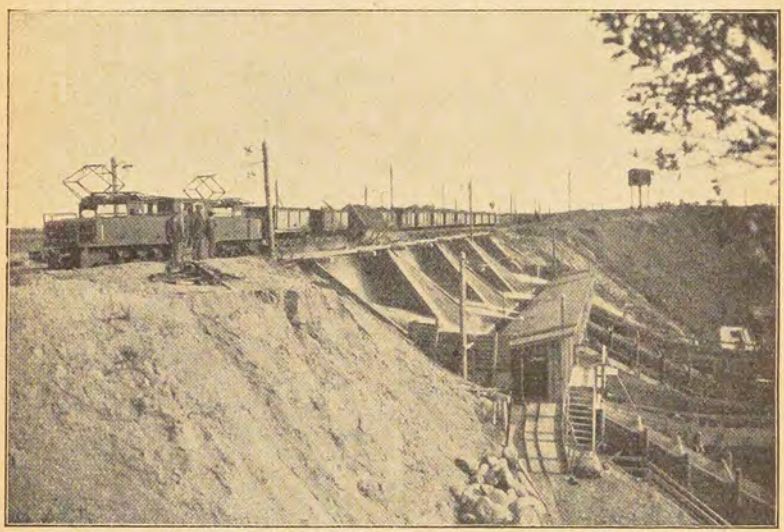
The great results achieved, which were only transiently disturbed even by the great war, may be briefly illustrated by a few plain figures (after Brühl). In 1912 the total yield of raw amber amounted to 436,000 kg in round figures. Of this about 78,000 kg went out direct for smokers' requisites and ornaments. The rest was made up by 23,000 kg of pressed amber, together with chemical, melting, and by-products, viz: 109,000 kg of amber colophony, which is used in the preparation of varnish, 3,000 kg of succinic acid, and 36,000 kg of amber-oil. The yearly net surplus of the State amber works was estimated before the war at an average of one and one-quartermillion marks.

In conclusion a few pretty sentences from Klebs on the world-wide trade: "Strings of beads from the purest, dim, dull-yellow kinds of amber are most popular with the Oriental and English ladies: the more bone-like, whitish kinds are the preferred ornaments of the inhabitants of West and East Africa; the light and clear ones go to the Caucasus; the finest clear ones to France, Brunswick, and Tartary; the inferior ones are used in Russia and Africa. The Chinese and the Corean official is probably as proud of possessing a long mandarin-chain of amber as the American Indian is of his ear-cobs of the same material. About 10,000 prayer-wreaths of amber pass every year into the hands of devout Mohammedans, and a far greater number of rosaries of like material to Southern France, Spain and Italy. The warrior in Morocco wears his amber amulet

The amber mine "Anna" (underground) near Palmnicken on the Samland coast, no longer operated since 1925

on his chest like the Chinese warrior. And many Persians adorn not only themselves and their dead but even their horses with strings of clear, chinked amber beads which often are as big as eggs."

. . . Would there ever be a sorcerer to turn the amber alone into a magic mirror?



Scene from modern surface mining for amber in the Samland. The earth containing the amber is emptied here from the tip-carts (which received it from the excavators) upon iron grates and carried to what is called the "wash" (Wäsche). Strong jets of water under high pressure dissolve it into a muddy liquid ("Trübe") which carries along the floating amber pieces. Finally the whole is passed down a trough where the amber is held back by suitable devices, while the muddy stream passes on into the sea

In one respect the two closing sections of our amber lore resemble each other: The last one, dealing with the scientific side, is likewise under the spell of genius, and, for that matter, an ingenious naturalist may not improperly be called a sorcerer among his fellow-scientists.

But even the greatest genius, whether economic or scientific, will never be able to rise and prove really fruitful unless he can build on the foundation provided by long continued toil preceding him.

All through the 19th century, besides the soaring flight of ideas, such detail work by scientific specialists had been going on.

The diligent attention paid to the tiny occasional inclusions in the amber itself. Could anything else perhaps be seen in them?

The compound microscope was called into requisition. The tiny golden bits of amber in which organic remains appeared, were superficially ground, to get a better look at the inside. And then only, aside from a number of discoveries regarding the structure of what had once been a resinous substance, appeared the whole wonder which Nature had accomplished here. For, millions of years ago (the length of time then just beginning to dawn upon the investigators) Nature had applied methods of preservation to these inclusions, which we can now hardly hope to improve upon by artificially imbedding our most delicate microscopic slides and sections in transparent Canadian balm. And for a long time it was believed that, strictly speaking, only the cavities in the amber had been preserved to us like approximate moulds of the contours of such insects, while the bodies themselves had all or nearly all faded away after such a length of time. That notion is still occasionally advocated even in modern text-books; yet it is incorrect, for lately Hanns von Lengerken succeeded in actually removing almost whole bodies of bugs from the holes.

On the other hand, as the technical exploitation of the blue earth increased, it was more and more clearly realized what a great quantity of amber with inclusions actually existed. What at first had looked merely like an occasional pretty addition, turned out to be practically the rule with certain kinds of amber which must have been particularly suitable. Some idea of the extent is conveyed by the fact that, before the war, the collection of the University Institute at Königsberg alone contained as many as 70,000 exceptionally fine specimens of animal inclusions. Small but very instructive collections for the use of schools can now be quite regularly furnished by the State amber works there from the output of their Palmnicken branch.

Ever since the thirties of the last century we see a number of typical figures among the German scientific world almost exclusively occupied with these detail studies. Near the parent soil itself G. C. Berendt, sr., and Joh. Chr. Aycke; at a greater distance (Breslau) the well-tried Heinrich Robert Goeppert, universally revered in Silesia (born 1800). Goeppert, who at first was working on

slight material, was most abundantly aided since the fifties by the splendid collector Menge at Dantzick. It was to be one of the last joys of the aged Alexander von Humboldt that he still lived to welcome these great results from what seemed so extremely humble.

In the course of these investigations particular attention was bound to be paid to the vegetable inclusions as well; not only because Goeppert himself happened to be a botanist, but from the very nature of the matter. There were such inclusions, of course, even though so far they had come in for less attention than flies and spiders; and many of them were in their own way equally plain and amenable to the more refined methods of investigation. Among them were particles of wood, mould, occasionally a whole little leaf, needles, flowers, catkins, and other related things.

The plain theory that amber was vegetable resin was necessarily even better proved by these than by mere animal inclusions. But this was second in significance to the further consideration that thus we could through the amber itself still see the primeval "amber trees", their presumable outward forms and botanical classes — in truly Liliputian miniature images, of course, somewhat like a landscape reflected in the facets of a set diamond, but nevertheless having the immediate value of a document. But how much more conclusive did this consideration necessarily become when toward the end of the sixties this was again established to be really our only document!

It was still the excellent Goeppert himself, then far advanced in years, who at that time conceived the plan for a great "Flora of the Amber", which was to comprehend all that was known by that time. Being then past eighty, however, he subsequently did no longer prove quite equal to carrying it out completely; a fresh and younger man had to join him, and this man was Hugo Conwentz. With Conwentz the leading figure of this last stage of our scientific amber research appears on the scene.

To the generation now growing up he (who has since departed this life) is mainly known as the vigorous later founder and past-master of the movement for the "Protection of Nature" — this, too, entitling him to everlasting fame. But in those days he conceived the ingenious idea of reconstructing a life-like image of the lost forest, which had never been reached by any "Protection of Nature",

from the very amber, since that was henceforth to be the only remaining document of it. And that plan he carried out in a masterly fashion, his work being a rare combination of happy intuition with strictly scientific research. Of the two wonderfully illustrated folio volumes he published on the subject, the first still closely follows the lines of Goeppert and Menge as a continuation, while the second volume is his own original and fundamental achievement: The "Monograph of the Baltic Amber-Trees" (Pinites), 1890. The remaining pages of this booklet will be essentially devoted to conveying a clear idea of the spirit and the contents of that work.

In it, one may justly say, the trees of the amber-forest are for the last time made to sway their boughs and rustling leaves for us, and this time definitely as they once used to do in olden times.

First, a bit of scientific definition of amber itself, since it is now to play the last part all alone. Since we want to get at the northern forest, we shall confine ourselves to the n o r t h e r n stone — the one of the blue earth, as we now know. The "burnstone" of the older German language. Coloured fossil resins, entirely unrelated to it, which have been found in Roumania and Sicily, and even in Japan and North America, should not be called amber, since it is apt to cause confusion. On the other hand, in the blue earth itself there occur a few other resins which are not genuine amber and have, therefore, quite properly received special names of their own: Brittle, yellow G e d a n i t e, brown G l e s s i t e, recalling our benzoin; black "Stantienite", and brown, earthy "Beckerite" (the last two plainly derived from the two names in the famous German firm above referred to). These, too, may have been vegetable gums of the forest, but certainly not from the real amber-trees (pinites). If the genuine resin is to be scientifically distinguished from them, it may be called S u c c i n i t e (from the original Latin word "succinum"); but just plain "amber" (in the strict sense) seems quite sufficient. On it exclusively will our interest hereafter be concentrated as we follow the lead of Conwentz.

The general geological view which he takes as a basis, is the one presented by Zaddach, whereas Goeppert was not yet quite sure of his ground in this respect: A pre-Scandinavian continent in the north, extending down to near what is now the Samland, and later submerged. How

far it extended to the east and west remains dark. There have been scientists, later, who believed that, prior to meeting the same fate as Atlantis, it had reached far into Poland and the South of Russia, where subsequently a sort of blue earth with genuine amber had been formed, but that is a moot question. The time of that continent real Eocene, which, nothwithstanding the opposition above referred to (e. g. by Tornquist, who presented us with an excellent geology of East Prussia), now seems to be the prevailing opinion again. But now the task arose of actually reconstructing its forest upon this geological Atlantis, and this was to be achieved exclusively through the amber. We follow the record inscribed by the style of genius. From the snug corner of a sofa, as modern theosophers fancied they could visualize the Greek Atlantis, this geological one cannot be reconstructed in a day-dream; that requires continued serious mental work.

The very presence of those various resins in the blue earth would seem to point to very diversified types of trees in that forest. And it is perhaps quite interesting to briefly call to mind, on the basis of the general genealogy of the vegetable kingdom, what a highly developed stage of plant-life m i g h t have been represented even by such an Eocene forest at that early period.

It is well known that the various primeval plants successively appeared at times approximately following the order of sequence established in the botanical system of classification, (cf., for instance, Gothan's new edition of Potonié's well-known hand-book). That may be embarrassing to anti-Darwinists, but here once more Nature is more important than philosophy. But since the plants of earlier and lower evolutionary stages never disappeared completely, plant-life in the aggregate was not only more highly developed,

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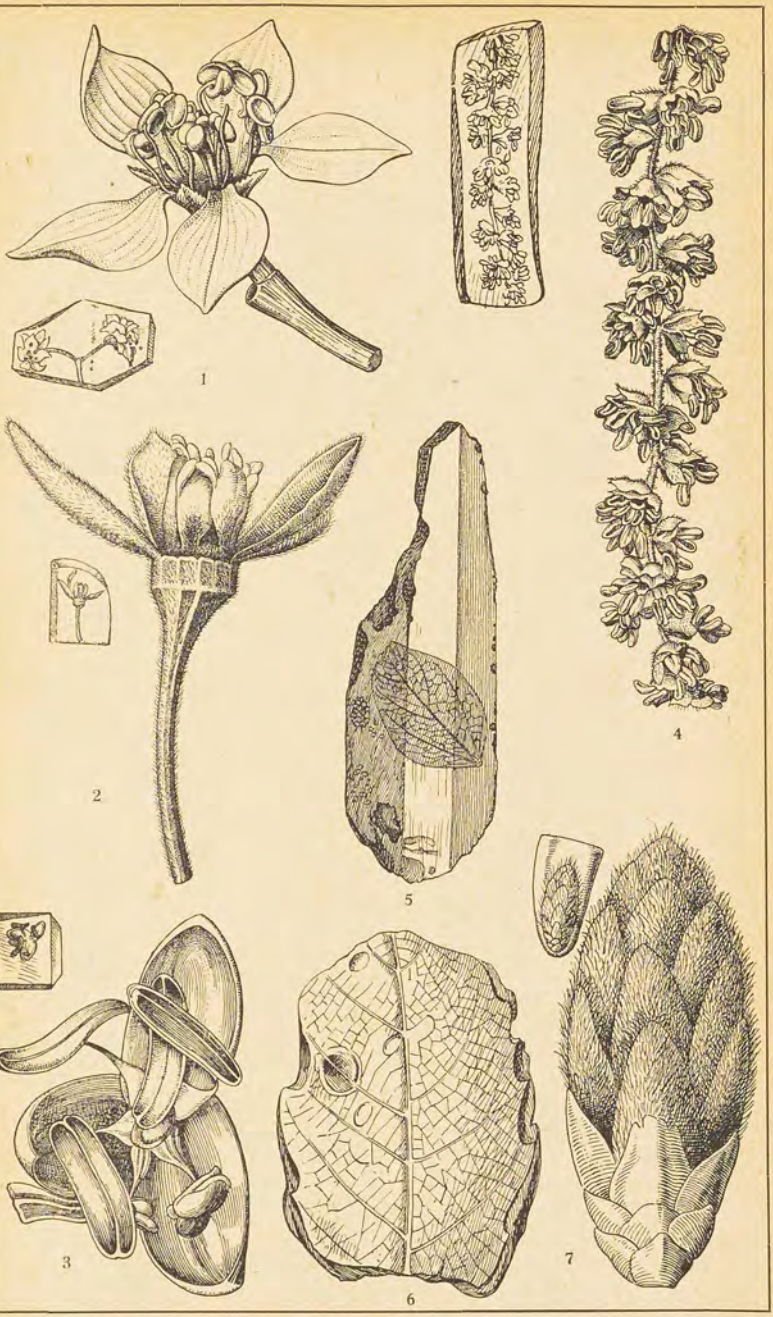
Explanation of the Illustrations on Page 59

Inclusions of flowering plants of the higher order (Angiosperms) in amber.

1. Two flowers of a tropical connaracea (Connaracanthium roureoides). Lower left: Natural size; above: Enlarged view, composed of two flowers. 2. Flower of a cinnamon tree (Cinnamomum Felixii), left side: Natural size, next to it: Strongly enlarged. 3. Flower of a palm related to our date-palm (Phoenix Eichleri). Left upper side: Natural size, next to it, strongly enlarged. 4. Male catkins of an oak (Quercus piligera); left: Natural size; next to it, strongly enlarged. The uncommonly well preserved inclusion bears 24 flowers. 5. Leaf of a cinnamon tree (Cinnamomum polymorphum), nat'l size. The well preserved leaf looks stiff, leathery, smooth, and bare, with a lustrous upper surface, and of greenish appearance. 6. Leaf of an oak (Quercus subsinuata), nat'l size. 7. Leaf-bud of oak (Quercus macrogemma), upper left side: Nat'l size; next to it, strongly enlarged. (Pictures after Goeppert and Menge: "The Flora of the Amber", edited and continued by H. Conwentz, 2nd vol., Dantzick, 1886)



but was continually widening in extent and getting more varied. Thus, for instance, in the most remote periods (the Cambrian and Silurian) we at first see nothing but algae, which probably settled only in the water at that time. Certain algae of the Cretaceous probably even belong to the pre-Cambrian time, as we suspect since quite lately. A land-forest would not, therefore, have been possible at all at that time. In the following Devonian period the first real land plants appear, which in the upper Devonian, after a short initial period of strange, almost moss-like growth, plainly develop into the fern-type. A forest of that time would have been composed almost exclusively of ferns, and such fern-forests have actually existed in the next ensuing Carboniferous period. When they disappeared, some individual fern species were left and, therefore, could have got into our real Eocene forest, just as they have come down to the present time. Now, from the very latest and highly revolutionary researches it appears with ever increasing clearness that in that Carboniferous period itself a powerful invasion must have been made upon those ferns by the next higher genealogical group, the so-called gymnosperms, which comprise our conifers or "needle-leafed" trees. Many of the types of that time, which have long been taken for pure ferns, are now shown to have been such most simple seed-plants, though bearing very little resemblance to our conifers of today.

And about the middle of the next ensuing Permian period (between the so-called lower new red sandstone and the Permian limestone) what may be called the terrestrial rule of the vegetable kingdom passed for a long time from the ferns to these conifers and allies. From that time on the conifers also could have qualified, as it were, for our Eocene forest. In that new red sandstone they already approach the well-known Araucaria form externally as well, and in the middle of the Mesozoic era, in the Jurassic period, they plainly assume the shapes of our taxodia and genuine cypresses, and but a little later even those of the pines and firs now so generally familiar to us. The haunts of the gigantic terrestrial saurians were almost exclusively in such forests of conifers. Until about the middle of the ensuing Cretaceous period an amazing and still somewhat puzzling pull upwards occurs; the change in the floral evolution seems to have almost demonstratively ignored the principal stages of our geological schedule. This

time the upper group of those seed-plants, that of the Angiosperms, conspicuously appears on the scene. Whether it had secretly developed from a branch of the ruling Gymnosperms we do not know; at any rate, the group is almost complete when it appears. As what are termed monocotyledons, and next to them also as dicotyledons, its second branch, which now exists. The latter from their organization undoubtedly the peak of the whole vegetable kingdom. But no family among them that does not exist today. If up to then ferns and conifers could have made up the amber forest, from that time on, if situated in a favourable zone, it might have comprised palms as well (from those monocotyledons) and laurels, magnolias, oaks, and other familiar trees of which great numbers are growing at the present time. On the whole, however, that completes the genealogy and, accordingly, we cannot expect any more fundamental gaps in the Tertiary this side of the Cretaceous.

Now, this impression tallies thoroughly with the actual evidence of the vegetable inclusions in the amber — so well, indeed, as to exclude any possibility of accidental agreement.

To begin with the most recent stage this time, what we see reflected in the magic little mirror of these inclusions is unmistakably a splendidly developed forest of a great variety of foliated flowering plants of higher order. Conwentz was the first to describe them in his second (supplementary) volume to Goeppert's work. Of course, the proper limitations must never be lost sight of in the reconstruction work. Our little tears of resin could not preserve whole trees. Much of what had got glued to them was accidental material least adapted to form a basis for botanical determination, such as tiny hairs widely scattered by the wind, scales, at best a whole little leaf. It is almost certain that much of the forest-stock which was unsuitable or not numerous, remains entirely unknown to us, and, in addition to this, a great deal of amber with inclusions never gets into the hands of a naturalist. So much more wonderful what a varied picture we get in spite of all this! In which connection I mention that the vegetable inclusions have now been proved by the junior Potonié to be no mere cavities but to contain real substance like the animal inclusions.

Palm-trees proved the most striking discovery in this respect. They can still be plainly recognized by tiny individual flowers and parts of leaves. Once, when such a forest

primeval was first vaguely visualized, palms looked like a matter of course. But, upon closer consideration of the matter from a geographical point of view, this seemed no longer true of a forest supposed to have been situated in the latitude of the Baltic. It must be called to mind, however, (as we have been taught but lately) that the climatic conditions in the earlier Tertiary widely differed from those now prevailing. A vegetation like that around Lake Geneva could extend as far north as Spitzbergen and Greenland at that time — and yet we cannot satisfactorily explain just what caused this difference. (Cf. the little Kosmos volume: "Ice-Age and Climatic Change" by myself). With such a climate, why should not palms have been among the trees of the genuine amber-forest? One of the types which we can still identify is our Phoenix, the date-palm, now North African and Indian. On the Riviera coast and in modern Rome it can still be seen how easily it can be acclimated on the European side of the Mediterranean; but in those early times it must have been indigenous up here. Another genuine amber-palmtree belonged to the beautiful American fan-palms of our hothouses, the Sabal species, of which the palmetto trees still extend farthest north over there.

Right here I want to point out a law which applies to nearly all the trees of the amber forest. They markedly remind of either the East Asiatic (e. g. Japanese) or the North American species of our day. For, throughout the Tertiary period Europe had a strongly common flora with those now exotic countries. In Europe even the last remnants of this vegetation were later destroyed by the glacial period, while in Japan and North America it was able to survive or else come back after being crowded out for a short while. But at the early stage of the Tertiary, when

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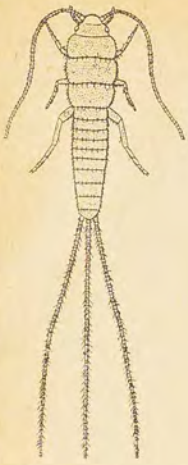
Explanation of the Illustrations on Page 63

Insects and spiders from the amber-forest, which have been preserved in the originally liquid amber.

1. Lepidothrix pilifera, a primitive, unwinged insect, allied to our s. c. sugar-louse; magnified. 2. Cronicus anomalus, an ephemeron. Line indicates nat'l size. 3. Holocompsa fossilis, a roach (Blattides); magnified. 4. Hagnometopias pater, a bug allied to our pselaphidae, part of which are now living as guests with the ants; magnified. 5. Dorcaschema succineum, a capricorn beetle; magnified. 6. Palaeognathus succini, a stag-beetle allied to the living lamprimines. 7. Prionomyrmex longiceps, an ant. Line ind. nat'l size. 8. Inocellia erigena, camel-necked fly; magnified. 9. Palaeopsylla Klebsiana, the only known primeval flea, preserved in the amber; magnified. 10. Platymeris insignis, a gerrida; magnified. 11. Chelifer Hemprichti, book-scorpion; line ind nat'l size. 12. Mizalia rostrata, spider; line indicates natural size. (1, 3, 4, 5, 6, 8, 9, 10 after Schröder-Handlirsch; 2, 7, 11, 12 after Zittel)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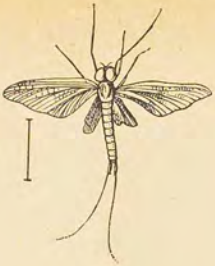
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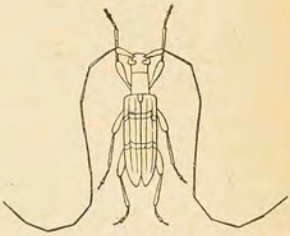
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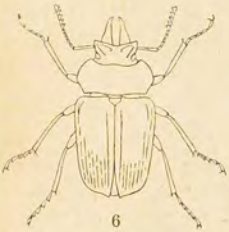
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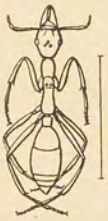
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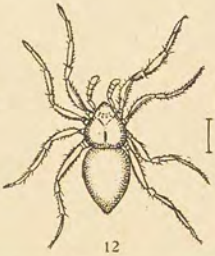
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our amber-forest existed, that close similarity was still in evidence everywhere.

As an illustration I mention the well-known magnolia-tree. Now North American and Japanese and only artificially grown with us on account of its beauty, it was once growing in our Baltic forests as a wild child of Nature.

An evidence of the warm climate there is the cinnamon tree. It reminds us of the tropical spice islands, although it occurs as far north as China. Reliable evidence of its existence in the amber-forest has been preserved to us by two flowers and a graceful oval leaf. Ever since 1858 this tiny leaf has been one of the most famous among all the amber inclusions, and indeed, who could fail to be fascinated by the charming idea that this far-famed and almost legendary spice-tree should have been so near to us at that time? Botanically the genus belongs to the laurels, and of these there has been no lack with us throughout the Tertiary. But to conjure up before our mental view a right dense forest primeval, we should be told that, in addition to such exotic strangers, it must have comprised vast areas of oak-trees as well. Dropped tiny bud-leaves and hairs of oaks make up practically the bulk of the vegetable amber inclusions. In keeping with the conditions of temperature, they must probably be assumed to have been evergreen species. Next to them there were two beach and four chestnut species, probably also elms, willows and various kinds of maples. These maples developed quite strongly only in the latter Tertiary, when the temperature gradually cooled off, and one is inclined to believe that in that warm paradise they were early harbingers presaging such a climatic change.

I shall just briefly touch upon a number of smaller types. From among the allies of the lilies there grew the smilax, of which there is but one species now in the region of the Mediterranean, otherwise now only in Japan and America. A calmus-like Arazea; among the grasses a maize, nettles and knotweed side by side with the wax-myrtle and the lovely rock-roses of Capri; the rose-apples of the tropics and East Asia together with the more familiar gerania; lady's clover and flax with sandal-wood. The elder bloomed with the olive-tree and again with our pretty spindle-tree. Madder and chervil, but then again, entirely surprising, the South-American soap-tree and allies of the splendid silver-tree of the Cape of Good Hope, with its silvery leaves.

Japanese deutzias and euphorbias and leguminous plants which are now tropical. The largest and finest among all the flowers furnished by the amber (almost 3 cm in diameter, i. e. about the size of a former German two-mark piece or a British half-crown) belongs to a species allied to the tea and camellia family (Stuartia), which — again in complete accordance with the rule above referred to — now has three species in North America and one in Japan. From the branches parasitic mistletoes were suspended, and even the heath could be found there in the right spots. And, as a matter of course, plenty of fungi, lichens, liverworts and large-leaved mosses, as well as ferns, which even then were primitive in the evolution of the vegetable kingdom. Here we have a real forest of Eden where everything one could think of, in leaf-wood alone, was growing pell-mell, all zones and countries thoroughly mixed-up. And how much more we might have found, had we only been allowed to botanize in the regular manner! Over the whole, however, as an equalizing agent, the warmth of the Paradise may have hung. Even on a conservative basis a mean temperature of over 20° C has been calculated, that is, say, the climate of North Africa. And this would be in keeping with the insects, of which, as we have seen before, almost an over-abundance has been preserved in the amber.

As the most delicate botanic details of the minutest flowers have been preserved, so with the animal inclusions it is a peculiar attraction that in many cases the insects, as we are looking at them, seem to be in the midst of the liveliest exertions, as if they were still struggling and kicking. Probably no observer can help being occasionally under the impression verging almost on horror that what he is looking upon, notwithstanding the interval of millions of years, is still a living creature, only imprisoned. With regard to species and broader groups of kinship practically everything is found among these insects that could possibly get in contact with resin. On the whole, all the forms throughout the whole range such as are still familiar to us today, since insect evolution, too, was completed at a relatively early time. A striking feature, however, may be the great number of small and still unwinged sugar-mites and allies, which are looked upon by some as the last stragglers of the primitive insects. (Cf. the little Kosmos volume: "The Genealogy of the Insects" by myself). An end-

less number of bugs, of course; gnats, wasps, bees, and ants — in short, practically everything in the way of insects that is in the air and on the ground. Very interesting in detail: Among the Cicindelidae the American Tetracha carolina; fully 46 species of the Pselaphidae, now mostly nursed by ants, and several of the southern Paussidae, likewise spoilt in those quarters; among the stag-beetles one species of the beautiful Australian Lamprimines. Side by side with genuine butterflies (of which, of course, only small, moth-like types are preserved), still numbers of their ancestors, the caddis-flies. Only once so far a flea was found (Palaeopsylla Klebsiana, named after the refined investigator of amber, Klebs), which, however, has thus become famous as the only "sucker" of its kind in the whole primeval world. Quite naturally we are set speculating as to what manner of pre-Adamite monster it had jumped off from, when it landed in the resin; sober zoologists, however, think of it as originally domiciled on some mouse or mole. Of great value as a corroboration of our climatic presumption are the unmistakably tropical guests: Nearly 50 different species of roaches (blattidae) part of them directly tropical, and together with some kinds of mantis and camel-locusts, termites in fairly large numbers. It is known that to this day these termites, as winged and sexually mature animals, occasionally rise in whole clouds from their holes in the ground, and during such a stage in the air our specimens were caught in the smothering embrace of the resin, — a charming spectacle under the microscope with their tiny wings still glittering. Among the arachnids (spider-like animals), which likewise are not infrequent in the inclusions, a funny sight was occasionally presented by a wee book-scorpion (Chelifer) which, quite like those of our time, had willingly or unwillingly fastened itself to a passing insect, an ichneumon-fly, and, although unable to fly itself, had been carried off through the air until both the horse and the rider came to an inglorious end in the glue-pot of the same Eocene resin-flux.

But as Atlantis is thus set blooming and humming, its palms swaying in the breeze once more and its cockchafers whirring to and fro, we still look for some particular action on it.

In the legendary paradise among the other trees there stood the tree of knowledge and from it started the action

of that paradise. The great action of our amber-forest was its production of resin. Where did it come from? Which one was its tree of knowledge in this sense?

None of the leafed plants so far described are likely to be the particular ones from which the amber came. It is quite easy to understand, of course, that wherever such resin was flowing, the objects which got stuck in it must have come from the same neighbourhood. But who had actually set the lime-twig?

Again it was an early idea of that time of Wrede that it must have been a tree with acicular (needle-shaped) leaves, a conifer.

We have seen above that such coniferous trees certainly could have existed in our paradise. That even in a warm forest such conifers may alternate with palms is shown by many a tropical landscape to this day. One of the first surprising impressions received by Columbus in Central America was such a mixed forest. The lone pinetree which, in Heine's poem, stands in the north, dreaming of a palm far, far away where it can never be reached, is, from the botanist's point of view, merely an expression of our European world after its devastation by the ice-age. And, as a matter of fact, the picture of the pure leafed-tree forest can be properly supplemented, in this respect as well, by the amber inclusions. Goeppert himself and Caspary have done preparatory work in that respect.

Even the first superficial examination of any fairly good collection of amber inclusions will invariably reveal great quantities of the Cypress type. Nearest relations to our pretty tree of life, the thuya, must have outgrown everything else in many places, judging from the endless number of the loose tiny twigs that got into the resin from them. Incidentally, the thuya also follows the rule mentioned, as it now comes to us from East-Asia and North America; over there it still brings forth gigantic stems as high as 60 metres. Added thereto are genuine cypresses and Chamaecyparidae of equally wide distribution, Californian cedars and South African Widdringtonias. In places one would have fancied to walk through a splendidly assorted grove of conifers. Even something remotely suggestive of the juniper-tree, the only Cypress-type still indigenous in Germany, existed at that early time. While apparently the true cypress of the swamps was missing, still the closely related Chinese Glyptostrobus and the gigantic sequoya were

represented. Even a tropical type, now so completely foreign to us as the Cycadea, which looks like a palm-tree and yet is remotely allied to the conifers, was there in places. So there is a great variety to select from, and if we could properly derive the resin, say, from the thuya, our work would easily be completed.

But here another reflection obtrudes itself.

Among the inclusions in genuine succinite we do not only find external particles of plants, but now and then wood itself.

And that is found not merely in loose crumbled particles, but not infrequently in rather stout fragments, the resin fairly permeating them even yet in its present form of amber. It is certainly a natural conclusion that this internally resinified wood comes from the amber-tree as the real source of resin — a remnant of wall, as it were, from its own workshop.

According to Conwentz, however, none of these wooden fragments preserved to us actually agree with the cypress-wood above referred to. Some pieces of that type may be among the loose and rather problematical drift-woods without ingrown resin, which were washed into the blue earth along with the stones. But wherever wood is intimately tied up with amber, it invariably points to a very definite trail.

When Berendt, in 1830, received such amber-wood, partly through Wrede himself, he concluded right after the first superficial examination that the fragments had apparently belonged to a very close relation of one of our best known and still indigenous types of conifers, viz., our pine-tree which, as Christmas tree, is associated with the sweetest romantic dreams of every child.

Berendt's idea was extremely suggestive. In fact, it led up to the neighbourhood of trees which are even now known to us on account of their abundant and industrially exploited production of resin. More than that, these trees could be most conveniently studied everywhere and in this way, if the idea proved correct, we could get a vast deal nearer to our forest. Again that antique view of the stone-pines and cedars re-appeared, crowding right in between the palms and cinnamon trees of millions of years ago.

Five years after Berendt (in 1835) such amber-wood was microscopically examined by the excellent investigator

Aycke at Dantzick. According to what was then a new method, he for the first time cut it up into thin slices and examined the delicate details of its structure, magnified a hundred times. While no botanical specialist, he still recognized the natural veins of resin in the wood itself and thereby made it absolutely certain that these must be particles of the tree yielding the resin. He too considered the structure of the wood as probably pine-like, leaving it in abeyance for the time being from which one of the species existing at the time it might have come or whether it had come from more than one species.

By this time, however, the matter was taken up by Goeppert, a botanical specialist, who in 1836 got hold of a piece of amber containing particles of dark wood, some of them being merely included in the amber while others were also fairly permeated by it. To him their pine-like structure seemed so clear that he did not hesitate to create immediately a permanent Latin name for the tree: Pinites succinifer, which, according to what he then had in mind, means something like the "amber producing primeval pine-relative".

Undoubtedly another great moment in our story. The tree of our knowledge permanently established for the first time by the Latin denomination of its genus and species on the basis of the immortal Linnaean classification. Not until that moment did the last mists seem to disperse: The fabulous tree entered the special botanical branch of science, which was henceforth to hold on to it with the full force of its own cohesion. The name, though, was to be somewhat modified in due course.

At first Goeppert saw no reason why more than one species should be assumed; later, however, he was no longer sure of that, thinking that from the wood he could determine no less than eight different species, part of them pointing to other members of this conifer family, until in his final work he reduced them to five (aside from a mistaken taxus species.)

He too, however, was influenced by the fact that, besides such wood particles, needles and flowers of various types from among the near or more remote relatives of the pine were found in pure amber. At an early stage, Bock had been under the impression of having seen in it needles from both firs and pines, and since 1830 male flowers had been reliably determined. Today it is certain that, according to

these parallel findings, spruces and firs as well as pines, and probably also larch-trees must have grown in the amber-forest. Again the only question was how much or little of them might have belonged to that wood which had been separately determined. On the one hand, there was no proof that everything was per se connected with it; for, aside from the true amber-yielding conifers, leaves and flowers might have been dropped on the resin from very remotely related needle-leafed trees which had no more to do with the source of resin than the palms and cinnamon trees. On the other hand, however, it looked probable from that very variety that there might have been several species of true amber-trees.

These later distinctions of Goeppert, however, proved useless to Conwentz. To say nothing of the non-existent taxus-wood, the last five types of wood are considered by him to be errors, due to the lack of adequate cuts and facets like those devised by later improved methods of microscopic examination. He insists that if these methods were applied to suitable material, there was no cogent reason for assuming particles of more than one type of tree from the wood a l o n e. The differences shown, he claimed, might all apply to different wooden parts of one and the same tree. This being so, Goeppert's first Latin name of the tree could stand.

On the other hand, however, Conwentz himself does not deny the p o s s i b i l i t y that several amber-trees may have existed, provided only their wood had been of practically the s a m e s t r u c t u r e. How difficult it was (he goes on) to determine any differences at all from the wood alone was apparent a. o. th. from the fact that by this method it was not even possible to clearly determine whether it had been a genuine pine o r a genuine fir. There were many indications pointing to such a fir, and therefore the Latin name (which is changed to Pinus succinifera by Conwentz) had to be left in abeyance for the time being. None but the silver-fir and the larch-tree were excluded fundamentally, he says. The unmistakable differences of the needle and flower inclusions are conceded by Conwentz himself to lend a certain conditional probablity to the assumption of several trees.

The inclusions of this kind are somewhat puzzling, anyhow.

In the first place, none of the inclusions of leaves (and that is where the needles belong in this respect) are so much more frequent than the others that, on account of that fact, they could be considered as connected with the true amber-tree. And furthermore, all needle inclusions, no matter of what kind, are strikingly rare. Those tiny loose cypress-twigs of the tree of life are incomparably more frequent in the amber. Conwentz explains that, as a rule, pines, firs, and spruces shed their leaves only in long intervals of several years, and besides, the principal time of shedding the leaves was late in the autumn, when there was little occasion for them to get into flowing resin. That the slender needles were not likely to be scattered by the wind, but instead would drop right to the bottom, without brushing against the resin on the stems or branches. That the colour of the needles in the amber was not of the same gay green as in life, but dull, probably because at the time they got stuck in the resin, they were no longer fresh and vigorous but either dying or dead. These explanations, however, do not seem entirely satisfactory, and the matter remains somewhat mysterious.

But, however that may be, as stated before, a limited number of such needles and flowers are extant, most of them excellently preserved, and on the basis of this concurrent material of needles Conwentz considered himself justified in recognizing four different types of pine, in the more narrow sense of the term, and one equally true fir. Accordingly, all of these five types would have to be considered as at least possibly pertaining to the identical kind of wood and, therefore, being connected with the production of resin. Added thereto are three pure pines, which are characterized by flowers, but it is evident that these flower-types correspond to three of the needle-types, and thus only those five types of trees would remain as possible producers of the resin.

None of the pines, which, in keeping with Conwentz's partiality for pine, are in the majority, are identical with or even closely allied to the species now indigenous with us. One recalls certain North American species, another the Japanese red fir, while a third comes near to our stone-pine and also to the Japenese knee-pine. The pine-tree determined from three incomplete needles, more closely tallies with a type now existing near the river Amur and on the island of Jezzo, and this again slightly suggests that

rule, mentioned before, about present distribution in East-Asia.

Within the forest as a whole, Conwentz assumes the genuine amber-trees to have exclusively covered areas of their own, only occasionally interposed with other kinds of trees. "The pine-trees occupied a thoroughly dominant position in it" and lent to those parts of the forest "a gay green colour, alternating in places with the grey of the long strings of beard-moss suspended from the boughs and branches."

On the basis of the differences which had been reliably established at least on the side of the needles and flowers, Conwentz distributed once more a number of more specific Latin names, with the explicit understanding, of course, that they were to be only provisional, against which, as the one point actually set at rest, there remains the old comprehensive designation as Pinites (or Pinus) succinifer.

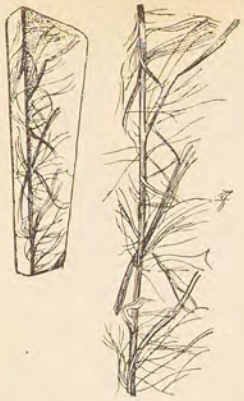
In this connection I will mention that since the days of Conwentz new examinations of wood have been made by Gothan, with the result that at least that excellent expert considers it probable that eventually the genuine fir has to be entirely eliminated and nothing but pine-wood remains. The species tallying most closely with this wood is said to be the Pinus silvatica, which was determined by Conwentz from the needle and reminds of certain American and Asiatic pines (Parrya) among the living types. According to this, therefore, we could no longer speak of anything but "amber-pines."

After the tree had thus been botanically determined at least with a very small margin for variations, the next question that arose was naturally whether we could not read off something about the "action" of the tree: that great action of p r o d u c i n g t h e r e s i n, which in turn resulted in the amber.

Explanation of Pictures on Page 73

Remnants of Conifers included in Amber.

1. Splinters of wood from trees damaged by lightning-stroke or high wind. Left side: Original size; right side: Magnified. 2. Bunch of needles from Pinus cembrifolia. Left: Original size; right: Magnified. 3. Part of inside surface of such a needle, strongly magnified. 4. Male flower of Pinus Reichiana. Left: Original size; right: Magnified. 5. Female flower of Pinus Kleinii. Right: Original size; left: Magnified. 6. Pollen grains (anther-dust), strongly magnified. 7. Strongly magnified piece from 4. 8. Same from 5. (Pictures from Conwentz's "Monograph of the Baltic Amber-Trees", 1890).



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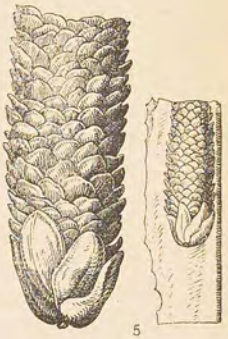

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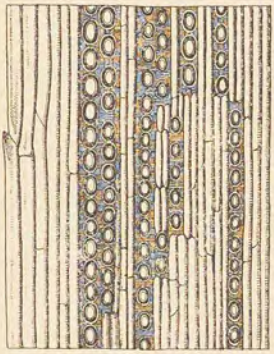

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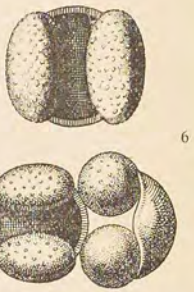

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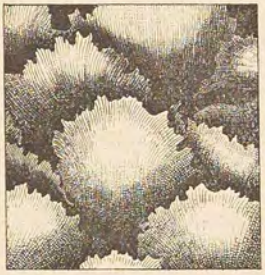

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In this respect the nature of that amber-resin, rather than what it included, was bound to be significant factor.

Whilst the wood, wherever intimately tied up with succinite, is invariably of very uniform type, the genuine succinite itself is by no means always of like structure. Pliny already, as we have seen, was aware of its varying colours, and whoever examines a fairly large modern collection for such differences, merely among the pieces contained in it, will certainly be surprised at the regular recurrence of certain different shapes, which seems to indicate some secret law.

Some of the strongest contrasts are, of course, plainly due to its later fate; for instance that a stone taken immediately from the blue earth is covered by a uniform, whitish, weathered skin, whereas the sea-stone appears cleaner and more naturally smoothed. But for some other differences that "action" must be at least partially responsible.

Since the development of the modern amber production an endless number of such different kinds have been distinguished from one another, yet a few basic types prevail, and to these permanent local designations have been given. Thus besides the stone of golden clearness, the kind we should most likely associate with pine-resin, there is one that is duller throughout. Microscopically magnified, this dullness is shown to be due to a greater or smaller number of air-bubbles included, of which there may be as many as a million per square millimetre, their own diameter being only from 0.0008 to 0.004 mm each. In excessively large numbers they produce an opaque white, "bony" stone; when more or less mixed with light spots, a "dappled-bony" one, or a "bastard", or a bluish one, looking like diluted milk, or else a greenish one. Other kinds are designated as "downy" or "cabbage-coloured", while the next best grade, of slightly duller golden hue — the "Brunswick clear" — may be the one which was once compared by Pliny to the noble Falernian wine. For what is called a "frothy" stone an addition of iron pyrites is partly responsible.

In addition, there are several characteristic differences of shape, which seem to follow some peculiar rule of their own regarding more regular cloudiness or transparency: Large, flat, and mostly cloudy "tiles" and "plates"; roundish, opaque tears, sometime flattened at the bottom;

finally, the fine and clear "pouches" ("Schlauben"), which appear like several resin-fluxes deposited one over another, and most frequently contain those animal and plant inclusions like glass caskets bright as the sun himself.

All these little contrasts seem to be of little significance to the cursory observer. Why shouldn't abundant resin have flowed now in this way and again in that? Or why shouldn't it have been soiled in this way or in that, or else have been left clear? Yet it is marvellous how Conwentz reconstructs this varying process from its product coagulated into stony rigidity millions of years ago, and sets it working again until that too gives quite definite answers to our questions.

It has been stated that the passages in the amber-wood, where once the amber-resin was originally produced, can still be recognized in the thin slices under the microscope. In its simplest form such a resinous passage, when studied on closely related living conifers, appears plainly as an interstice between separating cells, in which a transparent balm accumulates, probably produced by these cells themselves. Or else it may be produced as a result of dissolving neighbouring cells themselves, during which process its contents usually get cloudy from the cell-sap. With increased production of resin, whole tissues may thus be resinified and destroyed, leaving large, lentil-shaped cavities in which the fluid resin-balm accumulates as in natural tanks, often called "resin-galls". The development and ultimate fate of all these internal stores of resin vary greatly, of course. In some cases they may remain inside the tree during its whole life-time, gradually coagulating there into a permanently solid resin, until, at the end of its days, the whole tree falls apart from decay and the hardened inclusions, being no longer soluble, drop out on the forest-floor, remaining there as loose stones. Or else the tree, while still vigorous, may be more or less badly wounded from the outside and the resin, being still liquid, may flow out.

Applying this process, which can still be observed today, to our various amber-types, we immediately get the prittiest explanation.

Those thicknesses of tiles and plates, often very cohesive to this day, flat, slightly concave or plane on both sides, not infrequently still bearing the prints of the adjacent inside wood of the trees, are evidently such resin from passages and "galls", which hardened undisturbed in the

depths of the tree. It is invariably of dull colour, because infected from dissolving cells, and has no animal or leaf inclusions, which could not have easily got into the inside wood.

The many other forms and colours appearing in our amber collections reflect with equal faithfulness the adventures of resin-flux due to injuries received by the tree during its life-time. Probably this too, when first coming out, was more or less cloudy, either because it had been mixed with cell-sap inside the tree or was regularly infected from the wound and formed a corresponding number of air-bubbles. Thus from the first, milky flow "bony" or "downy" amber might have been formed at the orifice. No doubt, that first flow was quite viscous and very slow. Most likely it would form into large, dull tears, where the wound was small and emptied downward, the tears being flattened at the bottom in dropping and hitting the ground. And only after the hot sun had fairly scorched the orifice for a while, would the consistence of the resin become looser and more liquid, while at the same time the air-bubbles would be completely "cooked out" of it by the heat. Then only would the resin come out quite clear, in cones and "pouches" — that "golden" and "ice-clear" kind which is the delight of our eyes and furnishes the material for the finest amber ornaments. "In this liquid state the resin would either drop straight to the ground or flow down on an inclined plane. In the former case cones would form, and around them new layers would flow one after another, continually enlarging them and coating the boughs and branches of the amber-trees like stalactites. This growth was not a rapid but a slow and gradual one, since even yet the individual layers of the succinite-cones can be plainly distinguished. Each of them must, therefore, have had time to harden more or less, before a new flow followed, which points to certain intervals between them. In the other case nearly plane or slightly arched lamellae would successively form one over the other on the stems or branches — which are commercially termed pouches (Schlauben)".

In this last stage, however, the resin was evidently best suited for embalming insects or plant-flowers which came in contact with it. What could not be fully done by the resin-tear was most completely attained by the new coatings successively laid over the object, which was thus

enveloped on all sides, as if the coffin had been closed over it. And it is quite easy to imagine that the brilliant colour of the flowing resin must have been a fascinating lure to insects.

To picture all these last-named processes to ourselves we need no special vision for things primeval. As the permanent resin continues to this day to coagulate inside, so tapped resin still flows from our pine-trees in a milky stream, which will clear in the sun and form successive coatings, between which whole hosts of ants especially may still be caught and coffined-up occasionally, although there is no demand for them as curious. In reading Conwentz's description it is a real pleasure to note, time and again, how skillfully he derives and explains primeval processes from similar ones with which we are all familiar.

Where the resin, having become thoroughly liquid, eventually dropped down upon the dark "duff" of the forest floor, uniting with it, the combination resulted in that impure amber which is now the lowest quality but still of great commercial value as a wholesale product, being utilized in the preparation of varnishes. To the geologist that very kind of amber presents the rare spectacle of a preserved forest floor of the early Tertiary.

But still another observation obtruded itself upon Conwentz in connection with all this, and that, as with one stroke, conjures up before us a fascinating picture of the forest both in its days of joy and sorrow.

When we consider the vast quantities of amber yielded, we feel somewhat doubtful for a moment. Even assuming the trees to have stood on the same spot for many centuries, it still appears doubtful whether such a wealth could ever have been produced by simple pines and firs very closely related to those now existing. One feels inclined to think that those specific amber-trees must have had some particular advantage enabling them to produce such a tremendous mass of resin. Yet the result of an examination seems to contradict such an assumption. A close examination of those most simple normal passages of resin proves them to be perhaps a mere trifle wider and more numerous than those of our present trees, but the difference is not nearly sufficient to explain that production. It cannot, therefore, have been due to the different kind of the trees, but instead we are struck by something else, and that proves highly interesting indeed.

At every step we find indications in the amber-wood, pointing to individual peculiarities in regard to resin production. All those large resin tanks and resinous growths in the tissues would seem to indicate something of that sort, judging from conditions now prevailing. Where such phenomena now appear, they invariably indicate an anomalous, more or less morbid excess production of resin by the individual tree involved. It would be thinkable that such an individual overexertion, spread over wide areas of the forest at that time, explained the enormous quantity of what later changed to amber.

The question arises however what might have caused this morbid overproduction. And Conwentz has only one answer, which is again based on present forest conditions. Such an enormous production of resin by individual trees is always in direct ratio to external attacks and injuries sustained by the tree in any individual case. The greater the external damages, the more extravagant will be the internal production of resin by the tree. Originally that may be a sound natural healing process, but eventually it becomes itself a disease. For, "while resin-flux benefits the plant insofar as it protects its wounds against atmospheric and other influences and, in case the neighbouring parts of tissue have degenerated, renders the cellular walls impermeable to water, still it has the evil effect of weakening and eventually ruining the tree". Those resin-galls, in particular, most frequently establish themselves among morbid growths of tissue which has become diseased after lesions. The more a forest in a wild, lonesome country, far from all cultivation, is exposed to a thousand sufferings from the attacks of all the elemental forces, the more will this disease from resin grow upon it, until at last no individual tree remains in it that is entirely sound.

And here again enters Conwentz's conclusion, at once simple and significant: The amber-forest must have been engaged in such a struggle of the severest kind, which expressed itself in a fairly colossal overproduction of resin. For the amber coming exclusively from this forest Conwentz had coined the foreign designation of "succinite". Accordingly, he now teaches us this: The whole forest must have suffered from succinosis — from the "amber-disease" in the special sense that, in its time, it produced far more resin, later coagulated and changed into amber, than was normally in keeping with its kind. In that sense

hardly a single sound tree can have been left in it; not one but was suffering both inside and externally. Not the normal but the pathological state was the rule there. Like gouty salts the excess mass of resin either was deposited inside the stem or else would fairly rush out in gushes. In either case ultimately a senseless overproduction, but one which nevertheless achieved the marvel of our present immense amber-hoard, now being dug out by a cultured posterity. Unconsciously we are reminded of the pearls, which are likewise due to the presence of something morbid in the shell. Only, in the former case we profit by what was a primeval disease.

Meantime for the ingenious interpreter himself but one more task is left: To depict in an impressive manner the nature of the external attacks which drove the trees into that unfortunate reaction millions of years ago. In this respect also, he believes, the amber kept a very accurate record, partly direct and partly through its inclusions.

What a multitude of dangers are threatening, even to this day, such a wild tree left to its own resources in a primitive forest! Even the "shedding" processes, familiar to every forester, where trees growing in crowded places allow their ill-lighted and functionally useless lower limbs to wither, dropping them at the slightest shock, must have inflicted numberless small wounds which, at best, could heal over or be closed by the resin covering them, but often allowed harmful parasitic spores to enter. Far worse, however, was the damage wrought by the fury of certain violent elemental events. "Old, dead trees would sink to the ground, brushing against and breaking the limbs of other trees in every direction, and finally crashing down with the full weight of their immense bodies upon everything that opposed itself to them on the side where they fell. With terrific force they would knock against neighbouring stems, tearing off great strips of their bark and in places injuring the inside wood itself. Violent gales and tempests would pass over the amber-forest, working the worst kind of destruction in it. All the grand and splendid creations resulting from centuries of Nature's work would be destroyed in a few moments by the fury of a terrible elemental force. A whirlwind would catch the mighty tree-top, twisting it off the stem in a few seconds; the strongest trees would be snapped above the ground like blades of grass and

hurled about in wild confusion like so many matches of tremendous size. Other trees would be torn from the ground with their roots, lifted into the air and, whirling round and round, be carried over long distances until they dropped to the ground or were left suspended from some other tree that still remained standing upright". We cannot help admiring the skill of Conwentz in describing the furious work of such events in the amber-forest, which he reads off, with the eye of one who is at once an expert and a seer, from a few minute bits of wood now and then preserved in pieces of amber. They are edged or plane fragments with torn and ragged edges; often several of them near one another, suggesting that they had formerly been united. At any rate, the wood must have been torn by tremendous forces. Under the microscope the torn or broken sides are seen to be quite fresh without the slightest covering of dust, cobwebs or fungous matter. The wood must have been splintered or torn on the living tree. It is a natural conclusion, therefore, that it was caused by a lightning stroke or a storm. The splinters due to lightning stroke are possibly less complicated than those caused by strong gales.

"At other times an oppressive heat would prevail in the amber-forest and violent thunderstorms be discharged over it. A tree-top or the remaining stump of an old limb might be struck by lightning and long strips of the bark violently detached, some torn fragments of it being caught by the ragged edges of the wound and jutting out into the air. The wooden parts inside might likewise be split, and the splinters torn out of it together with some fragments of bark, would then be hurled far away. Sometimes lightning would strike a decaying tree or spongy wood and set it afire. The fire would not only spread over the stem originally struck and the neighbouring trees, but would run along the ground and consume the dry material desposited on it. The resin on the forest floor, surrounded by decayed matter and moss, would likewise be caught by the fire; it could not flare up, however, but would slowly smoulder below the protecting cover and form a dusky rind". The direct proof of lightning stroke in the amber-forest is the greatest triumph of the painstaking research concerned with those minute splinters. For, the effect of electricity not only loosens the cohesion of the cellular layers in such a splinter, but, if the bursting force operates from the interior

toward the exterior parts, the cells themselves are torn apart. Among the splintered wood from the amber-forest however, microscopical examination reveals some with the cellular membranes torn apart. Likewise, there is some amber with a black rind due to fire, and Conwentz was able to reproduce the process by experiment, showing that even today such a stone, surrounded by smouldering moss and wood-dust, will not melt but form just that characteristic rind.

This minute observation has itself something like the effect of a lightning flash: Plainly as if we could grasp it, the forest seems to stand before us, with the dark, stormy cloud threatening overhead.

Furthermore, the trees must have been threatened everywhere by what may often have been wholesale attacks from the animals living in the forest. "The amber-forest was alive with a very abundant fauna, since insects and spiders, snails and crabs, birds and mammals had their haunts in it, just as is the case in the forests of the present time. Intimate mutual relations existed between the lives of the trees and those of most of the animals, many of the latter being harmful to the living trees while others attacked the dead wood. Big animals would wantonly or accidentally break off limbs and injure roots above the ground by treading on them. Squirrels, alertly jumping from branch to branch, would peel off the young bark from them. The stillness of the forest was interrupted by the noise of the woodpecker, looking for insects in the bark and wood of the amber-trees and possibly driving holes into the stems for shelter at night or for breeding purposes". The existence of squirrels at that time was inferred by Conwentz from some specimens of hair among the amber inclusions, but these are more likely to have been left by a marsupial, a tupaja, which could have been native with us at that early period, while at present it is thoroughly foreign, its habitat being Australia.

A red feather among the amber inclusions seemed to indicate the little red-cap of the spotted woodpecker. As the avian genealogy had been largely completed in the early Tertiary, there is not much objection to that either. Certain vicious gadflies among the inclusions point to many a little monster which now only bobs up before us in this way like a phantom. It must be kept in mind that it was the time of the strange tapir-like palaeotheres, the anoplotheres

living in the swamps like the hippopotami, and the xiphodontes somewhat resembling antlerless stags.

On top of all, the worst of all bad forest destroyers were at work: Thousands of insects were buzzing through the forest and attacking the plants. It is not merely an accident that the amber has preserved such a faithful sample collection of these minute but persistent creatures, effective through their inexhaustible numbers. In fact, it looks like an almost complete collection of all the tree-destroyers still active in the forests of the present time. Bast-beetles, past-masters of forest destruction, bored their way into sound and diseased stems, causing the early decay of the injured ones and crippling the young trees. Wherever they appeared, the resin would drip fast. Larvae of the death-tick, the capricorn-beetle, and the brilliantly coloured buprestides were gnawing their way through the wood in every direction. "Wherever great masses of green timber had fallen after a storm, the bark-beetle never failed to make its appearance. Enormous numbers of it soon developed and, together with fungous spores, not only destroyed all of the fallen timber, but attacked even the less seriously injured trees still standing upright in the neighbourhood. In this way the holes left by limbs torn off in a storm would become breeding places for beetles and other insects, and infecting centres for parasitic and saprophyte fungi. When the fungi and insects had completed their work on this entire material, with the constant aid of atmospheric influences, then the young coppice had a chance to grow up in the gap thus made, filling it in the course of long spaces of time; but in the meantime it was almost certain that other damage had been done elsewhere". Gall-gnats and leaf-folders injured the needles. Of the hymenoptera the saw-fly and the wood-wasp were thriving. Tree-lice covered the stems and limbs of the trees and with the stings of their long beaks very likely caused just those treacherous growths of tissue which were in due course permeated by the increased flow of resin. The outcome of it all was that a great many dead tree-skeletons were left standing in the forest, particles of their peeled off grey patina being still preserved in the amber.

But where gap after gap had thus been relentlessly made in the tree-fortress and its gates had all been broken down, there the vicious, sap-drawing parasitic plants of like and this time also of hostile kind made their entrance.

In vain did the resin-flux endeavour to heal — it was outdistanced by those fungi of every variety. In the humid atmosphere of that warm forest (as amply evidenced by the many insects of the swamp and the luxuriant liverwort flora) "little by little all the trees would become infested with one parasite or another, and often even with several at a time, which slowly but with fatal certainty continued and completed the work of destruction. Through a knot-hole or some other open wound the mycelium would steadily advance toward the interior, causing the gradual decay of the wood from the inside toward the exterior parts. "The existence of the spores of heartrot and others which are still most deadly enemies of our present forest economy, has been explicitly proved. And in addition, local decay of the bark was brought about by plants of a higher order from among the parasitic relatives of the mistletoe.

On the whole, indeed, an almost ghastly spectacle. Nature itself relentlessly raging against its magic forest, and the latter in its distress unceasingly gushed forth its resin until at last what was intended to be a cure proved almost worse than the external attack itself. When even the last gravediggers had completed their finishing work among the successive decayed generations, then the only thing left of each of them as a truly indestructible remnant of resistance was invariably the petrified resin which permeated the floor of the graveyard. Who can tell for how many thousands of years? Until at length there came a generation which may have been the last of them all — probably leaving nothing but that graveyard. After which, again for many centuries, the former forest floor could not have been established as such except by its contents of resin, after the ground had been dug-up . . . Or was it at an earlier stage that the gradually expanding waters of the new primeval period, then being ushered in, called for their own, rolling their waves over the sinking land? Breaking the last of the forest itself and at the same time uncovering the amber deposits of all its earlier successive generations, washing them up, levelling and sweeping them away . . ?

Who is able now to have a look at the conclusion of the fairy-tale?

Here, all of a sudden, we are reminded that we are wandering way back in the past — millions of years ago.

In a dim visionary past, after all, from which we are separated by the unbounded blue waters of Time itself.

Where we do not belong, as yet no human being actually existing to listen to the softly rustling leaves of this blooming and dying magic forest, with its tune of loneliness.

Only the sun, which clarified its golden resin, is the same that we see.

The "Sun of Homer", as the poet says, "lo! He is smiling on us."

He then shone upon on his forest, long before man was ever thought of, just as today, spiritualized, he shines from our knowledge . . .

I am at the close of Conwentz's description and my own.

I wish the reader who followed me may have been made to feel also that every scientific picture of this kind, as it subsequently stands newly conjured-up like a beautiful, multicoloured work of fancy, must invariably be preceded by a great deal of w o r k if that final achievement is to be a true and valuable one — that preparatory work itself extending over long centuries of earnest endeavour in that forest where the blossoms of the human mind are blooming. As in this instance from the plain germ of ancient Pliny's idea that this golden stone was a tear of resin, dropped somewhere at some time in the past, to the mad raging of the storm in a mentally restored wild forest of the Eocene period.

While at the same time I wish he may have realized once more that every scientific problem of this kind passes along lines of inner development, ascending from night to light. Perhaps a guarantee, after a fashion, that, on the whole, our mental culture is likewise on the ascent.

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