

Bassariscus astutus. By Ivo Poglayen-Neuwall and Dale E. Towell

Published 27 December 1988 by The American Society of Mammalogists

Bassariscus Coues, 1887

Bassariscus Lichtenstein, 1830:119. Type species *Bassariscus astuta* Lichtenstein; not *Bassariscus*, Hubner, 1816.

Bassariscus Coues, 1887:516. Type species *Bassariscus astuta* Lichtenstein, a renaming of *Bassariscus*.

CONTEXT AND CONTENT. Order Carnivora, Family Procyonidae, and Subfamily Procyoninae. The genus contains two living species, *B. astutus* and *B. sumichrasti*. A key to the species follows:

Soles furred, ears rounded, claws semi-retractile, high ridges connecting cusps of molariform teeth, length of tail approximately equal to length of head and body *B. astutus*
Soles naked, ears smaller, claws non-retractile, low ridges connecting cusps of molariform teeth, length of tail distinctly longer ($\pm 11.5\%$) than length of head and body *B. sumichrasti*

***Bassariscus astutus* (Lichtenstein, 1830)**

Ringtail

Bassariscus astuta Lichtenstein, 1830:119. Type locality "Mexico City," exact locality unknown.

Bassariscus raptor Baird, 1859:19. Killed in Washington; escaped pet. Type locality designated by restriction "Glen Ellen, Sonoma County, California" (Hall, 1926:44).

Bassariscus astutus Coues, 1887:516, first use of current name combination.

Bassariscus flavus Rhoads, 1893:416. Type locality "Near Grants Pass in Josephine County, Oregon."

Bassariscus saxicola Merriam, 1897:185. Type locality "Espiritu Santo Island, Lower California."

Bassariscus albipes Elliot, 1904:258. Type locality "Xico, near Jalapa, Veracruz."

CONTEXT AND CONTENT. Context same as for genus. Fourteen subspecies of *Bassariscus astutus* are described as follows (Hall, 1981):

B. a. arizonensis Goldman, 1932:87. Type locality "Casper Ranch, Blue River, about 12 miles south of Blue, Greenlee County, Arizona (altitude 5,300 feet)."

B. a. astutus (Lichtenstein, 1830:119), see above (*albipes* Elliot, a synonym).

B. a. bolei Goldman, 1945:105. Type locality "Chilpancingo, Guerrero, Mexico."

B. a. consitus Nelson and Goldman, 1932:487. Type locality "La Salada, 40 miles south of Uruapan, Michoacán, Mexico."

B. a. flavus Rhoads, 1893:417. Type locality "Texas," exact locality unknown.

B. a. insulicola Nelson and Goldman, 1909:26. Type locality "San José Island, Lower California, Mexico."

B. a. macdougalli Goodwin, 1956:10. Type locality "La Ventosa, Salina Cruz, coastal lowlands, 20 kilometers south of the city of Tehuantepec, Oaxaca, Mexico."

B. a. nevadensis Miller, 1913:159. Type locality "Eldorado Canyon, Clark Co., Nevada."

B. a. octavus Hall, 1926:39. Type locality "San Luis Rey River, 1700 feet altitude, near Escondido, San Diego County, California."

B. a. palmarius Nelson and Goldman, 1909:26. Type locality "Comondu, Lower California, Mexico (altitude 700 feet)."

B. a. raptor (Baird, 1859:19) see above (*B. flavus* Rhoads, a synonym).

B. a. saxicola Merriam, 1897:185, see above.

B. a. willetti Stager, 1950:203. Type locality "Riverside Mountains, extreme northeastern corner of Riverside County, California."

B. a. yumanensis Huey, 1937:357. Type locality "Tinajas Altas, Gila Mountains, Yuma County, Arizona."

DIAGNOSIS. *Bassariscus astutus* differs from *B. sumichrasti*, its only relative, as follows: it is typically $\pm 24\%$ smaller and shows more contrasting facial and tail markings. Dorsal pelage is typically gray, with yellowish tinges, rather than sooty brown, and ventral pelage is whitish to buff rather than gray or tan. Muzzle is grayish rather than blackish and only moderately elongate. Ears are oval, narrowly rounded, and about 7% longer than in *B. sumichrasti* (Nelson and Goldman, 1932). Hind limbs are longer, giving a distinct downward slant of the body toward the head. Feet are grayish-buff rather than blackish, with naked digital pads surrounded by hair, except behind first digits; soles are naked in *B. sumichrasti*. Claws are short, straight, and semi-retractile rather than long, curved, compressed, and non-retractile (Hall, 1981; Leopold, 1959). The tail is approximately the length of the head and body, with seven or eight black rings alternating with white rings; the black rings are broken by white on the ventral surface, the terminal black band tipping the tail. In *B. sumichrasti* the tail is distinctly longer ($\pm 11.5\%$) than the head and body, with nine unbroken black rings alternating with the grayish rings in the proximal two-thirds of the tail; the distal third being nearly uniformly black. Tail diameter of *B. astutus* approximates body diameter when tail hairs are erected. Bacula of *B. astutus* have a shaft that bends upward, then downward, and the distal end is flattened dorso-ventrally with a lateral expansion; in contrast, the shaft is nearly straight with a condyle-like tip that has two ventral tubercles proximal to it in *B. sumichrasti* (Burt, 1960).

GENERAL CHARACTERS. Ringtails have a head and body resembling that of an American marten (*Martes americana*), with a distinctly annulated tail about head-body length (Fig. 1). Muzzle is elongate, pointed, and grizzled; nose pad is blackish. Mystical vibrissae mostly black and up to 75 mm long (Grinnell et al., 1937). Eyes have chestnut-brown iris and round pupil, are large and ringed with black or dark brown pelage, and are bounded by supraorbital, suborbital, and subauricular patches of white or pale buff (Hall, 1981) creating a striking "mask." A white fleck on center of forehead or back of muzzle, not related to subspecies, age, or sex, may be present. Eyelids black-edged; a black line extends from the medial



FIG. 1. Adult male *Bassariscus astutus arizonensis* from North McDowell Mountains, Maricopa Co., Arizona. Photograph by I. Poglayen-Neuwall.

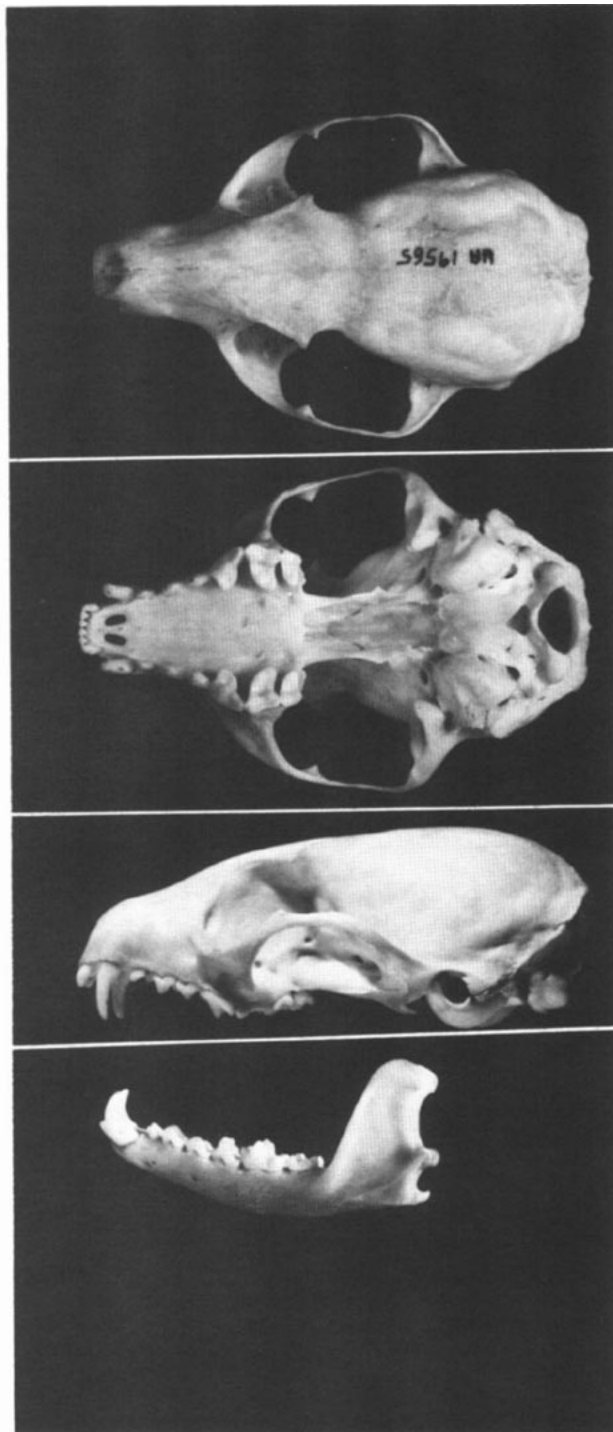


FIG. 2. Dorsal, ventral, and lateral views of skull, and lateral view of mandible of adult male *Bassariscus astutus arizonensis* from Chiricahua Mountains, Cochise Co., Arizona. Condylbasal length 72.1 mm (Univ. Arizona). Photographs by A. E. Gondor.

part of the upper lid through the white eye ring toward the forehead. Facial vibrissae well developed. Ears large, oval, thin, with well-developed bursa, covered with dusky cinnamon-drab hair becoming whitish on the edge of inner pinnae (Grinnell et al., 1937).

Body pelage ranges from stony gray through light brown to golden tan, with longer, black-tipped guard hairs and plumbeous underfur on upper body. Hair color paler on sides and dark down the middle of back. Dorsal coloration related to habitat (Dice and Blossom, 1937; Hardy, 1945), although as a general rule, darker upper body pelage commonly is associated with animals from northerly or higher-altitude populations; ringtails in more southerly or

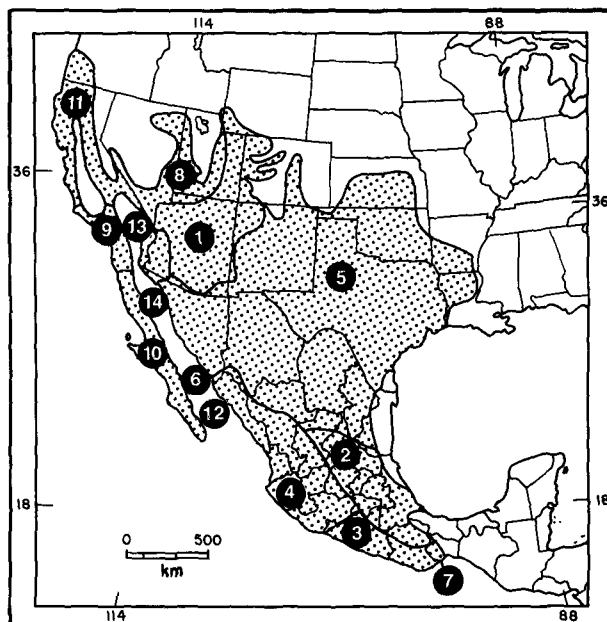


FIG. 3. Distribution of *Bassariscus astutus* (map modified from Hall, 1981): 1, *B. a. arizonensis*; 2, *B. a. astutus*; 3, *B. a. bolei*; 4, *B. a. consitus*; 5, *B. a. flavus*; 6, *B. a. insulicola*; 7, *B. a. macdougalli*; 8, *B. a. nevadensis*; 9, *B. a. octavus*; 10, *B. a. palmarius*; 11, *B. a. raptor*; 12, *B. a. saxicola*; 13, *B. a. willetti*; 14, *B. a. yumanensis*.

lower elevations tend to be lighter in color. Underparts white or pale buff (Grinnell et al., 1937; Hall, 1981). Melanism has been reported (Hoffmeister, 1960). In *Bassariscus* the length and thickness of the shaft of dorsal guard hair is shorter and thinner than in other procyonids, with a maximum length of 25 mm and width $\leq 100 \mu\text{m}$ (Mayer, 1952).

Feet are semi-plantigrade and pentadactyl; second, third, fourth, and fifth digits of fore and hind feet densely haired on lower surface behind and around digital pad; first digit naked posteriorly (Grinnell et al., 1937; Hall, 1981). Pads naked and pinkish. Claws short, straight, semi-retractile (Hall, 1981).

Tail long and solidly white or pale buff underneath; as viewed from above it is strikingly annulated. Bands narrow at base of tail, not distinct, and rather wood brown in color. Bands increase in width distally. Fur on the tail is short, averaging only about 10 mm in length on dorsal portion midway on tail; guard hairs at the same point average about 50 mm. The tail is parallel-sided, not tapering, somewhat flattened rather than cylindrical in cross section and about 70 mm wide (Grinnell et al., 1937).

Skull elongate with light zygomatic arches; braincase slightly flattened and expanded laterally (Fig. 2). Postorbital processes well developed from frontal and moderately from zygomata; sagittal crest lyrate. Posterior border of maxillary portion of zygoma lies at the plane of M1; palate extends slightly posterior to posterior margin of molars; tympanic bullae well inflated; foramen ovale opens somewhat downward (Durrant, 1952; Grinnell et al., 1937; Hall, 1981; Kortlucke, 1984). Ranges of skull measurements (in mm) for adults of both sexes from throughout the range are as follows: basilar length, 68 to 75; zygomatic breadth, 48 to 52; mastoid breadth, 33 to 35 (Hall, 1981). As a rule, males have larger, more sharply ridged skulls than females of corresponding age (Grinnell et al., 1937); characteristics of skull associated with age include pattern of closure of skull sutures, development of sagittal crest, and tooth wear (Towell, 1976). Dental formula: $i\ 3/3, c\ 1/1, p\ 3/4, m\ 3/2$, total 40. Cusps in large molariform teeth have high connecting ridges; upper carnassial irregular in outline, P4 sectorial; deutercone present; M1 subquadrate to triangular, broader than long; canines are smooth, slightly curved; and the cutting edges of I1 and I2 are normally smooth (Hall, 1981). The vertebral formula is 7 C, 13 T, 7 L, 3 S, and ± 25 Ca (Baird, 1859).

Maximum and minimum external measurements (in mm) for adult *B. astutus* of both sexes from throughout the geographic range of the species are: total length, 616 to 811; length of tail, 310 to

438; length of hind foot, 57 to 78; length of ear from notch, 44 to 50 (Hall, 1981); body mass, 870 to 1,100 g. Individuals of *B. astutus* are medium-sized in the Pacific Northwest, New Mexico, Texas, and across the northern plateau of Mexico, and smaller in the interior West, Southwest, and Baja California. The largest individuals occur in southern Mexico (Kortlucke, 1984).

DISTRIBUTION. The geographic range of *B. astutus* (Fig. 3) extends from the southern provinces of Guerrero, Oaxaca, Veracruz (where ranges of *B. astutus* and *B. sumichrasti* overlap) northward throughout Mexico, including Baja California and the islands of San José, Espiritu Santo, and Tiberón in the Sea of Cortez, and through the Southwest into the northwestern one-third of the United States (Hall, 1981; Leopold, 1959). Outlying records of *B. astutus* such as those from eastern Oregon (Bailey, 1936), Ohio (Bole and Moulthrop, 1942; Goodpaster and Hoffmeister, 1968), and Montgomery Co., Alabama (Brannon, 1922) likely represent escaped captive animals; the ability of ringtails to survive in non-native habitats is well documented (Baird, 1859; Edwards, 1955). Although recorded at elevations of 2,000 to 2,900 m (Moran, 1979; Nelson, 1918; Olin, 1975; Richards, 1968, 1976), they are usually found at elevations ranging from sea level to about 1,400 m.

FOSSIL RECORD. The genus *Bassariscus* is represented by several species from the Miocene of Nebraska, Nevada, and California (Hall, 1927; Kurtén and Anderson, 1980). Characters of the genus, although primitive compared to recent specimens of *B. astutus*, are strongly developed and suggest genetic departure from other lines of Procyonidae no later than the Oligocene (Hall, 1927). The Blancan species *B. casei* was probably directly ancestral to extant ringtails (Kurtén and Anderson, 1980). Another species, *B. sonoiensis* of the late Pleistocene of southern Arizona and Mexico, may have been intermediate between *B. astutus* and *B. sumichrasti* (Skinner, 1942). Recent material representing *B. astutus* has been found within the present range of the species in Arizona, California, Nevada, New Mexico, Texas, and Utah (Mead and Van Devender, 1981). Owing to the propensity of the species to use protective rocky caves and crevices in arid country as den sites, considerable material has been preserved. Mead and Van Devender (1981) reported 22 taxa including 6 mammal, 3 bird, 7 lizard, and 6 snake species in the late Holocene diet of ringtails from Vulture Cave in Grand Canyon, Arizona, on the basis of preserved fecal materials. The most abundant prey taken was *Neotoma*; all prey items presently occur in the immediate vicinity of the site.

FORM AND FUNCTION. Seasonal molt begins in late summer and is completed by late fall. Replacement of juvenile pelage with adult pelage starts around the mammae, under the forelegs, and under the throat, and proceeds anteriorly and posteriorly over the venter. When ventral pelage replacement is nearly complete, replacement of dorsal pelage begins above each eye and below each ear, and proceeds posteriorly (Toweill and Toweill, 1978).

Shoulder morphology of *B. astutus* differs from the generalized carnivore condition, foreshadowing conditions of the bears, and is more primitive than in *Nasua* and *Procyon* (Davis, 1949). On the basis of arterial pattern *Bassariscus* and *Bassaricyon* are intermediate between *Procyon* and *Potos*. *Bassariscus* is the only procyonid exhibiting the primitive condition of basicranial origin of the large occipital artery (Story, 1951). The vessel pattern of the arteries of the forearm in *Bassariscus* is most closely related to that of the Ursidae (Davis, 1941).

Electrophoretic analysis demonstrated that *B. astutus* and *Nasua narica* as well as five mustelid species have two major hemoglobins in approximately equal concentrations, whereas Canidae, Ursidae, other Procyonidae, and Mustelidae have only one hemoglobin (Seal, 1969). Antiserum prepared to *Ursus americanus* serum albumin, and *Procyon lotor* have been used for phylogenetic inferences. The results placed the Ursidae closest to the Procyonidae. The procyonids were closely grouped, supporting the placement of these genera in one family (Seal et al., 1970).

Normal body temperature of ringtails is 37.6°C (Burton, 1962). Heat stress caused by excessive ambient temperatures is evidenced by panting and inertia (Chevalier, 1984). The structure of the auditory bulla of *B. astutus* was described by Pocock (1928), and Segall (1943) examined ossicles and reported that the malleus closely resembled the mallei of the Ursidae, *Ailuropoda*, and *Ailurus*. Visual response to a brightness test described by Gossette and Kraus (1968) revealed performance by *B. astutus* superior to that of *Mephitis*

mephitis and *Potos flavus*, but inferior to *Saimiri sciurus*. Mystical vibrissae help orient the animal in dark, narrow crevices and in food detection, and tactile sensory hairs on the forearm of ringtails aid in prey capture (Toweill and Toweill, 1978; Welker and Campos, 1963).

Bassariscus astutus possesses no coecum. Feces typically occur in 1 to 4 segments with a mean diameter of 9.6 mm ($SD = 1.9$; range, 1 to 13) and a total length (all segments) of 75.7 mm ($SD = 56.1$; range, 15 to 601) (Trapp, 1973). *Bassariscus* possesses paired anal glands lateral to the anus (Pocock, 1921). Glands open via single ducts cranial to the sphincter and discharge a pungent, cream-colored secretion (Toweill and Toweill, 1978). Ringtails are dependent on open water (Armstrong, 1975; Cahalane, 1947; Carnes, 1965; Grinnell et al., 1937; Seton, 1929; Taylor, 1954). Kidney function is highly modified for water conservation, allowing ringtails to maintain water balance in the absence of open water, provided that an abundant diet of high protein prey is available (Richards, 1976) or a diet of succulent fruits, berries, and insects is utilized (Chevalier, 1984). Ringtails can produce urine concentrations among the highest known within the order (3,641 mOsm/l) when water-stressed (Richards, 1976).

Male reproductive organs include paired scrotal testes, epididymides and vasa deferentia; they possess a well-developed baculum, the simplest among procyonids (Burt, 1960; Pocock, 1921). Length of baculum averages 45 mm. Changes in bacula associated with age include thickness, degree of taper, and enlargement of basal end (Wood, 1952).

Reproductive organs of females consist of paired ovaries, complete ovarian bursae, oviducts, a bicornuate uterus, and a single vagina. A cartilagenous os clitoridis is located within the glans clitoridis, dorsal to the urethral orifice (Arata, 1965). Placentation is endo-tiliochorial zonary; implantation of embryos may occur in either or both horns of the uterus. Through much of the year ovaries demonstrated moderate follicular activity with vesicular follicles in an atretic state. Primary and secondary follicles were more active in April and May. Rapid degeneration of luteal tissue was evidenced by lack of identifiable corpora lutea or corpora albicantia by mid-June (Snyder, 1977). There are four functional mammae, arranged in two pairs (Grinnell et al., 1937; Richardson, 1942); five (Poglayen-Neuwall and Poglayen-Neuwall, 1987; Toweill and Toweill, 1978) and six mammae have been reported (Burt and Grossenheider, 1976).

ONTOGENY AND REPRODUCTION. The breeding season extends from February into May, but most breeding occurs in March and April (Bailey, 1974; Fry, 1926; Poglayen-Neuwall and Poglayen-Neuwall, 1980a; Taylor, 1954; Toweill, 1976). Ringtails are monestrous; estrus is manifested by vulval tumescence, beginning 6 to 14 days before copulations. The female is receptive to the male during a period of 24 (Poglayen-Neuwall and Poglayen-Neuwall, 1980a) to 36 h (Bailey, 1974). A postpartum estrus may occur, although it is apparently rare (Poglayen-Neuwall and Poglayen-Neuwall, 1980a). Gestation ranges from 51 to 54 days, the shortest among procyonids. Recurrent vulval swelling and hair loss around the mammae are indications of pregnancy (Poglayen-Neuwall and Poglayen-Neuwall, 1980a).

Parturition usually occurs in May or June (Bailey, 1974; Poglayen-Neuwall and Poglayen-Neuwall, 1980a; Richardson, 1942; Toweill and Toweill, 1978). Litter size usually ranges from one to four (Bailey, 1905; Davis, 1960; Fry, 1926; Grinnell et al., 1937; Poglayen-Neuwall and Poglayen-Neuwall, 1980a; Richardson, 1942; Snyder, 1977; Taylor, 1954; Toweill and Toweill, 1978), but five young have been reported (Cahalane, 1947; Lechleitner, 1969).

Newborns are altricial with sealed eyelids, closed ear canals, and with fuzzy hair on their back (Bailey, 1974; Davis, 1960; Richardson, 1942; Toweill and Toweill, 1978). Mass of newborns is 14 to 40 g each ($\bar{X} = 22$), corresponding to about 3% of maternal mass (Toweill and Toweill, 1978). Eyes open at 21 to 34 days and ears at 18 to 30 days postpartum (Richardson, 1942; Toweill and Toweill, 1978). At 6 weeks young are fully furred and drooping pinnae begin to become upright as in the adult (Richardson 1942; Toweill and Toweill, 1978). Deciduous teeth appear between 3 and 4 weeks, permanent dentition is complete at 17 to 20 weeks (Toweill and Toweill, 1978). Solid food is taken at 30 to 40 days (Richardson, 1942; Toweill and Toweill, 1978). Young walk well at 6 weeks, climb at 8 weeks, are weaned about 10 weeks (Toweill and Toweill, 1978). Testes, measuring 4 mm, descend at 16 weeks. Young

ringtails attain full size at about 30 weeks (Richardson, 1942; Toweill and Toweill, 1978).

Sexual maturity in both sexes is attained near the end of the second year, but successful matings of young-of-the-year have been reported (Poglayen-Neuwall and Poglayen-Neuwall, 1980a). Longevity in captivity averages 12 to 14 years (Crandall, 1964) with a maximum of 16.5 years (Poglayen-Neuwall, 1987).

ECOLOGY. The great horned owl (*Bubo virginianus*) is probably the major predator; others include coyotes (*Canis latrans*), raccoons (*Procyon lotor*), and bobcats (*Felis rufus*) (Errington, 1967; Mollhagen et al., 1972; Sumner and Dixon, 1953). Carcasses of ringtails killed by mammalian predators were not fed upon on several instances, perhaps because of the strong flavor of the flesh (Bradley and Hansen, 1965; Halloran, 1947; Sumner and Dixon, 1953). Diseases such as rabies, feline and canine panleucopenia, and parasites may play a large part in population control. Known ectoparasites of *B. astutus* are the fleas *Pulex simulans*, *P. irritans*, *Malariaeus sinomus*, *Anomopsyllus nudatus*, *Orchopeas sexdentatus*, *Polygnus gwyni*, *Hoplopsyllus affinis*, the mites *Enschoenegastia eadsi*, *Pseudoschoengastia apista*, *Encheyletia hardyi*, *Cheyletus eruditus*, *Dermacarus hypudei*, *Hirstionyssus breviseta*, *H. staffordi*, *Androlaelaps fahrenheitzi*, the louse *Neotrichodectes thoracicus*, and the ticks *Dermacentra variabilis*, *D. parumapertus*, *Haemaphysalis leporispalustris*, *Ixodes kingi*, *I. conepati*, *I. cooki*, *I. texanus*, *Amblyomma americanum* (Beck et al., 1963; Custer and Pence, 1979; Toweill and Price, 1976). Endoparasites are Cestodes such as *Taenia martis*, *Mesocestoides*, and the Nematodes *Pneumospirura bassarisci*, *Physaloptera*, *Uncinaria lotoris*, and *Macracanthorhynchus ingens* (Pence and Stone, 1977; Pence and Willis, 1978; Price, 1928).

In the southernmost part of the range where *B. astutus* and *B. sumichrasti* are sympatric, the latter is a competitor in rocky outcroppings frequented by both species (Alvarez del Toro, 1977). Although *B. astutus* is sympatric with either *Urocyon cinereoargenteus* or *Vulpes macrotis* over much of its range, these species are not true competitors because they differ in mode of habitat usage, technique of habitat exploitation, and temporal use of habitat and food habits (Chevalier, 1984; Trapp, 1973, 1978). Ringtails shared den sites with *Conepatus mesoleucus* and *Dasyops novemcinctus* in Kerr Co., Texas (Toweill and Price, 1976). There is evidence of competition for food with *Procyon lotor*, *Didelphis marsupialis*, *Urocyon cinereoargenteus*, and *Mephitis mephitis* (Wood, 1952). *Bassariscus* typically yields to *Urocyon*, *Procyon*, *Mephitis*, and *Spilogale* or there is mutual avoidance (Gander, 1965a, 1965b; Ingles, 1954; Lemoine, 1977).

Ringtails exploit a variety of habitats; they occur in broken, semi-arid country characterized by oak (*Quercus*), pinyon pine (*Pinus edulis*), or juniper (*Juniperus*) woodland, may also inhabit montane conifer forests, chaparral, desert, and dry tropical habitats, provided there are rocky outcroppings, canyons, or talus slopes present. The relative abundance of food in riparian forests, as well as the availability of open water, attracts ringtails (Davis, 1960; Grinnell et al., 1937; Lacy, 1983; Toweill and Teer, 1980). *B. astutus* dens most often in rock crevices, boulder piles, or talus, but also uses hollows in trees and under roots, burrows dug by other animals, brush piles and rural buildings (Chevalier, 1984; Davis, 1960; Grinnell et al., 1937; Toweill and Teer, 1980; Trapp, 1978).

Population density has been estimated (mark/recapture) as high as 10.5 to 20.5 individuals/km² in the northern Central Valley of California (Belluomini, 1983; Belluomini and Trapp, 1984). Lacy (1983) estimated a density of 7 to 20 individuals/km² from a radiotelemetry study in the Central Valley that concentrated along shorelines of ponds and sloughs. Grinnell et al. (1937), estimated a density of 0.08 to 2.3 individuals/km² in the chaparral country of the Pacific drainage of the Sierra Nevada, California. Based on radio-monitoring of free-ranging ringtails, density estimates of 1.5 to 2.9 individuals/km² were derived for Zion National Park, in a habitat with a mixture of pinyon pine, juniper woodland, blackbrush (*Coeologyne*), and riparian vegetation (Trapp, 1973, 1978), and 2.2 to 4.2/km² for Edwards Plateau, Texas, a habitat characterized by juniper and oak woodland (Toweill and Teer, 1980).

Ringtails typically do not construct or modify dens (Toweill, 1976; Trapp, 1978), although they may construct a nest of dried grass (Toweill, 1976). They change dens frequently; an individual rarely spends more than three consecutive days in the same shelter, except during inclement weather. Two females with new litters began

to move their young from den to den 10 days after giving birth. They moved the young almost daily after day 20 (Toweill, 1976).

Seasonal shifts of home ranges occur on the Edwards Plateau (Toweill and Teer, 1980), and in Zion National Park some individuals use completely different home ranges in different months (Trapp, 1978). Home range areas used by ringtails vary widely, by habitat, estimation techniques, and perhaps by sex. Lacy (1983), using the atypical habitat elimination method of Ables (1969), reported that four home ranges in riparian habitat ranged from 5.0 to 13.8 ha during 8 months. Home range areas used by *B. astutus* (minimum convex polygon) over a 15-month period in an oak woodland averaged 43.4 ha (35 and 51.7 ha) for two males and 20.3 ha (15.7 to 27.7 ha) for three females (Toweill and Teer, 1980). In another study, a mean home range (modified minimum area) for nine males and four females averaged 136 ha (49 to 233) over a 1 to 2-month period in canyonlands of Zion National Park. Little or no intrasexual overlap in ringtail home ranges was found, although home ranges of males and females regularly overlapped (Trapp, 1978).

Ringtails, although omnivorous, show a preference for animal matter. Principal food items are arthropods, mammals, and fruits. Seasonal diet varies with food availability and location. Arthropods of the orders Orthoptera, Coleoptera, and Lepidoptera are favored as are arachnids (Davis, 1960; Taylor, 1954; Toweill and Teer, 1977; Trapp, 1973; Wood, 1952). Mammals eaten typically include cricetine rodents, rabbits (*Sylvilagus*), hares (*Lepus*), squirrels (*Spermophilus*), and carrion (Davis, 1960; Taylor, 1954; Toweill and Teer, 1977; Trapp, 1973; Wood, 1952). Plant matter eaten includes *Juniperus*, *Celtis*, *Diospyros*, *Quercus*, *Ficus*, *Phoradendron*, *Arbutus*, *Arctostaphylos*, *Opuntia*, *Cereus giganteus*, and *Pinus cembroides* (Davis, 1960; Taylor, 1954; Toweill and Teer, 1977; Trapp, 1973; Wood, 1952). Nectar feeding from *Agave havardiana* has been reported (Kuban and Schwartz, 1985). Birds, including *Falco peregrinus* (White and Lloyd, 1962), passerines, Columbinae, and Percidinae complete the diet along with cold-blooded vertebrates, chiefly lizards and snakes and occasionally frogs and fish (Davis, 1960; Taylor, 1954; Toweill and Teer, 1977; Trapp, 1973; Wood, 1952). Grinnell et al. (1937) indicated the average mass of a ringtail meal was 55 g, whereas Howard (1957) mentioned 90.6 g; about 10% of ringtail body mass. A captive *B. astutus* ate 20 to 25 g of dry cat food and raisins daily (Toweill and Teer, 1977). Protection of habitat by regulation of grazing and wood cutting is of benefit to this procyonid (Kaufmann, 1982).

Bassariscus commonly seeks food and shelter among human habitations in rural and urban areas and is harvested as a furbearer. In Texas, the harvest is estimated at 75,000 to 100,000 ringtails annually (Deems and Pursley, 1983). Fur is of poor quality and used as trim only (Leopold, 1959). Although ringtails have legal protection in many states, many fall victim to traps set for other furbearers. Animals may be anesthetized for handling with ketamine hydrochloride given intramuscularly, or tranquilized with Tranvet 25 given orally (Trapp, 1978).

BEHAVIOR. Ringtails rarely are active in daytime (Atkinson, 1934; Davis, 1960; Grinnell et al., 1937; Sumner and Dixon, 1953), and behavior studies indicate an aversion to daylight beginning soon after birth (Toweill and Toweill, 1978) that persists through adulthood (Kavanau and Ramos, 1975). Of 390 observations at a feeding station, 93.6% were after dusk and 6.4% occurred during dusk. Activity of radio-tracked individuals showed 46.8% beginning in darkness, 26.4% beginning in dusk, 8.8% within 45 min before dusk ($n = 34$). Termination of activity was noted to be 42.3% in darkness, 34.6% at dawn, and 23.1% within 45 min after sunrise ($n = 26$; Trapp, 1978). Seton (1929) mentioned that they may bask in early morning sun. Kavanau (1971) found them active only during night and twilight.

Telemetry studies have shown no tendency toward monogamy but indicate a social structure based on land tenure (Toweill, 1976; Trapp, 1978). Ringtails occur singly or as pairs in local concentrations, with individuals denning separately (Grinnell et al., 1937). In captivity, unlike in the wild, adults, regardless of sex or season, may sleep together in the same nest box (Richardson, 1942; Trapp, 1972). Depending on the ambient temperature, ringtails may sleep on their side in warm weather, on their back with rear legs spread and forelegs in the air during hot weather, or curled with feet under the body, head against the belly, and tail wrapped around the body when the weather is cold (Toweill and Toweill, 1978).

Grinnell et al. (1937) reported grooming of an adult male by

an adult female, a behavior which, in this species, seems restricted to maternal care. Self-grooming consists of a cat-like licking of the forepaws, followed by wiping motion from behind the ears over the head and down the muzzle. This activity may be followed by scratching with front or rear feet, combing with claws or teeth, or rubbing on a nearby rough object (Poglayen-Neuwall, 1973; Towell and Towell, 1978).

Play has been observed at 45 days, consisting of batting one another with forepaws and pouncing on each other. By 70 days, play included picking up objects with the mouth, tossing them with a flip of the head, and pouncing on them when they landed (Poglayen-Neuwall, 1973; Towell and Towell, 1978). Sexual play was first reported among 13-week old ringtails (Bailey, 1974). Defensive behavior in young animals, accompanied by an explosive bark and release of musk from the anal glands was described at 47 days (Towell and Towell, 1978). Food defense became apparent at 80 days, and consisted of bristling of the tail hair and growling. Repeated barking and attempts to bite an intruder occurred at about 100 days (Towell and Towell, 1978).

Ringtail vocalizations were recorded and analyzed audiospectrographically by Bailey (1974), Peters (1984), Richards (1976), and Willey and Richards (1981). Vocalizations include metallic chirps, squeaks, and whimpers (infant vocalizations), chitters, (juvenile distress, female copulatory and labor stress vocalizations), chucking and barks (alarm, defensive threats), hisses, grunts, growls, ululations (aggressive vocalizations) (Bailey, 1974; Gander, 1965a; Willey and Richards, 1981). Scent seems to be as important as vocalizations for communication within the species. Urine is rubbed on the ground and on raised objects (Kaufmann, 1982; Poglayen-Neuwall, 1973) as a home range marker, and latrine areas with accumulations of feces are typical (Lemoine, 1977; Mead and Van Devender, 1981; Poglayen-Neuwall, 1973; Towell, 1976; Trapp, 1978). Increased localized urine deposits and scattered defecation are apparent just before and during the mating season (Bailey, 1974).

At the peak of estrus, the male chases and frequently copulates with the female. He typically mounts the female several times per hour in a sitting position, grasping her anterior to the pelvis with his forefeet. Copulation consists of repeated quick thrusts by the male, followed by brief pauses. Thrusting periods average a few seconds, and the male usually maintains his hold for 1 to 2 min. Females utter a typical mating chitter before and during copulations, and sometimes also in the absence of the male (Bailey, 1974). Pairs may stay together, but the male is excluded from use of the den 3 to 4 days before parturition. The female may allow the male to rejoin her about 3 weeks later (Fry, 1926).

Parturition observed in six females lasted from 85 to 126 min; expulsion of fetus lasted from 2 to 47 min ($n = 13$, $\bar{X} = 14$). Intervals between expulsions ranged from 7 to 49 min ($n = 10$, $\bar{X} = 24.4$). The young usually are born head first. Placentophagia occurs regularly (Poglayen-Neuwall and Poglayen-Neuwall, 1980a).

In the first days after birth, the mother nurses in a hunched, sitting position, later more often in lateral recumbency (Towell and Towell, 1978). She may move the young with a forepaw to the mammary region (Richardson, 1942). The young show no nipple preference. They search at random, swinging their head from side to side, pawing and poking the nose into the fur of the mother until a nipple is reached. Metallic squeaks accompany the search for the nipple. The newborn shows pronounced movement toward tactile stimuli and warmth (Towell and Towell, 1978).

Locomotion is accomplished in the newborn by bracing a foot to either side of the body and dragging the abdomen. Neonates right themselves by rolling toward a braced forefoot (Richardson, 1942). By 10 days of age, the rear legs contribute to forward locomotion, and the forepaws can be rotated to grasp objects. Between 37 and 45 days, they are able to hold the body off the ground for short distances (Richardson, 1942; Towell and Towell, 1978).

Until 3 to 4 weeks after birth, the young sleep stretched out. Later they curl up with their head tucked beneath the ventrum and the tail wrapped around the body like the adult (Bailey, 1974; Towell and Towell, 1978). Upon disturbance the mother grasps the young at its shoulder or head and carries it around until her excitement subsides. During transport, the young becomes limp (Richardson, 1942).

Excrement of young is consumed by the female until the young begin to take solid food. Although young void randomly at 3 weeks of age (Bailey, 1974; Richardson, 1942), by 120 days of age, they develop localized "toilet" areas (Towell and Towell, 1978). Partic-



FIG. 4. G-banded karyotype of female *B. astutus arizonensis* from Santa Catalina Mountains, Pima Co., Arizona, $2n = 38$, karyotype arranged as in Wurster-Hill and Gray (1975) to show that most of *B. astutus* chromosomes are shared with felids, four (A, B, C, E,) are modified from their felid counterparts and three (boxed) have no felid counterparts. Felid homologs A_2 , C_2 , C_3 , E_4 , E_5 , and F_1 are lacking in *B. astutus*. Photograph by O. G. Ward.

ipation in the provisioning of young by both parents, starting around 3 weeks, has been reported (Fry, 1926; Lechleitner, 1969), although Towell and Towell (1978) and Trapp (1972), based on telemetry data, assigned this task to the female alone. The metallic squeaks of the infant gradually disappear and are replaced at 10 weeks by a spitting, explosive bark (Towell and Towell, 1978). Chevalier (1984) and Poglayen-Neuwall and Poglayen-Neuwall (1980b) reported licking of saliva from inside the mother's mouth by the young during the transition period, when the milk supply diminishes and young are not sufficiently mobile to follow her on extended excursions; this behavior may be a method of providing additional fluids for the young.

The young begin to forage with the mother between 60 and 100 days of age (Fry, 1926; Gander, 1956a; Kaufmann, 1982; Towell and Towell, 1978). Towell and Towell (1978) saw a family of one adult and two young, approximately 100 days old rapidly searching over the ground, and descending trees head first. Both young remained within 5 m of each other, but the adult occasionally moved 10 to 15 m from either young. When eating, food items such as small rodents and lizards are pinned with the front feet. Feeding commences at the head. Large fruits are also pressed to the ground, and small pieces bitten off (Grinnell et al., 1937).

Ringtails progress in a steady, gliding motion with tail carried straight out behind, barely clearing the ground. Rather than jumping from rock to rock, they crawl over and around obstacles (Grinnell et al., 1937; Trapp, 1978). There are two modes of walking: a crouch-like low walk, probably used more under conditions of apprehension, and the high, confident walk with legs extended (Trapp, 1978). They cross open spaces with the tail arched over the back toward the head, making the animal appear larger and the tail functioning as a decoy for predators (Gander, 1965a; Ingles, 1965; Lemoine, 1977; Trapp, 1972). Ringtails scale cacti with apparent impunity (Chevalier, 1984), and have locomotory adaptations for ricocheting, chimney stemming, and accurate power leaps (Trapp,

1972). Vertical descents, head first, are accomplished by rotating the hind foot 180°, allowing pads and claws to retain contact with the substrate (Trapp, 1972).

GENETICS. The diploid chromosome number of all procyonids is 38 (Wurster and Benirschke, 1968; Wurster-Hill and Gray, 1975). The karyotypes are similar and include a large number of felid homologs (Wurster-Hill and Gray, 1975), though felids and procyonids are only distantly related. *B. astutus* has a karyotype of $2n = 38$, $fn = 68$, which includes a large submetacentric X chromosome (Fig. 4) and a small acrocentric Y. In addition, it has the small submetacentric marker chromosome satellited on the short arms that is possessed by most carnivores.

REMARKS. The scientific name, *Bassariscus astutus*, is derived from *bassar* (fox), *isc* (little), and *astut* (cunning), meaning cunning little fox (Jaeger, 1955). Vernacular names are ringtailed cat, bandtailed cat, cat squirrel, coon cat, coon fox, bassarisk, civet cat (because of its musk), and miner's cat (historically in mining camps, this animal was appreciated as a mouser). Cacomistle or cacomixtle, wide-spread names in the southern part of the range, are derived from the Aztec language. Babisuri is a name restricted to Baja California, Mexico. Although *B. astutus* and *B. sumichrasti* have many morphological characteristics in common (Kortlucke, 1984) and have overlapping ranges (Hall, 1981), no interbreeding has been reported.

We thank O. G. Ward for assisting in obtaining karyotypic analysis and I. Poglayen-Neuwall for assistance with this manuscript.

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