

Cryptoprocta ferox. By Michael Köhncke and Klaus Leonhardt

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***Cryptoprocta* Bennett, 1833**

Cryptoprocta Bennett, 1833:46. Type species *Cryptoprocta ferox* Bennett, 1833, by original designation.

CONTEXT AND CONTENT. Order Carnivora, Family Viverridae, Subfamily Cryptoproctinae (Simpson, 1945). The subfamily includes a single living species.

***Cryptoprocta ferox* Bennett, 1833**

Fossa

Cryptoprocta ferox Bennett, 1833:46. Type locality "from Madagascar."

Cryptoprocta typicus A. Smith, 1834:34. Type locality Madagascar.

CONTEXT AND CONTENT. Context noted in generic summary above. No subspecies have been recognized.

DIAGNOSIS. *Cryptoprocta* differs externally from other carnivores of Madagascar in being considerably larger and cat-like (Fig. 1). The combined characters of uniformly colored pelage, large size (largest of Viverridae other than *Macrogalidia* and *Viverra*), long tail (slightly shorter than head and body), semiplantigrade feet, retractile claws, rounded external ear, and relatively short face render it distinctive among viverrids. *C. ferox* somewhat resembles a small, short-legged, dark-colored puma (*Felis concolor*).

GENERAL CHARACTERS. Published measurements are few, and for most the method of measurement and the source of information are omitted. Measurements (in mm) of adult specimens are: length of head and body, 700 to 800; tail, 650 to 700; hind-foot, 120 to 128; body mass ranges from 7 to 12 kg (Albignac, 1973). Other measurements (in mm) of head and body are 600 to 750 (Haltenorth and Diller, 1977) and 850 to 900 (Grzimek, 1972). Nowak and Paradiso (1983) listed the height at the shoulder as 370 mm. Our measurements of mounted specimens in Rijksmuseum van Natuurlijke Historie, Leiden, indicated that the external ear was about 45 mm long and the hindfoot about 142 mm. Body size increases from the east to the southwest in Madagascar (Ljungquist, 1930). Males are slightly larger than females (Albignac, 1973).

The reddish-brown pelage blends to grayish on the dorsum; the underparts are nearly beige, and the tail is paler than the flanks. The pelage is without pattern or spots and it resembles the winter pelage of the European roe deer (*Capreolus capreolus*), but with a reddish tinge. Published details of the coloring of *C. ferox* differ greatly; however, all authors acknowledge the predominance of reddish brown. Vosseler (1929) stated that the underparts of males in rut are stained reddish, similar to that on male red kangaroos (*Macropus rufus*), although Albignac (1973) was unable to confirm this observation. Darker fossas (Decary, 1950; Joleaud, 1924; Ljung-

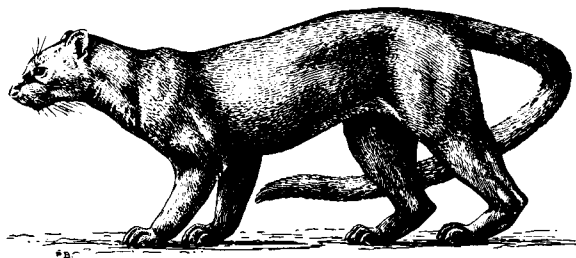


FIG. 1. Drawing of *Cryptoprocta ferox* (from Grassé, 1955).

quist, 1930) probably are melanistic rather than subspecifically distinct, as proposed by Kaudern (1915). The neonatal pelage is gray or nearly white, but adult coloration is attained after 6 months (Albignac, 1973; Kaudern, 1915). Body hairs are relatively short, straight, and dense.

DISTRIBUTION. *Cryptoprocta ferox* occurs throughout Madagascar and on the small island of Saint-Marie (Fig. 2) off the east coast of Madagascar (Kaudern, 1915). On Madagascar, fossas are common near Bongolava (in the NW near Majunga), on the E coast near Morondava, and on the NE coast near Antalaha (Albignac, 1973). They occur in forested areas including mountains to 2,000 m (Atringitra Mountains), but avoid treeless habitats (central highlands).

FOSSIL RECORD. Grandidier (1902) described material from the cave of Andrahamana, 40 km S of Fort Dauphin in southern Madagascar as a new subspecies, *C. f. spelea*. Petit (1935) redescribed the same subfossil cave material, but regarded it as a separate species and applied the name *C. spelea* to it. He described

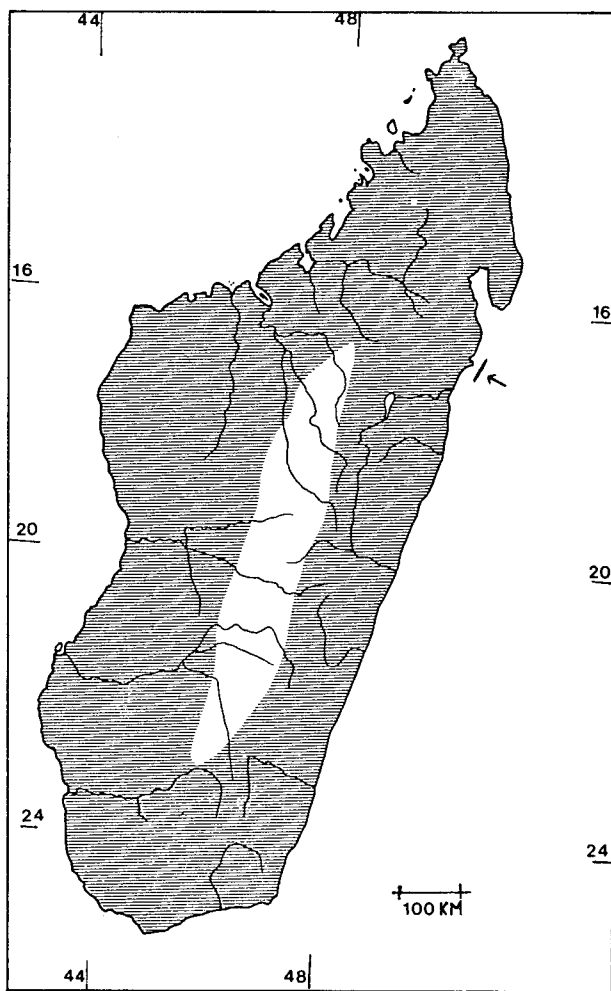


FIG. 2. Distribution of *Cryptoprocta ferox* on Madagascar (after Albignac, 1974). The arrow identifies the island of Saint-Marie.

it on the premise that the earlier appellation was a *nomen nudum*. We consider the earlier name valid because Grandidier (1902:592) gave a short but clear description "de grande taille," and thereby followed the *International Code of Zoological Nomenclature* (1958: Art. 12, 32[a], 45[e]j). Lamberton (1939) described the species, *Cryptoprocta antamba*, from subfossil material from near Triandrina in southern Madagascar.

Lamberton (1939) joined Petit (1935) in giving specific rank to *Cryptoprocta spelea* and in considering it subfossil. Two skulls labelled *C. spelea* on deposit in the Museum National d'Historie Naturelle, Paris (nos. 1977-755 and 1977-756), have condylo-basal lengths of 152 and 138 mm, respectively. In our opinion, the cranial differences between *C. ferox* and *C. spelea*, as understood and described by Lamberton (1939), can be explained by allometric changes in *C. spelea* with growth; therefore, the validity of *C. spelea* as a separate species is questionable. Skulls, teeth, and post-cranial materials identified as *C. ferox*, *C. spelea*, and *C. antamba* from different caves in central, southern, and southwestern Madagascar give no indication of the phylogeny of the Recent population because they are inseparable morphologically. *Palaeoprionodon* Filhol, 1880 (upper Eocene or lower Oligocene, Europe and Asia; Viverridae) is similar to *Cryptoprocta* (Simpson, 1945). *Proailurus* Filhol, 1879 (upper Eocene or lower Oligocene-Miocene, Europe) also has many viverrid-like characters but is a member of the Felidae (Simpson, 1945). Conversely, Simpson (1945) called *C. ferox* a viverrid with many cat-like characters. "Cats and viverrids were closely similar in the early Oligocene. . ." (Simpson, 1945:229).

FORM. The rhinarium is large and prominent as in other viverrids, but the large and rounded external ear with a lateral bursa resembles that of Felidae. The conspicuously long facial vibrissae, some even longer than the head (Bennett, 1835), are arranged as in other carnivores, but the interramal group in *C. ferox* and other viverrids is lacking in the Felidae (Pocock, 1916b). Carpal vibrissae are present as in some other viverrid genera (*Galidia*, *Herpestes*; Carlsson, 1911). The soles of the feet bear strong pads and are nearly naked (Albignac, 1970; Milne-Edwards and Grandidier, 1867). The claws are retractile but not hidden in skin sheaths as in Felidae. Perianal skin glands are contained in an anal sac surrounding the anus like a pocket as in Herpestinae (Carlsson, 1911). The anus lies within this pocket which opens to the exterior as a horizontal slit below the tail. A sternal gland that supposedly produces a reddish substance during rut in males (Vossele, 1929) could not be found by Albignac (1973). Other scent glands lie near the penis or vulva and on the neck (Albignac, 1973). Albignac (1973) mentioned that a strong odor emanates from scent glands near the penis. Prescrotal glands are absent as in Herpestinae (Carlsson, 1911; Grandidier and Petit, 1932). Scent glands are less developed in females. There are three pairs of teats; the composition of milk is unknown.

The skull of *C. ferox* is constricted behind the orbits (Fig. 3). The postorbital processes of frontal and jugal are short and do not meet to separate the orbit and temporal fossa. The alisphenoid extends some distance between the squamosal and frontal bones, a feature associated with the relatively long braincase and common in other Viverridae (Carlsson, 1911). The facial skull is shorter than in almost all other viverrids, but longer than in any felid. The heavily built masticatory muscles are large and robust at their origins. The sagittal and lambdoidal crests are well developed (Milne-Edwards and Grandidier, 1867), the zygomatic arch extends broadly from the skull, and the internal pterygoid process is long and supports the action of the strong internal pterygoid muscle (Carlsson, 1911). An alisphenoid canal is always present (present in Viverridae, except Galidiinae and sometimes *Eupleures* and *Cynogale*; lacking in Felidae and Hyaenidae, except sometimes present in *Crocuta*; Carlsson, 1911; Flower, 1869; Mivart, 1882; Pocock, 1916a). The carotid canal lies entirely within the basisphenoid, but has no contact with the petrosus (as in all Viverridae but none of the Felidae; Pocock, 1916c). The hypoglossal condyloid foramen is separated from the jugular foramen (= posterior lacerate foramen) by a bony wall as in *Galidia* and *Felis*; in *Herpestes*, *Viverra*, and *Paradoxurus* both foramina form a single opening (Carlsson, 1911; Petit, 1935). The bulla is typical of that of viverrids (Carlsson, 1911), probably exhibiting greatest affinity with that of *Viverra*. The bulla is united (synostosis) with the basisphenoid (Fig. 3) as in the Viverridae but not among Felidae (Pocock, 1916c). The tympanic bone (= ectotympanic) lies rostrolaterally and constitutes the smaller part of the bulla; it is in synostosis with the entotympanic, but is easily



FIG. 3. Dorsal, ventral, and lateral views of the cranium, and lateral and dorsal views of the mandible of an adult *Cryptoprocta ferox* (total length of skull is 140 mm; from Milne-Edwards and Grandidier, 1867).

distinguished as a separate bone. The tympanic is not inflated and there is no depression or hole in its ventral surface. The external auditory meatus is large, and its rim is more or less smooth and not extended like a spout (Fig. 3). Thus, the tympanic is different from that in Herpestinae. The large caudomedial entotympanic forming the larger part of the bulla is bony, mainly inflated caudally, and flattened on both sides (Flower, 1869). The paroccipital process resembles that of Herpestinae; it is flatly attached to the bulla caudally by its whole anterior surface and does not extend ventrally

to the bulla. The lower jaw is robust; its articular process extends farther posteriorly than its coronoid process (Fig. 3).

The condylobasal length (in mm) for five males (mean and range) and one female are: 128.7 (115.1 to 139.5) and 117.2, respectively. The dental formula for the permanent dentition is $i\ 3/3$, $c\ 1/1$, $p\ 3-4/3-4$, $m\ 1/1$, total 32 to 36, and for the deciduous dentition is $i\ 3/3$, $c\ 1/1$, $p\ 3/3$, total 28.

Carnassials (especially $m1$) and molars have an almost cat-like "grade of advancement" (Gregory and Hellman, 1939), whereas incisors and the remaining premolars are typical of the Viverridae (Carlsson, 1911). The upper canine is developed as in *Felis*, and $P1$ and $p1$ are small or missing in *C. ferox*; they are present in most Viverridae, but not in Felidae. Most authorities refer to these teeth as being of the second dentition, but the first premolars are not replaced in fissipeds. Both $P2$ and $p2$ have two roots (these teeth are missing in felids), and $P3$ has a talon, as in some other Viverridae but not in Felidae (Leche, 1915). The upper carnassial ($P4$) is large, sectorial, and of nearly the same shape as that in Felidae; $M1$ is small (as in *Felis*) and $M2$ is missing (as in Felidae, but in contrast to its presence in most Viverridae).

The similarity of the lower carnassial ($m1$) with that of the Felidae is related to the absence of a metaconid and the greatly reduced talonid; $m1$ in other Viverridae has a metaconid and larger talonid. Deciduous incisors are similar to those of other Viverridae; the deciduous canine is similar to that in *Herpestes* and *Viverra*, and unlike that of the Felidae. In the deciduous dentition, $dp2$ has two roots, $dp3$ is similar to that in Felidae, and $dp4$ is similar to that in *Genetta*.

The postcranial skeleton presents no unusual features (Milne-Edwards and Grandidier, 1867). The vertebral formula is $7C$, $13T$, $7L$, $3S$, and 29 or 30 Ca , total 59 or 60. The clavicle is small, 8 mm long in an adult female (Carlsson, 1911), and is fixed by ligaments to the sternum and scapula. The entepicondylar foramen of the humerus is present as in most non-Malagasy viverrids. The supraspinous fossa of the scapula is larger than the infraspinous one (ratio 1.5:1), as in *Galidia*, *Herpestes*, and *Felis*. The radius is shorter than the humerus and the tibia shorter than the femur (Carlsson, 1911).

Certain myological characteristics (Carlsson, 1911) are of interest for comparative studies: overall strong masticating musculature; existence of an intermediate tendon within the digastric muscle; long origin of the latissimus dorsi over 14 vertebrae; existence of teres minor and supinator brevis muscles; and unusual muscles in the soles of the feet (Beddard, 1895; Carlsson, 1911).

According to Carlsson (1911), herpestine features of the brain of *C. ferox* include the presence of a crucial sulcus, a short sylvian sulcus (missing in some herpestine species; Radinsky, 1975), and the absence of a presylvian sulcus. Unlike Herpestinae, there is a suprasylvian sulcus complete posteriorly and a postlateral sulcus medially (Radinsky, 1975). Beddard (1895) reluctantly described a short "fissure" (= sulcus) as the postsylvian, but Carlsson (1910) and Mivart (1885) emphasized that such was the sylvian sulcus. This agrees with the figures of the brain provided by Brauer and Schober (1970).

As typical in carnivores, the left lung has three lobes and the right four (Carlsson, 1911). Features of the circulatory system described to date are typical among the Feloidea (Beddard, 1895, 1907, 1909; Carlsson, 1910, 1911). The ramification of the aorta also follows the carnivore pattern (Carlsson, 1911).

The tongue is broad and rounded; Carlsson, (1911) reported two circumvallate papillae on each side, whereas Beddard (1895) reported three. The paucity of spiny papillae on the tongue and palatal ridges (eight) are reminiscent of Felidae. *C. ferox* has no *lyssa* (Carlsson, 1911) in contrast to viverrids and the domestic cat (*Felis catus*). The two parts of the thyroid gland are linked by a small isthmus (Carlsson, 1911). The stomach resembles that of the domestic cat (Beddard, 1895; Carlsson, 1911), being somewhat elongate with the pyloric part distinctly bent rostrally.

The unique structure of the external genitalia in both sexes was the primary reason that Pocock (1916b) and Lönnberg (1911) proposed a separate family for *C. ferox*. Penis and baculum (Didier, 1948) are extremely long; erected, the penis extends forward between the forefeet (Vosseler, 1929) and is nearly 20 mm thick. The baculum in adult males is between 58 (Carlsson, 1911) and 71 mm (Didier, 1948) long, and is about 3 mm thick. The glans occupies nearly half of the length of the penis and is spiny except at the tip (Carlsson, 1911). In felids the glans is extremely short and spiny; in viverrids it is smooth and long. The urethra opens immediately

below the tip of the glans. The clitoris is penis-like, with a well-developed preputium and an os clitoridis (about 16 mm long and 3 mm thick; Lönnberg, 1902) and a pair of scrotular sacs (glands of Bartholini; Carlsson, 1911) that form a scrotum-like structure. As in all Malagasy carnivores, the uterus of *C. ferox* is paired throughout its length (duplex uterus); each opens into the vagina with a separate cervix. All features of the genitalia occur in other carnivores, but the mosaic is unique to *C. ferox*.

Structural affinities to other groups of carnivores are as follows: those features associated with food and its acquisition (facial skull, teeth, tongue, and digestive tract) resemble those of the felids most closely; the skull, exclusive of the dentition, exhibits greatest resemblance to *Viverra*; some characteristics of the body are most similar to those of the Herpestinae.

ONTOGENY AND REPRODUCTION. Copulation occurs in September or October (Albignac, 1975) in wild *C. ferox* and parturition occurs in December or January (Albignac, 1969), indicating a gestation period of about 90 days. Köhncke (1985) found greater morphological affinities to other viverrids than to felids in the chondrocrania of fetuses 6 to 7 weeks of age. Birth of two to four young takes place in a concealed location such as a den or beneath a tree (Albignac, 1972). Each neonate weighs about 100 g (or less) and is furred, but toothless and blind (Albignac, 1969). Contrary to a statement by Albignac (1973), siblings are not always of the same sex (Köhncke and Schliemann, 1977).

Observations in zoos reveal that postnatal development is slow (Albignac, 1973, 1975). Eyes open after 2 to 3 weeks (Albignac, 1969, 1975), the young first leave the den after 4.5 months, then weaning takes place (Albignac, 1973). Permanent dentition appears before 20 months of age (Albignac, 1973; Bojer, 1834). Onset of sexual maturity is not before year 3 (Albignac, 1969). There is a longevity record of 17 years from the "Zoologischer Garten" in Hamburg, Germany (Vosseler, 1929), and a male of over 20 years is still living in the zoo at Duisburg, Federal Republic of Germany.

ECOLOGY. *Cryptoprocta ferox* is generally regarded as the main predator of lemurs, but the evidence is based on a single field observation by woodcutters (Albignac, 1973). Many foods are taken in captivity: insects, amphibians, reptiles, birds, and small to medium-sized mammals, including a ring-tailed lemur (*Lemur catta*; Albignac, 1973). In some accounts (Decary, 1950; Ljungquist, 1930; Louvel, 1954; Rand, 1935), *C. ferox* is described as a fierce predator on domestic animals, especially poultry, but also on goats and small calves. In the wild, *C. ferox* probably preys on other viverrids (Louvel, 1954), but it seems to have no predators of its own other than man.

Cryptoprocta ferox lives in virtually all climates on Madagascar and has no special habitat requirements except the presence of trees; it avoids open treeless regions. Unlike other viverrids of the island, it is not bound to the tropical rainforests. It is not viewed as greatly endangered at present, but is definitely declining in numbers (International Union for the Conservation of Nature and Natural Resources, 1978).

Sizes of territories or hunting areas for *C. ferox* have not been determined, but, in dense populations, each animal is estimated to require 1 km² (Albignac, 1973).

The tick, *Haemaphysalis obtusa*, is the only known parasite (Hoogstraal, 1953).

The zoo at Montpellier, France, was the first to succeed in breeding (Albignac, 1975) and handrearing (Albignac, 1969) fossas outside Madagascar. Other than at this zoo, few fossas are held in captivity.

BEHAVIOR. All *C. ferox* caught and observed were solitary except for one instance in which several males were noted with a female in estrus (Albignac, 1973). Courtship behavior of males has not been described. Females ready for copulation take a typical lowered stance during which the outer genital area is extruded 2 to 3 cm (Vosseler, 1929). Copulation usually lasts for more than 1 h (Albignac, 1975), but can last as much as 165 min (Vosseler, 1929) and takes place on the ground or on horizontal branches. The female mews during copulation (Albignac, 1975). Pregnancy is recognizable only a few days before birth by swelling of the mammae (Albignac, 1973). Young suckle for about 5 min at a time and put their forefeet on the belly of the mother while she lies on her side. Observations of some of the ontogenetic behavior of fossas in captivity include the first scent-marking by males (from glands in the genital region) at 7 months of age and by females (from glands in the anal

region) after 9 months (Albignac, 1973). Probably young part from their mothers at 15 to 20 months of age.

Cryptoprocta ferox is active mainly at dawn and at night, with a peak of activity in the hours before dawn (Albignac, 1973; Grandidier and Petit, 1932). They also have been observed in the field during the day. In captivity, *C. ferox* can change to diurnal activity. The mating season (during spring months of September and October in wild *C. ferox* shifted to April and May in specimens maintained in the "Zoologischer Garten" in Hamburg (Vosseler, 1929).

Intraspecific communication consists of relatively long-lived scent marks made by both sexes, a few acoustical signals (threatening call, mewling by female during copulation, purring), and visual signals (expression of the face and of the whole body), but nothing is known about their exact messages (Albignac, 1973).

Fossas move in a more digitigrade fashion on the ground and more plantigrade on branches (Albignac, 1973). They climb and jump easily (Grandidier and Petit, 1932). The forefeet are used to capture and pin prey to the ground.

Agonistic behavior has been observed only during mating when aggression, including threatening calls and postures, are evident (Vosseler, 1929). Males are fierce fighters; a female was observed to attack a male in the field and the opponents attempted to bite each other (Albignac, 1973). Fights usually are of short duration, after which the loser flees and the winner follows for a few meters.

GENETICS. The diploid number of chromosomes is 42 (Ewer, 1973); those of other Viverridae range from 24 to 52, whereas those of Felidae range from 36 to 38. Rumpler (pers. comm.) studied the karyotype and found no information "which would allow us to classify *Cryptoprocta* closer to the viverrids than to the cats."

REMARKS. The name *Cryptoprocta* refers to the anus (procta) being hidden (crypto-) by an anal pouch. The vernacular name also is spelled "fosa."

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