

= Fossa (animal) =

The fossa (/ ˈfʊsə / or / ˈfuːsə / ; Malagasy [ˈfusʔ ?] ; *Cryptoprocta ferox*) is a cat @-@ like , carnivorous mammal endemic to Madagascar . It is a member of the Eupleridae , a family of carnivores closely related to the mongoose family (Herpestidae) . Its classification has been controversial because its physical traits resemble those of cats , yet other traits suggest a close relationship with viverrids (most civets and their relatives) . Its classification , along with that of the other Malagasy carnivores , influenced hypotheses about how many times mammalian carnivores have colonized Madagascar . With genetic studies demonstrating that the fossa and all other Malagasy carnivores are most closely related to each other (forming a clade , recognized as the family Eupleridae) , carnivores are now thought to have colonized the island once around 18 to 20 million years ago .

The fossa is the largest mammalian carnivore on the island of Madagascar and has been compared to a small cougar . Adults have a head @-@ body length of 70 ? 80 cm (28 ? 31 in) and weigh between 5 @.@ 5 and 8 @.@ 6 kg (12 and 19 lb) , with the males larger than the females . It has semiretractable claws and flexible ankles that allow it to climb up and down trees head @-@ first , and also support jumping from tree to tree . The fossa is unique within its family for the shape of its genitalia , which share traits with those of cats and hyenas .

The species is widespread , although population densities are usually low . It is found solely in forested habitat , and actively hunts both by day and night . Over 50 % of its diet consists of lemurs , the endemic primates found on the island ; tenrecs , rodents , lizards , birds , and other animals are also documented as prey . Mating usually occurs in trees on horizontal limbs and can last for several hours . Litters range from one to six pups , which are born blind and toothless (altricial) . Infants wean after 4 @.@ 5 months and are independent after a year . Sexual maturity occurs around three to four years of age , and life expectancy in captivity is 20 years . The fossa is listed as " Vulnerable " by the International Union for Conservation of Nature . It is generally feared by the Malagasy people and is often protected by their fady (taboo) . The greatest threat to the species is habitat destruction .

= = Etymology = =

The generic name *Cryptoprocta* refers to how the animal 's anus is hidden by its anal pouch , from the Ancient Greek words *crypto-* " hidden " , and *procta* " anus " . The species name *ferox* is the Latin adjective " fierce " or " wild " . Its common name is spelled fossa in English or fosa in Malagasy , the Austronesian language from which it was taken , but some authors have adopted the Malagasy spelling in English . The word is similar to *posa* (meaning " cat ") in the Iban language (another Austronesian language) from Borneo , and both terms may derive from trade languages from the 1600s . However , an alternative etymology suggests a link to another word that comes from Malay : *pusa* refers to the Malayan weasel (*Mustela nudipes*) . The Malay word *pusa* could have become *posa* for cats in Borneo , while in Madagascar the word could have become *fosa* to refer to the fossa .

= = Taxonomy = =

The fossa was formally described by Edward Turner Bennett on the basis of a specimen from Madagascar sent by Charles Telfair in 1833 . The common name is the same as the generic name of the Malagasy civet (*Fossa fossana*) , but they are different species . Because of shared physical traits with civets , mongooses , and cats (*Felidae*) , its classification has been controversial . Bennett originally placed the fossa as a type of civet in the family *Viverridae* , a classification that long remained popular among taxonomists . Its compact braincase , large eye sockets , retractable claws , and specialized carnivorous dentition have also led some taxonomists to associate it with the felids . In 1939 , William King Gregory and Milo Hellman placed the fossa in its own subfamily within *Felidae* , the *Cryptoproctinae* . George Gaylord Simpson placed it back in *Viverridae* in 1945 , still

within its own subfamily , yet conceded it had many cat @-@ like characteristics .

In 1993 , Géraldine Veron and François Catzeflis published a DNA hybridization study suggesting that the fossa was more closely related to mongooses (family Herpestidae) than to cats or civets . However , in 1995 , Veron 's morphological study once again grouped it with Felidae . In 2003 , molecular phylogenetic studies using nuclear and mitochondrial genes by Anne Yoder and colleagues showed that all native Malagasy carnivorans share a common ancestry that excludes other carnivores (meaning they form a clade , making them monophyletic) and are most closely related to Asian and African Herpestidae . To reflect these relationships , all Malagasy carnivorans are now placed in a single family , Eupleridae . Within Eupleridae , the fossa is placed in the subfamily Euplerinae along with the falanouc (Eupleres goudoti) and Malagasy civet , but its exact relationships are poorly resolved .

An extinct relative of the fossa was described in 1902 from subfossil remains and recognized as a separate species , *Cryptoprocta spelea* , in 1935 . This species was larger than the living fossa (with a body mass estimate roughly twice as great) , but otherwise similar . Across Madagascar , people distinguish two kinds of fossa ? a large fossa mainty (" black fossa ") and the smaller fossa mena (" reddish fossa ") ? and a white form has been reported in the southwest . It is unclear whether this is purely folklore or individual variation ? related to sex , age or instances of melanism and leucism ? or whether there is indeed more than one species of living fossa .

= = Description = =

The fossa appears as a diminutive form of a large felid , such as a cougar , but with a slender body and muscular limbs , and a tail nearly as long as the rest of the body . It has a mongoose @-@ like head , relatively longer than that of a cat , although with a muzzle that is broad and short , and with large but rounded ears . It has medium brown eyes set relatively wide apart with pupils that contract to slits . Like many carnivorans that hunt at night , its eyes reflect light ; the reflected light is orange in hue . Its head @-@ body length is 70 ? 80 cm (28 ? 31 in) and its tail is 65 ? 70 cm (26 ? 28 in) long . There is some sexual dimorphism , with adult males (weighing 6 @.@ 2 ? 8 @.@ 6 kg or 14 ? 19 lb) being larger than females (5 @.@ 5 ? 6 @.@ 8 kg or 12 ? 15 lb) . Smaller individuals are typically found north and east on Madagascar , while larger ones to the south and west . Unusually large individuals weighing up to 20 kg (44 lb) have been reported , but there is some doubt as to the reliability of the measurements . The fossa can smell , hear , and see well . It is a robust animal and illnesses are rare in captive fossas .

Both males and females have short , straight fur that is relatively dense and without spots or patterns . Both sexes are generally a reddish @-@ brown dorsally and colored a dirty cream ventrally . When in rut , they may have an orange coloration to their abdomen from a reddish substance secreted by a chest gland secretions , but this has not been consistently observed by all researchers . The tail tends to be lighter in coloration than the sides . Juveniles are either gray or nearly white .

Several of the animal 's physical features are adaptations to climbing through trees . It uses its tail to assist balance and has semi @-@ retractable claws that it uses to climb trees in its search for prey . It has semiplantigrade feet , switching between a plantigrade @-@ like gait (when arboreal) and a digitigrade @-@ like one (when terrestrial) . The soles of its paws are nearly bare and covered with strong pads . The fossa has very flexible ankles that allow it to readily grasp tree trunks so as to climb up or down trees head first or to leap to another tree . Captive juveniles have been known to swing upside down by their hindfeet from knotted ropes .

The fossa has several scent glands , although the glands are less developed in females . Like herpestids it has a perianal skin gland inside an anal sac which surrounds the anus like a pocket . The pocket opens to the exterior with a horizontal slit below the tail . Other glands are located near the penis or vagina , with the penile glands emitting a strong odor . Like the herpestids , it has no prescrotal glands .

= = External genitalia = =

One of the more peculiar physical features of this species is its external genitalia . The male fossa has an unusually long penis and baculum (penis bone) , reaching to between his forelegs when erect , with an average thickness of 20 mm (0 .79 in) . The glans extends about halfway down the shaft and is spiny except at the tip . In comparison , the glans of felids is short and spiny , while that of viverrids is smooth and long . The female fossa exhibits transient masculinization , starting at about 1 ? 2 years of age , developing an enlarged , spiny clitoris that resembles a male 's penis . The enlarged clitoris is supported by an os clitoridis , which decreases in size as the animal grows . The females do not have a pseudo @-@ scrotum , but they do secrete an orange substance that colors their underparts , much like the secretions of males . Hormone levels (testosterone , androstenedione , dihydrotestosterone) do not seem to play a part in this transient masculinization , as those levels are the same in masculinized juveniles and nonmasculinized adults . It is speculated that the transient masculinization either reduces sexual harassment of juvenile females by adult males , or reduces aggression from territorial females . While females of other mammal species (such as the spotted hyena) have a pseudo @-@ penis , no other is known to diminish in size as the animal grows .

= = Comparison with related carnivorans = =

Overall , the fossa has features in common with three different carnivoran families , leading researchers to place it and other members of Eupleridae alternatively in Herpestidae , Viverridae , and Felidae . Felid features are primarily those associated with eating and digestion , including tooth shape and facial portions of the skull , the tongue , and the digestive tract , typical of its exclusively carnivorous diet . The remainder of the skull most closely resembles skulls of genus *Viverra* , while the general body structure is most similar to that of various members of Herpestidae . The permanent dentition is 3 @. 1 @. 3 @- 4 @. 13 @. 1 @. 3 @- 4 @. 1 (three incisors , one canine , three or four premolars , and one molar on each side of both the upper and lower jaws) , with the deciduous formula being similar but lacking the fourth premolar and the molar . The fossa has a large , prominent rhinarium similar to that of viverrids , but has comparatively larger , round ears , almost as large as those of a similarly sized felid . Its facial vibrissae (whiskers) are long , with the longest being longer than its head . Like some mongoose genera , particularly *Galidia* (which is now in the fossa 's own family , Eupleridae) and *Herpestes* (of Herpestidae) , it has carpal vibrissae as well . Its claws are retractile , but unlike those of Felidae species , they are not hidden in skin sheaths . It has three pairs of nipples (one inguinal , one ventral , and one pectoral) .

= = Habitat and distribution = =

The fossa has the most widespread geographical range of the Malagasy carnivores , and is generally found in low numbers throughout the island in remaining tracts of forest , preferring pristine undisturbed forest habitat . It is also encountered in some degraded forests , but in lower numbers . Although the fossa is found in all known forest habitats throughout Madagascar , including the western , dry deciduous forests , the eastern rainforests , and the southern spiny forests , it is seen more frequently in humid than in dry forests . This may be because the reduced canopy in dry forests provides less shade , and also because the fossa seems to travel more easily in humid forests . It is absent from areas with the heaviest habitat disturbance and , like most of Madagascar 's fauna , from the central high plateau of the country .

The fossa has been found across several different elevational gradients in undisturbed portions of protected areas throughout Madagascar . In the Réserve Naturelle Intégrale d 'Andringitra , evidence of the fossa has been reported at four different sites ranging from 810 to 1 @, 625 m (2 @, 657 to 5 @, 331 ft) . Its highest known occurrence was reported at 2 @, 000 m (6 @, 600 ft) ; its presence high on the Andringitra Massif was subsequently confirmed in 1996 . Similarly , evidence has been reported of the fossa at the elevational extremes of 440 m (1 @, 440 ft) and

1 @, @ 875 m (6 @, @ 152 ft) in the Andohahela National Park . The presence of the fossa at these locations indicates its ability to adapt to various elevations , consistent with its reported distribution in all Madagascar forest types .

= = Behavior = =

The fossa is active during both the day and the night and is considered cathemeral ; activity peaks may occur early in the morning , late in the afternoon , and late in the night . The animal generally does not reuse sleeping sites , but females with young do return to the same den . The home ranges of male fossas in Kirindy Forest are up to 26 km² (10 sq mi) large , compared to 13 km² (5 @. @ 0 sq mi) for females . These ranges overlap ? by about 30 percent according to data from the eastern forests ? but females usually have separated ranges . Home ranges grow during the dry season , perhaps because less food and water is available . In general , radio @-@ collared fossas travel between 2 and 5 kilometres (1 @. @ 2 and 3 @. @ 1 mi) per day , although in one reported case a fossa was observed moving a straight @-@ line distance of 7 km (4 @. @ 3 mi) in 16 hours . The animal 's population density appears to be low : in Kirindy Forest , where it is thought to be common , its density has been estimated at one animal per 4 km² (1 @. @ 5 sq mi) in 1998 . Another study in the same forest between 1994 and 1996 using the mark and recapture method indicated a population density of one animal per 3 @. @ 8 km² (1 @. @ 5 sq mi) and one adult per 5 @. @ 6 km² (2 @. @ 2 sq mi) .

Except for mothers with young and occasional observations of pairs of males , animals are usually found alone , so that the species is considered solitary . A 2009 publication , however , reported a detailed observation of cooperative hunting , wherein three male fossas hunted a 3 kg (6 @. @ 6 lb) sifaka (*Propithecus verreauxi*) for 45 minutes , and subsequently shared the prey . This behavior may be a vestige of cooperative hunting that would have been required to take down larger recently extinct lemurs .

Fossas communicate using sounds , scents , and visual signals . Vocalizations include purring , a threatening call , and a call of fear , consisting of " repeated loud , coarse inhalations and gasps of breath " . A long , high yelp may function to attract other fossas . Females mew during mating and males produce a sigh when they have found a female . Throughout the year , animals produce long @-@ lasting scent marks on rocks , trees , and the ground using glands in the anal region and on the chest . They also communicate using face and body expression , but the significance of these signals is uncertain . The animal is aggressive only during mating , and males in particular fight boldly . After a short fight , the loser flees and is followed by the winner for a short distance . In captivity , fossas are usually not aggressive and sometimes even allow themselves to be stroked by a zookeeper , but adult males in particular may try to bite .

= = = Diet = = =

The fossa is a carnivore that hunts small to medium @-@ sized animals . One of eight carnivorous species endemic to Madagascar , the fossa is the island 's largest surviving endemic terrestrial mammal and the only predator capable of preying upon adults of all extant lemur species , the largest of which can weigh as much as 90 percent of the weight of the average fossa . Although it is the predominant predator of lemurs , reports of its dietary habits demonstrate a wide variety of prey selectivity and specialization depending on habitat and season ; diet does not vary by sex . While the fossa is thought to be a lemur specialist in Ranomafana National Park , its diet is more variable in other rain forest habitats .

The diet of the fossa in the wild has been studied by analyzing their distinctive scats , which resemble gray cylinders with twisted ends and measure 10 ? 14 cm (3 @. @ 9 ? 5 @. @ 5 in) long by 1 @. @ 5 ? 2 @. @ 5 cm (0 @. @ 6 ? 1 @. @ 0 in) thick . Scat collected and analyzed from both Andohahela and Andringitra contained lemur matter and rodents . Eastern populations in Andringitra incorporate the widest recorded variety of prey , including both vertebrates and invertebrates . Vertebrates consumed ranged from reptiles to a wide variety of birds , including both understory and

ground birds , and mammals , including insectivores , rodents , and lemurs . Invertebrates eaten by the fossa in the high mountain zone of Andringitra include insects and crabs . One study found that vertebrates comprised 94 % of the diet of fossas , with lemurs comprising over 50 % , followed by tenrecs (9 %) , lizards (9 %) , and birds (2 %) . Seeds , which comprised 5 % of the diet , may have been in the stomachs of the lemurs eaten , or may have been consumed with fruit taken for water , as seeds were more common in the stomach in the dry season . The average prey size varies geographically ; it is only 40 grams (1 @. @ 4 oz) in the high mountains of Andringitra , in contrast to 480 grams (17 oz) in humid forests and over 1 @, @ 000 grams (35 oz) in dry deciduous forests . In a study of fossa diet in the dry deciduous forest of western Madagascar , more than 90 % of prey items were vertebrates , and more than 50 % were lemurs . The primary diet consisted of approximately six lemur species and two or three spiny tenrec species , along with snakes and small mammals . Generally , the fossa preys upon larger lemurs and rodents in preference to smaller ones .

Prey is obtained by hunting either on the ground or in the trees . During the non @-@ breeding season the fossa hunts individually , but during the breeding season hunting parties may be seen , and these may be pairs or later on mothers and young . One member of the group scales a tree and chases the lemurs from tree to tree , forcing them down to the ground where the other is easily able to capture them . The fossa is known to eviscerate its larger lemur prey , a trait that , along with its distinct scat , helps identify its kills . Long @-@ term observations of the fossa 's predation patterns on rainforest sifakas suggest that the fossa hunts in a subsection of their range until prey density is decreased , then moves on . The fossa has been reported to prey on domestic animals , such as goats and small calves , and especially chickens . Food taken in captivity includes amphibians , birds , insects , reptiles , and small- to medium @-@ sized mammals .

This wide variety of prey items taken in various rainforest habitats is similar to the varied dietary composition noted occurring in the dry forests of western Madagascar , as well . As the largest endemic predator on Madagascar , this dietary flexibility combined with a flexible activity pattern has allowed it to exploit a wide variety of niches available throughout the island , making it a potential keystone species for the Madagascar ecosystems .

= = = Breeding = = =

Most of the details of reproduction in wild populations are from the western dry deciduous forests ; determining whether or not certain of these details are applicable to eastern populations will require further field research . Mating typically occurs during September and October , although there are reports of its occurring as late as December , and can be highly conspicuous . In captivity in the Northern Hemisphere , fossas instead mate in the northern spring , from March to July . Intromission usually occurs in trees on horizontal limbs about 20 m (66 ft) off the ground . Frequently the same tree is used year after year , with remarkable precision as to the date the season commences . Trees are often near a water source , and have limbs strong enough and wide enough to support the mating pair , about 20 cm (7 @. @ 9 in) wide . Some mating has been reported on the ground as well .

As many as eight males will be at a mating site , staying in close vicinity to the receptive female . The female seems to choose the male she mates with , and the males compete for the attention of the female with a significant amount of vocalization and antagonistic interactions . The female may choose to mate with several of the males , and her choice of mate does not seem to have any correlation to the physical appearance of the males . To stimulate the male to mount her , she gives a series of mewling vocalizations . The male mounts from behind , resting his body on her slightly off @-@ center , a position requiring delicate balance ; if the female were to stand , the male would have significant difficulty continuing . He places his paws on her shoulders or grasps her around the waist and often licks her neck . Mating may last for nearly three hours . This unusually lengthy mating is due to the physical nature of the male 's erect penis , which has backwards @-@ pointing spines along most of its length . Fossa mating includes a copulatory tie , which may be enforced by the male 's spiny penis . The tie is difficult to break if the mating session is interrupted . Copulation

with a single male may be repeated several times , with a total mating time of up to fourteen hours , while the male may remain with the female for up to an hour after the mating . A single female may occupy the tree for up to a week , mating with multiple males over that time . Also , other females may take her place , mating with some of the same males as well as others . This mating strategy , whereby the females monopolize a site and maximize the available number of mates , seems to be unique among carnivores . Recent research suggests that this system helps the fossa overcome factors which would normally impede mate @-@ finding , such as low population density and lack of den use .

The birthing of the litter of one to six (typically two to four) takes place in a concealed location , such as an underground den , a termite mound , a rock crevice , or in the hollow of a large tree (particularly those of the *Commiphora* genus) . Contrary to older research , litters are of mixed sexes . Young are born in December or January , making the gestation period 90 days , with the late mating reports indicating a gestational period of about six to seven weeks . The newborns are blind and toothless and weigh no more than 100 g (3 @. @ 5 oz) . The fur is thin and has been described as gray @-@ brown or nearly white . After about two weeks the cubs ' eyes open , they become more active , and their fur darkens to a pearl gray . The cubs do not take solid food until three months old , and do not leave the den until they are 4 @. @ 5 months old ; they are weaned shortly after that . After the first year , the juveniles are independent of their mother . Permanent teeth appear at 18 to 20 months . Physical maturity is reached by about two years of age , but sexual maturity is not attained for another year or two , and the young may stay with their mother until they are fully mature . Lifespan in captivity is up to or past 20 years of age , possibly due to the slow juvenile development .

= = Human interactions = =

The fossa has been assessed as " Vulnerable " by the IUCN Red List since 2008 , as its population size has probably declined by at least 30 percent between 1987 and 2008 ; previous assessments have included " Endangered " (2000) and " Insufficiently Known " (1988 , 1990 , 1994) . The species is dependent on forest and thus threatened by the widespread destruction of Madagascar 's native forest but is also able to persist in disturbed areas . A suite of microsatellite markers (short segments of DNA that have a repeated sequence) have been developed to help aid in studies of genetic health and population dynamics of both captive and wild fossas . Several pathogens have been isolated from the fossa , some of which , such as anthrax and canine distemper , are thought to have been transmitted by feral dogs or cats . *Toxoplasma gondii* was reported in a captive fossa in 2013 .

Although the species is widely distributed , it is locally rare in all regions , making fossas particularly vulnerable to extinction . The effects of habitat fragmentation increase the risk . For its size , the fossa has a lower than predicted population density , which is further threatened by Madagascar 's rapidly disappearing forests and dwindling lemur populations , which make up a high proportion of its diet . The loss of the fossa , either locally or completely , could significantly impact ecosystem dynamics , possibly leading to over @-@ grazing by some of its prey species . The total population of the fossa living within protected areas is estimated at less than 2 @, @ 500 adults , but this may be an overestimate . Only two protected areas are thought to contain 500 or more adult fossas : Masoala National Park and Midongy @-@ Sud National Park , although these are also thought to be overestimated . Too little population information has been collected for a formal population viability analysis , but estimates suggest that none of the protected areas support a viable population . If this is correct , the extinction of the fossa may take as much as 100 years to occur as the species gradually declines . In order for the species to survive , it is estimated that at least 555 km² (214 sq mi) is needed to maintain smaller , short @-@ term viable populations , and at least 2 @, @ 000 km² (770 sq mi) for populations of 500 adults .

Taboo , known in Madagascar as fady , offers protection for the fossa and other carnivores . In the Marolambo District (part of the Atsinanana region in Toamasina Province) , the fossa has traditionally been hated and feared as a dangerous animal . It has been described as " greedy and

aggressive " , known for taking fowl and piglets , and believed to " take little children who walk alone into the forest " . Some do not eat it for fear that it will transfer its undesirable qualities to anyone who consumes it . However , the animal is also taken for bushmeat ; a study published in 2009 reported that 57 percent of villages (8 of 14 sampled) in the Makira forest consume fossa meat . The animals were typically hunted using slingshots , with dogs , or most commonly , by placing snare traps on animal paths . Near Ranomafana National Park , the fossa , along with several of its smaller cousins and the introduced small Indian civet (*Viverricula indica*) , are known to " scavenge on the bodies of ancestors " , which are buried in shallow graves in the forest . For this reason , eating these animals is strictly prohibited by fady . However , if they wander into villages in search of domestic fowl , they may be killed or trapped . Small carnivore traps have been observed near chicken runs in the village of Vohiparara .

Fossas are occasionally held in captivity in zoos . They first bred in captivity in 1974 in the zoo of Montpellier , France . The next year , at a time when there were only eight fossas in the world 's zoos , the Duisburg Zoo in Germany acquired one ; this zoo later started a successful breeding program , and most zoo fossas now descend from the Duisburg population . Research on the Duisburg fossas has provided much data about their biology .

The fossa was depicted as an antagonist in the DreamWorks 2005 animated film Madagascar , accurately shown as the lemurs ' most feared predator .