SMALL CARNIVORE CONSERVATION

The Newsletter and Journal of the IUCN/SSC Mustelid, Viverrid & Procyonid Specialist Group

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Fanaloue *(Eupleres goudotii)* - Photo: Roland Wirth

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We are particularly grateful to Walter Rasmussen for reading the manuscripts and improving the English style.

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The aim of this publication is to offer the members of the IUCN/SSC MV&PSG, and those who are concerned with mustelids, viverrids, and procyonids, brief papers, news items, abstracts, and titles of recent literature. All readers are invited to send material to:

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Owston's Palm Civet Conservation Breeding Project Cuc Phuong National Park, Vietnam

Shelagh HEARD ROSENTHAL

Introduction

Chrotogale owstoni Thomas, 1912 is a highly range-restricted species believed confined to northern Laos, central to northern Vietnam, and a small area of China bordering Laos and Vietnam. It is listed as "vulnerable" in the IUCN (1996) Red List of globally threatened species, and included as a protected species in Vietnam's own Red Book (1995). At least in Vietnam, the little information available points to a patchy distribution. Nowhere does the species appear abundant (especially as compared to several other civet species such as *Paguma larvata, Paradoxurus hermaphroditus, Viverricula indica*, and *Viverra zibetha*). Due to its restricted distribution and low abundance it is of high conservation concern. While apparently not targeted by hunting and Vietnam's rampant wildlife trade, it does succumb to both uncontrolled pressures.

The Owston's Palm Civet Conservation Breeding Project was initiated in 1995, and grew out of a field research project on civets at Cuc Phuong National Park, Vietnam. The park is located in northern Vietnam, approximately 120 kilometers southwest of Hanoi. The original aim of the field study was to investigate the ecology and behaviour of the park's several sympatric civet species, which include *Chrotogale owstoni*. Cuc Phuong was Vietnam's only protected area where *Chrotogale* was known to occur when the IUCN Mustelid & Viverrid Action Plan was compiled in 1989, a key reason for siting the project at Cuc Phuong.

Over a three-year period, the field study failed to sight or trap *Chrotogale owstoni* at the park. The Action Plan stated that villagers reported that the species may still be common in the park, and that it would approach houses in search of kitchen waste – this is now assumed to be erroneous. Village interviews confirmed that the species is uncommon in the park and that it has become rarer in recent years. In early 1995, however, two fresh skins were viewed in a village shop at the north end of the park; the animals were reported to have been hunted in the park. Also in May 1995, two infant female *Chrotogale* were confiscated by park rangers from a local hunter who had hand caught them inside the park. The park authorities subsequently requested the author to care for and raise them. Approximately two weeks later, three (1.2) infants were confiscated from a logger in Kim Boa District (approximately 30 kilometers northeast of the park) and also sent to the park for care. These animals thus formed the basis of the Owston's Palm Civet Conservation Breeding Project.

The initial reason for raising the *Chrotogale* was to collect information on their growth, behaviour; and basic biology, with an intention to undertake a monitored release once they reached adulthood. Over time, however, the decision was made to maintain the animals captive due to both hunting pressure at the park and the need for firm evidence that *Chrotogale owstoni* could be bred successfully in captivity, something that had never been achieved. Although Hanoi Zoo had held several animals for more than four years, their attempts to breed and successfully raise this species had failed, and animals kept at Frankfurt Zoo for the period 1993-1996 also failed to reproduce. Hence, there seemed to be some concern that this species might be difficult to breed in captivity. This continues to be the case as Saigon Zoo has attempted to breed *Chrotogale* without success over the last few years, and a private facility in Laos reported births last year but no survivors (N. Schonwalter, pers.com.). As the Cuc Phuong animals were housed in very good conditions and in excellent health, for conservation concerns this seemed like a valuable opportunity to gather further information on the species' behaviour and reproduction. In addition, given the limited knowledge of most civet species biology and reproduction, it was hoped that the experience and information obtained might be relevant to the care and captive breeding of other more threatened civet species.

DATE	SEX	SOURCE	LOCALE	AGE	BREEDER
May 1995	F	Confiscate	Ninh Binh	A	Y
"	F	Confiscate	Ninh Binh	A	Y
May 1995	F	Confiscate	Hoa Binh	A	Y
"	F	Confiscate	Hoa Binh	A	Y
"	M	Confiscate	Hoa Binh	Died 10'98	Y
Nov 1996	M	Confiscate	Unknown	Died 05'98	Y
April 1997	M	Captive birth		YA	
"	F	Captive birth		YA	
"	M	Captive birth		YA	
"	M	Captive birth		Dispersed '97	
"	M	Captive birth		Dispersed '97	
"	M	Captive birth			
"	M	Captive birth		Died newborn[1]	
"	F	Captive birth		YA	
Nov 1997	F	Confiscate	Unknown	A	Y
April 1998	M	Captive birth		J	
"	F	Captive birth		Died infant[2]	
May 1998	M	Confiscate	Unknown	OA	

J = juvenile; YA = young adult; A = adult; OA = old adult

[1] Neonate was rejected by mother who did not nurse it, died after 36 hours

[2] Infant squeezed through wire into adjoining cage where it was killed by adult civet(s)

Table 1. *Chrotogale owstoni* maintained at Cuc Phuong NP

Notes on husbandry

HOUSING

The fact that Owston's palm civets are placid, relatively approachable and unaggressive (both towards conspecifics and humans) animals facilitates ease in keeping them. The species is suspected to be largely solitary in the wild, however the project has managed to house several animals together without incident. For the first eighteen months of their lives, all five original animals were housed together and appeared to be a very content social group: although two nest boxes were available in the cage, the animals always slept in one box together. It appears that up to about one year of age, young animals can live together very easily, during which social interactions are characterised by allo-grooming, some forms of play, purring, resting together rather than separate, etc. After this time, mildly aggressive interactions begin to appear (chasing, snapping, avoidance, etc.). With adults, it has been easy to keep one pair together (either male/female or female/female), although there is great variation in relationships between individual animals and this is an important factor in deciding which to house together.

Housing conditions have expanded and improved with the growth of the project and breeding success. At the end of 1996, the animals were split into two groups housed in a 6x6x4 meter cage and a 6x8x4 meter cage. Enclosures now number ten, with the latest additions being four 6x4x3 breeding cages. These are constructed of wire mesh sides and top, with concrete footings for the mesh, and earthen floors. There are two clusters of cages, each centered on a large catch cage area. In general, animals are housed in pairs or singly, although as mentioned groups of up to five juveniles have been kept together for extended periods.

Mother and young (about 12 weeks) – mother in typical nursing position.

The enclosure floors are covered bi-weekly in fresh forest leaf litter. As the Owston's are very light-footed animals, the ground area successfully supports live ground cover, grasses, shrubs and small trees, and seasonally this vegetation becomes quite dense, offering a habitat which varies over time. The vegetation attracts insects and other invertebrates that serve as forage, and occasionally rodents and birds will also enter the enclosures. Rocks and logs are placed on the ground for climbing, and numerous branches of varying width and size give access to all areas of the cages. Sleeping boxes have been placed at a height of approximately 1 - 2 meters, with access to the ground and upper reaches via branches. When given a choice, all animals prefer the higher sleeping boxes to those placed on or near the ground, and they prefer to sleep socially rather than in individual boxes (bar one temporary pairing). Cages are re-furbished with branches at least once a year, with minor adjustments periodically. Shade is provided by trees and bamboo planted around the perimeter, and bamboo mats have been secured on the roof for additional protection against wind, rain and sun. A plastic roof mat over the area of the sleeping boxes provides additional rain protection. A large shallow plastic bowl is placed in a corner of each enclosure; with the addition of a few centimeters of water (which seems to both attract the animals and facilitate cleaning), the animals use this as a permanent toilet site.

DIET

Testing for dietary preferences has confirmed that Owston's palm civet has a predilection for earthworms. Working from the suspicion that lack of keeping success elsewhere may be due partly to a dietary problem, every effort has been made to include a high proportion of wild-type foods in the daily diet. Thus, freshly dug earthworms are a regular feature on the evening menu. At feeding time the worms are scattered around the cage so that the animals must search for them; the leaf litter provides cover for some worms so that foraging time is prolonged. Another feeding technique has been to throw the worms on top of the wire-topped cage so that they fall through gradually, stimulating prolonged foraging in the civets. Foraging time has been increased and resting and walking time reduced by employing such feeding methods.

The remainder of the diet has been worked out within the constraints of cost, preparation time demands, and seasonal availability of fruits and vegetables. In addition to worms, the other daily staple is a mix of raw beef, cooked potato and carrot, sweet potato, banana, beetroot when available, and frequently egg. As *Chrotogale* has a very fine dentition and the jaws do not appear particularly robust, it seems the species may be more adapted to consuming soft-bodied foods (invertebrates, soft fruits, etc.). With this in mind, most hard or tough ingredients in their diet are reduced to a fairly fine consistency in a food processor to facilitate mastication. Grapes are also given every night as a staple fruit item. Other items, which are offered depending on their seasonal availability, are orthopterans, snails, geckos, tadpoles, forest fruits, apples, pears, and other cultivated fruits. Some of the animals will also take small frogs, and certain species of small freshwater fish. While dead rodents have been rejected and no interest shown in captive domestic mice, one civet did catch and consume – with great effort – a small wild rat which entered the cage. The civets also take small, soft-shelled snails, orthopterans and other insects that enter the cage. In addition, they occasionally eat the grass and the leaf tips of wild ginger plants in the enclosures; presumably these are consumed as an intestinal scourer.

Young Owston's palm civets (about 10 weeks)

Several scats were collected from captive civets which temporarily free-ranged (see *Development*, below) in botanical gardens and degraded secondary forest habitat. Initial analysis of a few of these scats revealed that the majority of food items taken were invertebrate, and they also contained large amounts of undigested plant matter and small amounts of fruit. Much of the plant matter was composed of fruit calyx bracts from *Rubus* sp., seeds of which were also found in the scat indicating fruit ingestion. Remnants of six other plant species were also found, but no vertebrate remains were present. Invertebrate remains were primarily orthopterans and giant centipedes (Myriapoda) – which can inflict a painful bite. Other items found in small amounts were Mollusca (snails), Coleoptera, Hymenoptera, and Mantodea (praying mantises). The scats have not yet been analysed for earthworm remains, but judging from the earthy, compacted nature of the scats, they are likely to be present.

HEALTH ISSUES

To date, the civets have remained very healthy with only minor problems. Occasionally a few animals have experienced ear mites that were treated with oral or injectable Ivomec. A few new arrivals have carried intestinal parasites which were also treated with Ivomec. Minor wounds such as cuts, abrasions, and punctures have been left to heal naturally, or a topical ointment or powder applied (Negasunt, etc.). Two deaths through illness have occurred: one adult male (died May 1998) developed a malignant tumour on his neck, which surgery revealed had become invasive and could not be successfully removed. Autopsy revealed additional small tumours in other major organs. A second adult male (died October 1998) died of unknown causes after a three-day illness; poisoning or a viral infection is suspected, however no other civets became ill.

Three animals have required surgery that was performed by skilled veterinarians: one partial tail amputation, two leg amputations, and one paw operation. Both the leg and paw injuries were on new arrivals confiscated from the wildlife trade, and were most likely sustained from hunter's traps or from an injury during transportation. For surgery and handling requiring anaesthesia, animals have been anaesthetised with Zoletil 100 (teletamine & zolazepam) at a dosage of 7 mg/kg (or 0.07ml/kg). Ketamine, or a combination of Ketamine and Rompun (0.1ml/kg or 2.0 mg/kg of each drug) also works well. The effects of anaesthesia with these two drugs is marked, with Zoletil effecting an increased heart rate and lower temperature than the Rompun/Ketamine combination. With *Chrotogale*, the Rompun/Ketamine combination is preferable to Zoletil. While Zoletil was seen to be very well tolerated in species-specific doses with wild caught *Paradoxurus hermaphroditus*, *Paguma larvata*, and *Viverra zibetha* (3.5, 3.0 and 4.0 mg/kg respectively) during the field survey, it was more problematic with *Chrotogale*. Although the drug took effect quickly and uneventfully with all species and induced a deep anaesthesia, *Chrotogale* demonstrated a long recovery, often accompanied by salivation, panting, foot peddling, occasional vomiting, and a long period (up to one hour) of disorientation. Recovery in the other civet species was not marked by these events. With all drug types used, there is also striking individual variation in down times with equal doses, which is in part likely caused by the varying levels of stress individuals experience with handling prior to injection.

Breeding

MATING

Owston's palm civet appears to take two years to reach full adult size, with sexual maturity obtained at approximately 18 months of age and a first breeding season at about 21 months after their birth. From observations made in 1997 and 1999, oestrus appears to occur within the period end January to early February. Breeding occurs only once a year, based on the fact that pairs kept together throughout the year have not bred at any other time. At the end of January 1997, three females were presumed to be in oestrus based on their slight swelling of the vulva and increased interest in the male housed adjacent. This interest was demonstrated in both sexes by uncharacteristic pacing and flank rubbing along their separating fence, increased scent marking on the adjacent ground, and increased vocalisation. Given these cues, the animals were paired and mating occurred immediately, and in the second week of February a fourth female mated. Mating and breeding success was 100 percent.

The situation in 1999 involved five females and four males, and success was mixed. Two females were alternated with a male starting the third week of January, but nothing occurred initially. It is presumed that the females had not yet entered oestrus and were thus unreceptive. During the non-receptive stage leading up to oestrus, the females were more inactive than normal and displayed little or no interest in the male. Mating occurred on January 30th and 31st in one of these pairs, while the second female was not seen to mate. A third pair mated as soon as they were put together on February 5th and 6th. Apart from these two confirmed matings, it is possible - but unlikely - that the other three females did mate but were not observed to do so. One of these females was tried with two males at different times, one of whom she was very aggressive towards; mating definitely did not occur with one male.

Mating behaviour observed was similar to that reported by Dang (1997). Successful copulations could not always be seen and/or distinguished from mere mountings (due to the dense cage vegetation), however as observed in 1997, mountings were numerous with 8 to 15 bouts per night observed and possibly many more occurring. Copulation bouts usually lasted two to three minutes but occasionally four, during which the female lowered herself flat and would often purr, and both male and female would often growl and snap immediately before and after copulation.

In all four of the 1997 pairings and one from 1999, there was very little aggression between the animals which would sleep together in one nest box, allo-groom frequently and at times purr. With four pairs in 1999, cohabitation was characterised by more growling, chasing and snapping than usual. In two other pairings, the aggression and avoidance was much more marked, in one case to the point where the male and female slept in different nest boxes – the only case of two civets not preferring to sleep together. In the rare case where the male aggressively pursued the female for mating, the result was often increased aggression from the female. Outside the breeding season, it appears that such uncharacteristic aggression diminishes between male and female pairs.

PARTURITION AND BIRTH

With the 1997 births, three females were separated from their mates in late March, and one female was left with her mate. Pregnancies progressed without any complications, weight gain was noticeable in the latter part of the pregnancy in three animals but not in the fourth (which had only one offspring). Throughout pregnancy an emphasis was placed on minimising all forms of stress for the animals, thus no weight measurements were taken and no data were collected via invasive techniques. There were no obvious behavioural changes prior to parturition, although data for this period are yet to be analysed. In the two to three days immediately preceding delivery, females "bagged up", with the teats mildly elongated and the surrounding area swollen. Contrary to information reported by Dang (1997) no nest building ensued, even though grasses, leaves, and other plant materials were available. Straw placed in nest boxes was pushed aside. Gestation periods ranged between 77 and 87 days (see Table 2). Of the five litters born so far, three have occurred during the night, with one mid-day and one early evening birth.

The latter birth of a sole young was observed: from the time contractions were noticed and the vulva seen to be protruding, the delivery took approximately one hour. The contractions appeared to be infrequent but very strong, lasting approximately 30-45 seconds. During this time the female's body was strongly arched, with her head tucked down, and her vagina would protrude extensively. After each contraction she would lick her vagina and then walk slowly around the cage. She continued to eat her evening meal intermittently. Once the head of the baby appeared at the vagina, it quickly progressed to about halfway out, then remained at this station for about two minutes after which time it was expelled from a standing position. The mother immediately began to lick it and eat all the afterbirth, finishing with chewing down to the umbilical cord. She subsequently spent several minutes repeatedly picking up the baby in her mouth and dropping it, then about 30 minutes walking around the cage during which she carried it firmly. The baby was dry by the time she finally entered her nest box to settle. Another female carried her two babies alternately in and out of her nest box for almost 1.5 hours shortly after their birth; it appeared she was searching for a new place to hide them. Despite subsequent birthing mothers being offered a second nest box, did not choose to move their babies from their original boxes.

Facial markings; note elongated face suited to ground foraging and catching earthworms

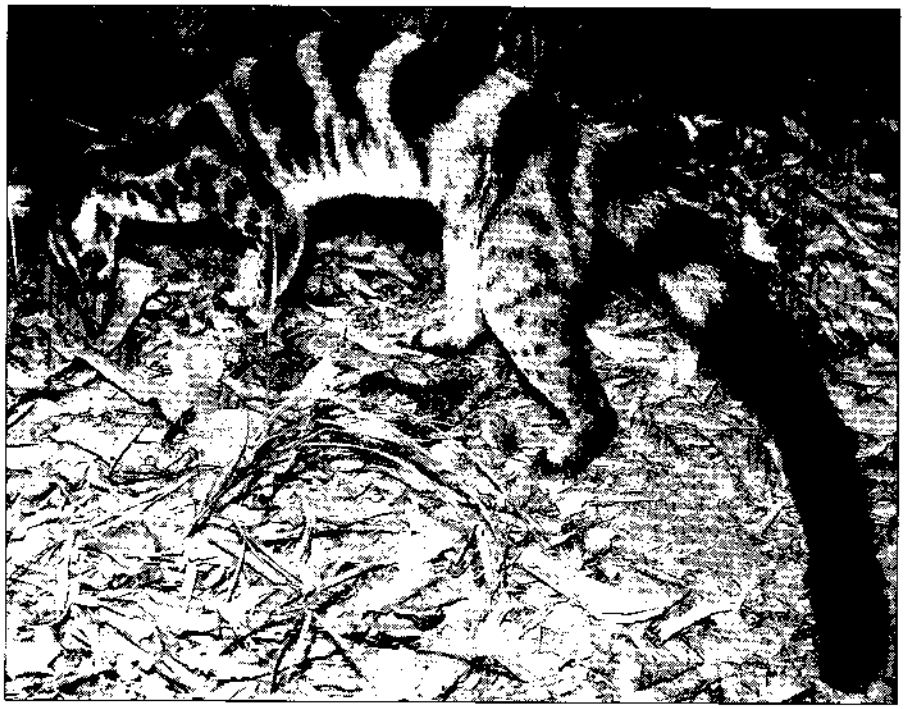
As mentioned, three females were separated from their mates well prior to delivery. This was done as a precaution based on information provided by Hanoi Zoo, whereby they feared that an adult male would harm the young. In the 1997 breedings, however, one pair was left together for the duration of pregnancy, parturition and raising of young, without incident. This same male was mated and housed with a different female in 1998, and again, successfully lived with the female and young. Although in both cases there were two nest boxes in the cage, the pair always slept together. In 1997 the male moved to a second nest box the night before the female delivered, and back into the female's box three days after the young were born. In 1998 he also moved the day before delivery, but back to the female and young after only two days. In both cases, his interaction and behaviour with the young was very similar to the female's, in that he groomed them, slept, played and eventually foraged with them.

DEVELOPMENT

The young from two litters of longest gestation periods were much more developed at birth (thicker fur, with genitals, feet, and noses much less pink, and more robust behaviour) and opened their eyes much earlier. It appears clear from the recorded gestation period range (75-87 days) and ensuing development that a gestation of 80 days is advantageous. Still births recorded at Hanoi Zoo occurred after gestation periods of 60-70 days, indicating premature delivery of fetuses.

The young civets opened their eyes between four and fifteen days, the marked difference being a reflection of the range of litter gestation length. In general, the young were capable of very wobbly walking at 10-14 days. At four to six weeks of age they began to emerge from the nest box. Further exploration of the cage began a few days later, closely following the mother who would oftentimes carry them back to the box. Mothers carried their babies in their mouths by grasping them around the middle. Independent cage exploration occurred at about seven weeks of age. Beginning at this age the young showed only mild interest in the adult's food, but did not poke or actively smell it. At 8 to 10 weeks of age the first solid food was taken, which were grapes. Within days, the longest gestation period litters began to play and poke at worms and other forms of wild food, but did not eat them until 9 weeks, with the other young eating worms at 11 weeks of age. On no occasion was any female seen to call her young to feed, or to take food to them. After about 12 to 13 weeks they began to catch grasshoppers on their own, and at approximately 16 weeks began to eat the daily beef mixture.

The offspring weaned at approximately 12, 15 and 18 weeks, and it appeared that the sole young of one female continued to suckle occasionally until 21 weeks. *Chrotogale* have four mammae, and all young have preferred to suckle from the lower two teats, which are embedded in a more fleshy, soft area of the



Owston's palm civet's pelage is characterised by the same number of distinct dorsal bands (4), however there is great individual difference in pattern details.

belly. The most common nursing position was with the mother reclined on her back against a wall of her nest box, with the young laying on the stomach whilst suckling. With two being the maximum number of surviving offspring from any female, there was little competition for teats or nursing position.

The young civets demonstrate an impressive array of vocalisations. From birth they are able to purr, mew, growl and "chuff", a call used to draw the mother, which was also used to communicate with siblings and other civets in adjoining cages. Adults also use this vocalisation to call to the young and occasionally other civets. Up until seven weeks of age, when presented with a frightening or threatening situation, the young would not spit or attempt to bite, but only press themselves flat or try to retreat from the threat, and growl.

The young animals are also very social. With the 1997 offspring, at 8 to 9 weeks of age the civets discovered that they could squeeze through their cage wire and enter the main catch cage to which all the cages adjoined. They were most likely attracted initially by the food preparation carried out there. Within a matter of days, it became a regular appearance for all the young civets to congregate and play (run, chase, play bite, chase their tails, jump on others) in the catch cage at dusk, during feeding time. Shortly thereafter they began to follow each other into different cages; all adults tolerated this and there were only a few minor incidences of mild aggression (growl and snap) directed towards strange young. Interestingly, the young civets

Litter birth date	Gestation (days)	Number of young	Eyes open (days old)
17/04/97	77	1.0	15
23/04/97	84	1.1	4
27/04/97	87	2.0	6
28/04/97	approx.75	2.1	13
25/04/98	unknown	1.1	10

Table 2. Birth date, gestation and litter size of some captive born *Chrotogale owstoni*

even began to visit the lone adult male's cage, again without incidence. This lead to the young sleeping in nest boxes other than their own, so that some nights a mother would have up to five young in her box, while others would have none. Several of the young would also sleep with the lone adult male in his box. In 1998, however, an offspring of the one litter produced (one female only was bred) was found dead in an adjoining cage, presumed killed by one or both of the male and female adult civets there after entering the cage. This was indeed in contrast to the behaviour of 1997. It is speculated that had these adults been caring for their own young and been in "parental mode", they might have been more tolerant.

At about 10 weeks of age the civets also began to venture out of the catch cage at dusk and into the surrounding grounds, returning after 10 to 20 minutes initially, then longer periods thereafter. At approximately twenty weeks some of the young started staying out overnight, initially for one night, then for several nights before returning to the cage. At about six months old they seemed to be ready to leave their mothers, as they were leaving the cage for up to a week at a time. At this point, the cages were re-covered with smaller gauge wire to prevent them dispersing permanently.

Conclusion and Future Plans

To date the project has been very fortunate with its breeding success, in so far as all matings have resulted in live births. Just as importantly, the young have been successfully raised, bar one neonatal death and one accidental infant death. However, breeding attempts in 1999 were mixed; although five pairings were attempted (four females), it is certain that mating occurred in only two pairs. One female - who bred successfully in 1998 - was tried with two different males over a two week period. She was paired first with an older adult male, and while they got along well no mating occurred (this male subsequently mated with another female). She was next paired with one of the 1997 captive born males, which resulted in the only case of extreme aggression witnessed between the civets to date. One suspicion for the difficulties encountered this year is that there were too many paired animals in too close quarters, which may have affected behaviour. The experience this year has highlighted the fact that while successful breeding of Owston's palm civet can be achieved, the animals are very individual and the relationships between them are not all equal. It is thus extremely important to know the traits of each animal, and the breeding process requires very close monitoring and management to ensure that animals are appropriately paired.

Another possible reason for the difficulties encountered this year is that as the oestrus period is not known accurately, the animals may have been paired too early or too late. It is not known what triggers the oestrus, but if it is at all weather related, this may have been a factor. In 1997 and 1998, the winters included typical spells of cold weather through January, whereas winter this year was marked by unseasonal warmth. In an effort to better understand the reproductive cycle in Owston's palm civet, the project is collecting fecal samples from several females (from this breeding season to the next) in hope of undertaking hormonal analysis.

The project will continue to operate on a small scale, with limited captive breeding and ongoing research and data collection. Under consideration is a plan to undertake a closely monitored, limited release of some of the captive born animals (of local gene stock) in order to collect much-needed ecological data on the species. The project will also continue to serve as a rescue centre for the very few Owston's palm civets confiscated from the wildlife trade. Another small study to be undertaken is an examination of the genetic variability within the species, hopefully including samples from Laos animals in addition to the Vietnamese stock. Depending partly on the results of this study, it may be permissible to release within the park (after a suitable quarantine and veterinary inspection) some of the civets rescued by the project in future.

Maintaining the civets in captivity and captive breeding are the least desirable tools of conservation, but to date this has provided some valuable insights into the species behaviour, biology and reproduction. In addition, the project has also provided reassurance that this species can be captive bred successfully, important knowledge should its status become more precarious. There is no doubt that like all mammals in the Indochina region, Owston's palm civet is under threat from habitat destruction, subsistence hunting and the seemingly insatiable demands of the wildlife trade. While to date there is virtually no effective protection for national parks and protected areas in Vietnam, since the *Action Plan* was written, Owston's palm civet has at least been confirmed in some other protected areas which retain good habitat. Three of these areas —Vu Quang, Pu Mat and Phong Nha Nature Reserves, which all lay along the Vietnam-Laos border — are large and contain some relatively undisturbed areas, and could support good populations of this small carnivore. In addition, conservation initiatives to improve reserve management are underway at the first two sites. Pu Mat in particular has been revealed as good habitat for the species: approximately half a dozen individuals were photo-trapped as part of Fauna & Flora International's 1998 baseline biodiversity survey for the "Social Forestry and Nature Conservation Project" (funded by the European Economic Community). The Phong Nha Owston's palm civet sightings were of two animals being carried out of the forest by hunters (R. Timmins, pers.com), but on the positive side this may be an important site for the species given its close proximity to Pu Mat, and the reserve is also beginning to receive attention from international conservation organisations.

Note the leaf ground cover that provides an ideal cage substrate for captive Owston's palm civets.

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Preliminary report on the status, activity cycle, and ranging of *Cryptoprocta ferox* in the Malagasy rainforest, with implications for conservation.

Luke DOLLAR

Abstract

A preliminary study of Fossa (*Cryptoprocta ferox*) in a southeastern rainforest of Madagascar examined their morphometrics and activity patterns from May-August 1996. Two fossa, a juvenile male and an adult male were captured and followed using radiotelemetry. *C. ferox* in Ranomafana National Park (RNP) maintained a cathemeral or non-period-specific activity pattern. This observation of fossa activity pattern is contrary to previously published accounts. This is the first study of the behavior of *C. ferox* in the rainforest of Madagascar.

Introduction

In the absence of additional endemic carnivoran competitors, the eight viverrid and herpestid carnivore genera found on Madagascar must fill a particularly broad range of niches (Wright *et al.*, 1997). Despite their unique ecological roles and evolutionary histories, the Malagasy carnivores (Table 1) have been the subject of few in-depth field studies and there is an unfortunate paucity of data on their current distributions, abundances, and behavioral ecologies. The largest of the extant Malagasy carnivores, *Cryptoprocta ferox*, commonly known as the fossa (Fig. 1), displays an enigmatic conglomeration of morphological characteristics that have facilitated some questioning of its taxonomic assignment between either the Viverridae or the Felidae. It is generally agreed that the fossa may resemble modern representative evidence of a primitive connecting link between these two families (Wozencraft, 1989). The fossa is currently more commonly allied with the viverrids (Wozencraft, 1989).

C. ferox is equipped with carnassial teeth and sharp, semiretractable claws (Fig. 2), making it a formidable hunter. The fossa is the only Malagasy predator capable of successfully preying upon adults of all extant lemur species in Madagascar. Rainforest territory size for this solitary predator has not yet been conclusively studied and reported, but a 12-month project recently completed in RNP (Dollar, in prep) will help eliminate this deficit. A series of lemur kills in RNP in 1994 indicated that hunting area is likely to exceed four square kilometers (Wright *et al.*, 1997).

Order Carnivora, Bowdich 1821

Family Viverridae, Gray 1821

SUBFAMILY CRYPTOPROCTINAE, GRAY 1864

Cryptoprocta ferox, Bennett 1833; Fossa

SUBFAMILY EUPLERINAE, CHENU 1852

Eupleres goudotii, Doyère 1835; Fanaloue

Fossa fossana, (Müller 1776); Fanaloka or Malagasy civet

SUBFAMILY VIVERRINAE, GRAY 1821

Viverricula indica, (Desmarest 1804); Small Indian civet

Not endemic to Madagascar.

Family Herpestidae, Bonaparte 1845

SUBFAMILY GALIDIINAE, GRAY 1864

Galidia elegans, I. Geoffroy St.Hilaire 1837; Ring-tailed mongoose

Galidictis fasciata, (Gmelin 1788); Broad-striped mongoose

Includes *G. ornata* & *G. striata* listed separately by Ewer (1973).

Galidictis grandidieri, Wozencraft 1986; Giant striped mongoose

Mungotictis decemlineata (A. Grandidier 1867); Narrow-striped mongoose

Includes *M. substriata* listed separately by Ewer (1973).

Salanoia concolor, (I. Geoffroy St.Hilaire 1837); Malagasy brown mongoose

Includes *S. olivacea* listed separately by Ewer (1973).

Table 1. Classification of the Malagasy carnivores, with scientific and common names (derived from Wozencraft, 1989).

Fig. 1. Subadult *Cryptoprocta ferox* with radiocollar in Ranomafana National Park, Madagascar.

In addition to primate prey, the diet of the fossa includes other mammals, birds, and reptiles (Albignac, 1973), even other viverrids (Louvel, 1954). In a recent analysis of *C. ferox* feces found in the dry, deciduous forest in western Madagascar, Rasoloarison, *et. al.* (1995) note that 57% of the biomass of prey items in these scats was lemur matter, with a significant representation of large lemurs such as *Propithecus verrauxi*. All fossa feces found in RNP before 1996 contained matter from lemurs (Wright *et. al.*, 1997).

From May through early August 1996, a preliminary study was conducted in the southeastern rainforest of RNP, Madagascar to assess the density, ranging, and activity patterns of *C. ferox*. Data were collected on fossa morphometrics, activity, and ranging to obtain a more detailed account of rainforest *C. ferox* populations and to afford a more balanced view of Malagasy rainforest ecosystem dynamics. This report represents the first examination of fossa activity patterns in the Malagasy rainforest. This report focuses on the morphological and activity data collected in this preliminary study.

Study area and methods

The study was conducted from the Vatoharanana site (altitude 1,000 m; Fig. 3) in RNP, which consists of 41, 000 ha of submontane rainforest ranging in altitude from 500-1,500 m. This site was selectively cut in the early 1980s and contains some introduced plant species, but is relatively undisturbed. Average rainfall is approximately 2,500mm. (Overdorff, 1988).

Fig. 2. Semi-retractable claws of *C. ferox*.

Seven traps were placed along a seven km transect spanning between Vatoharanana and two additional sites (Talatakely and Valohoika). Live adult chickens, canned corned beef, and raw pork were used as bait. Traps were checked at least twice daily. Trapped fossa were tranquilized while still in the trap, using Telazol and the Pneu-dart blowpipe system. Once adequately tranquilized, fossa were removed from the trap for collection of anatomical measurements and attachment of a specially designed Telonics MOD-365 radiocollar equipped with an activity sensor. After anatomical measurements and collar attachment were complete, the fossa were returned to their traps and locations of capture, monitored until free from drug effects, and released.

Anatomical measurements included body length, tail length, hindlimb length, hindfoot length, hindlimb circumference, forelimb length, forefoot length, forelimb circumference, chest circumference, neck circumference, canine lengths, and genital measurements. Body length was measured from the tip of the nose to the base of the tail. Tail length was measured from the base of the tail to the tip of the most distal bony tail segment. Hindlimb and forelimb length was measured from the medial fold of the limb to the tip of the longest portion of the footpad. Hindfoot and forefoot length was measured from the most proximal to the most distal portion of the footpad. Forelimb circumference was measured around the widest portion of the brachium. Hindlimb circumference was measured aroung the widest portion of the thigh region. Chest circumference was measured just inferior to the forelimbs. Neck circumference was measured at its most caudal point. Canine lengths were measured from the gumline to the tips of the teeth.

Activity and movement patterns were monitored at five-minute intervals using close- to medium-range (25-500 m) single-receiver radiotracking. Activity state was determined with the aid of the collars' activity sensors and movement patterns.

Results

Two fossa, an adult male and a subadult male, weighing 8.1 kg and 6.5 kg, were captured during this study. The anatomical measurements taken on these two animals are presented in Table 2. Daily path lengths ranged from 2-≥5 km/day. Home ranges overlapped by approximately thirty percent. *C. ferox* travel paths extrapolated from radiotracking indicate heavy use of man-made trail systems when travelling for extended periods of time.

The overall activity cycle for both fossa is presented in Fig. 4. Both individuals maintained a cathemeral activity pattern, with activity levels highest through the late night hours but always complemented by several hours of daytime activity.

The subadult male in this study was killed by local villagers in late July 1996.

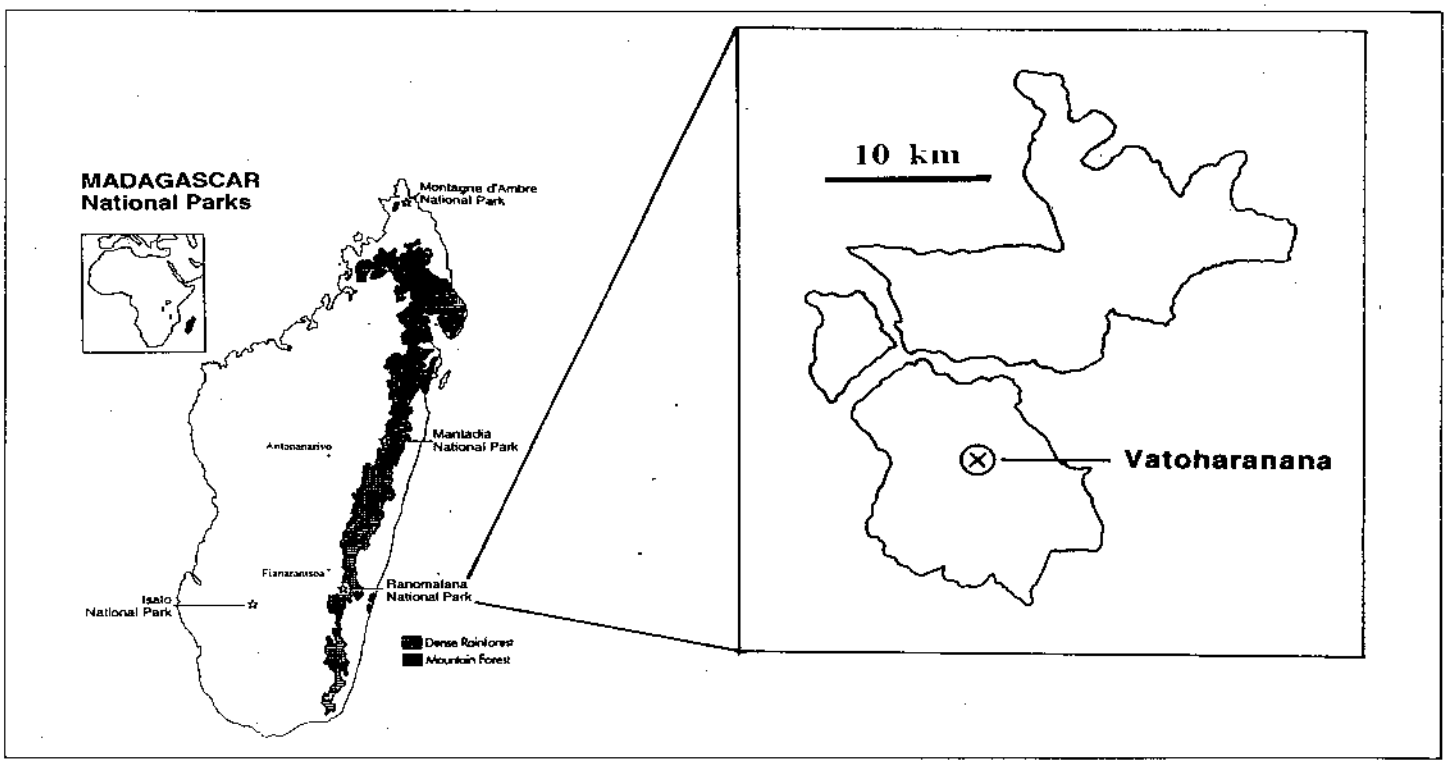

Fig. 3. Map of Madagascar noting the locations of several National Parks, with Ranomafana National Park enlarged. The study site for this project was Vatoharanana, in the southern parcel of the Park.