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Hose's Civet *Diplogale hosei*

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Small carnivores in a logging concession in the Upper Baram, Sarawak, Borneo

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Abstract

Sarawak, Borneo, faces high levels of deforestation: logging, oil palm plantations, hunting and shifting cultivation pose major threats to its diverse fauna. Very little credible, accurate and up-to-date information exists regarding the small carnivores of Sarawak, even though many are considered threatened by the IUCN Red List. The first 54 months of a long-term wildlife monitoring programme in a logging concession in the Upper Baram of Sarawak found 14 of the 19 small carnivores expected there. Yellow-throated Marten *Martes flavigula*, Binturong *Arctictis binturong*, Masked Palm Civet *Paguma larvata*, Common Palm Civet *Paradoxurus hermaphroditus*, Banded Civet *Hemigalus derbyanus* and Short-tailed Mongoose *Herpestes brachyurus* seemed fairly widespread, and Hose's Civet *Diplogale hosei*, endemic to Borneo, was recorded often: the site may thus be a valuable one for further research into this little-known species. Main threats to small carnivores remain unclear, but they are not the primary quarry species of local hunters. Further camera-trapping of small carnivores supplemented with techniques to study the semi-arboreal and semi-aquatic species is urgently required to clarify their conservation status.

Keywords: activity patterns, camera-trapping, *Diplogale hosei*, Hose's Civet, logging

Karnivora kecil di satu kawasan pembalakan di Ulu Baram, Sarawak, Borneo.

Abstrak

Sarawak, Borneo, sedang mengalami kadar kemusnahan hutan yang tinggi: pembalakan, perladangan kelapa sawit, pemburuan dan pertanian pindah randah merupakan ancaman utama kepada kepelbagaian faunanya. Sangat sedikit maklumat terkini yang tepat dan sahih wujud berkaitan karnivora kecil di Sarawak, walaupun kebanyakannya tergolong dalam "IUCN Red List". 54 bulan pertama dalam program kajian jangka panjang pemantauan hidupan liar di sebuah kawasan pembalakan di Ulu Baram, Sarawak, mendapati 14 spesis daripada 19 spesis karnivora kecil yang dijangkakan di situ, dengan kadar penemuan yang rendah berbanding hidupan liar yang lain. Yellow-throated Marten *Martes flavigula*, Binturong *Arctictis binturong*, Masked Palm Civet *Paguma larvata*, Common Palm Civet *Paradoxurus hermaphroditus*, Banded Civet *Hemigalus derbyanus* dan Short-tailed Mongoose *Herpestes brachyurus* nampaknya bertaburan meluas, dan Hose's Civet *Diplogale hosei*, endemik ke Borneo, nampaknya juga biasa ditemui: ini menunjukkan tempat ini suatu tempat kajian sangat bernilai untuk penyelidikan spesis yang sangat kurang kita ketahui ini. Ancaman utama kepada karnivora kecil di sini masih kita tidak pasti,tetapi spesis-spesis ini bukanlah tumpuan utama pemburu-pemburu tempatan. Kajian seterusnya menggunakan perangkap kamera, dan dibantu oleh teknik-teknik penyelidikan untuk spesis-spesis semi-arboreal dan semi-akuatik amatlah diperlukan segera untuk menentukan status pemuliharaannya.

Kata kunci: corak-corak aktiviti, perangkap kamera, Hose's Civet, *Diplogale hosei*, pembalakan

Introduction

The Sundaic subregion of Southeast Asia, comprising the Thai–Malay peninsula, Borneo, Sumatra, Java and Bali, has very high mammal species richness and endemicity (Corbet & Hill 1992). Borneo, approximately 746,337 km², is among its biologically richest units, and a centre of distribution for many Indomalayan faunal genera (MacKinnon et al. 1996) with a high level of mammalian endemicity (Payne et al. 1985).

Borneo currently suffers high levels of deforestation (Langner *et al*. 2007). In the state of Sarawak, forests outside protected areas are rapidly being degraded by timber extraction and converted to oil palm plantations and other land developments. Protected areas make up just 4% of Sarawak's land area whereas 35.2% are earmarked for logging activities (Sarawak Forest Department 1997), so it is critical to document status of mammals in forest remnants within logging concessions and in the modified habitats themselves, to determine conservation priorities and management strategies.

Forest health can, in some circumstances, be ascertained by monitoring carnivores, but this requires sufficient data to be gathered with the resources available. Carnivores sit high in the food chain, and regulate populations of prey and other carnivores through predation and competition. Apart from diverse vertebrate and invertebrate prey, carnivores in Sarawak eat many fruits, and regularly pass intact seeds in their faeces, indicating their importance as seed dispersers (Wells *et al*. 2005). They thus have cascading effects on the entire forest trophic system and play a vital role in forest regeneration.

Borneo was identified as one of seven global priority areas in the 1989 *IUCN/SSC Action plan for the conservation of mustelids and viverrids* (Schreiber *et al*. 1989). It has more endemic carnivores than any other island except Madagascar (calculated from data in Meiri 2005): Bay Cat *Catopuma badia*, Hose's Civet *Diplogale hosei*, Bornean Ferret Badger *Melogale everetti*, and, if a valid species, which most recent authors (e.g. Corbett & Hill

1992, Patou *et al*. 2009) doubt, Hose's Mongoose *Herpestes hosei*. The term 'small carnivores' is used here for small-bodied members of the order Carnivora; that is, all Bornean species of that order excepting Sun Bear *Helarctos malayanus* and Sunda Clouded Leopard *Neofelis diardi*. In the Schedules of Totally Protected and Protected Species in Sarawak (under the Wild Life Protection Ordinance 1998), only the felids (excepting Leopard Cat *Prionailurus bengalensis*) are listed as Totally Protected, with special protection and severe punishment to offenders; all other small carnivores are listed as merely Protected, with limited protection and lenient punishment. In spite of the undoubted importance of Borneo to small carnivores, credible, accurate and up-to-date information about their distribution and ecology in Sarawak is scarce, with few systematic studies.

To understand status and ecology of wildlife in logging concessions in Sarawak, and evaluate conservation priorities and management recommendations, a long-term monitoring programme was launched by WCS Malaysia in 2004 in the Sela'an-Linau Forest Management Unit (FMU), the first of only two concessions in the state to be certified under the Malaysian Timber Certification Scheme. The main objective was to document the diversity and distribution of non-volant mammals, birds and bats within the FMU; small carnivores were simply part of the general remit, and reported here are records of them from the first 54 months. This FMU lies near the Kelabit Highlands that were, through the efforts of T. Harrisson in the 1940s, among the historically best collected parts of Borneo. This collection (Davis 1958) recorded several small carnivores of particular interest through their endemicity to Borneo and/or present global threat status, making a modern assessment of the area a high priority.

Methods

Study Area

The Sela'an-Linau FMU, of 55,949 ha, lies in the hinterland of northern Sarawak, north of the upper Baram River (Fig. 1). Samling Strategic Corporation (Samling) is the licensed concessionaire, under Timber Licence T/0412. In the FMU live many indigenous communities such as the Kayan, Kelabit, Kenyah and Penan, many of whom depend on forest for their livelihoods and on wildlife for their protein.

The Sela'an-Linau FMU is undulating in nature, with altitudes from 300 m above sea level (a.s.l.) in its south-west to about 2,000 m a.s.l. in the Tama Abu Range on its eastern edge. Much supports mixed dipterocarp forest (60%), with some montane forest on higher ground (4%) and tropical heath forest (*kerangas*) on infertile soils (21%). Old and current swidden (*temuda*) covers 15%. Enrichment planting with native timber species is occurring in some 3,000 ha that burnt during the 1997–1998 El Niño event. About half the forest was logged conventionally in the past, and since 2003 a reduced impact logging (RIL) is applied. The area receives high rainfall (3,400–5,900 mm annually) with no distinct wet or dry season. Temperatures in low-lying areas average around 26˚C, falling to 14˚C on summits.

Surveys were concentrated in 14 sites in the western, northern and central Sela'an-Linau FMU (Fig. 2). The survey areas was divided into sectors based on a variety of human uses, to allow investigation of occurrence patterns for regularly encountered species (Table 1; elaborated in Hon *et al*. 2009); no small carnivore was found frequently enough to allow an analysis of such spatial precision. Most of the survey efforts were performed in the Pro-

Fig. 1. The Sela'an-Linau Forest Management Unit (FMU) in Upper Baram.

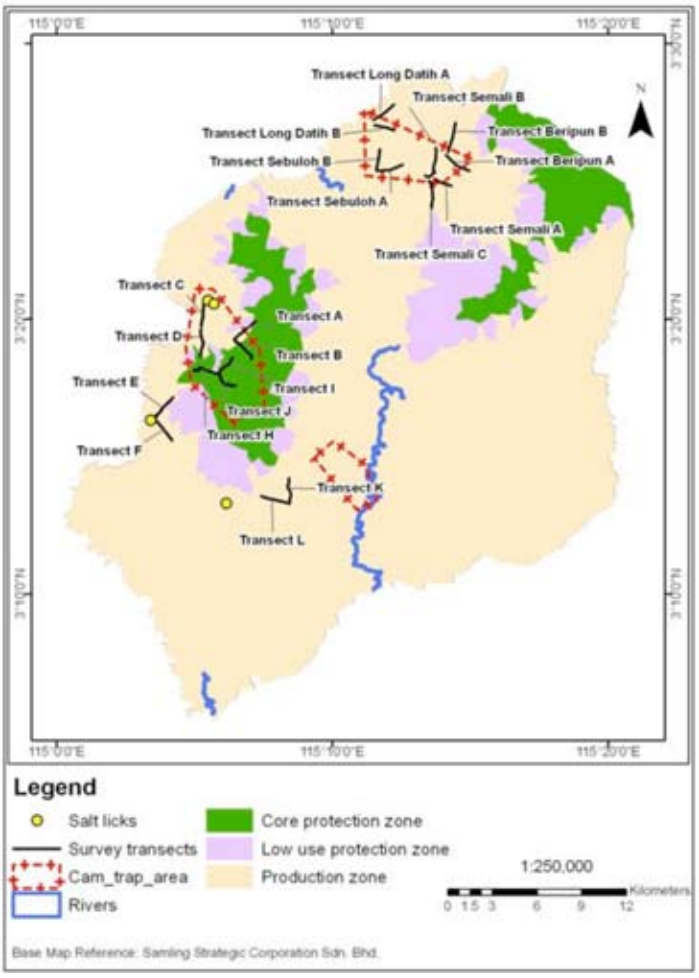

Fig. 2. Location of line transects used for wildlife surveys and focal areas of camera-trapping in the Sela'an-Linau FMU.

tected Zone (PZ), an area which is set aside for conservation, with no timber harvesting planned in the FMU's current Forest Management Plan. The PZ is not gazetted under the state government and hence, has no legal protection. The PZ covers roughly 15,000 ha, comprising a fairly contiguous block of about 8,000 ha and clusters of smaller, oddly shaped, patches. It is mainly montane and submontane forest, ranging from 900 m to almost 2,000 m a.s.l.

Methodology

Fieldwork spanned March 2004 to September 2008, using multiple methods. Three recorded small carnivores: line transects (diurnal direct observation), sign surveys, and camera-trapping. The survey walked 789⅛ km of line transects, 277½ km during sign surveys, and camera-trapped for 5,252 trap-nights.

Camera-trapping occurred from January 2005 to September 2008, using 40 Camtrakker™ units. In 2008, two LeafRiver digital units were acquired. By the end of survey, all 42 cameras were out of commission, mainly through high humidity. Cameras were set at salt licks, at Great Argus *Argusianus argus* dancing grounds, and along ridges near the transect lines. Some were placed far from transect lines. Cameras were placed typically at heights of 20–30 cm above ground level, at a distance 1–1½ m from the animal trail. All cameras were set to run all 24 hours per day. Initially, baits of sardines and dead chicken, and lures consisting of commercially available essences of banana, pandan and yam were trialled. This was abandoned because ants and rats quickly consumed baits and the heavy rains in the study area soon washed away all traces of the lures. Because many cameras malfunctioned, it was not possible to determine whether the baits/lures increased encounter rate of animals. Independent observations were taken as consecutive images of conspecifics at the same camera location separated by at least half an hour (O'Brien *et al*. 2003). This did not pose much of a problem: most such images were separated by at least 2 hours, with Malay Civet and Masked Palm Civet the species most often providing repeat photographs within half an hour. The 24 hours of the day were divided into 01h01–04h00 = Late night; 04h01–07h00 = Dawn; 07h01–10h00 = Morning; 10h01–17h00 = Day; 17h01–19h00 = Dusk; 19h01–23h00 = Early night; 23h01–01h00 = Midnight.

Line transects undertaken separately for direct sighting and for sign surveys were the major general survey methods (Hon *et al*. 2009) but both yielded too few small carnivore records for species-level analysis. Latrines, with multiple piles of faeces of different ages, were reported by local people to be only from Malay Civet. If true, it would enable effective detection and visual identification of Malay Civet through signs. These records, those from reconnaissances, and incidental records were all used in the preparation of the present text.

Results

In total, 16 carnivore species were recorded: 14 small carnivores, Sun Bear and Sunda Clouded Leopard (Table 2). Of the small carnivores, four are listed as Vulnerable under the *IUCN Red List of Threatened Species* and one as Data Deficient (IUCN 2009). Otters could not be identified to species; the species present is/are Endangered, Vulnerable and/or Near-Threatened. Both large carnivores are Vulnerable. The Protected Zone recorded nine of the 14 small carnivore species found (64.3%). Survey effort and type varied too much from site to site for comparisons between them of their small carnivore records to be meaningful (Table 1).

Malay Weasel *Mustela nudipes*

Malay Weasel was encountered twice, on the ground, by line transect surveys (Table 3). It was never camera-trapped, reflecting a great rarity of such photographs from across its range, for as yet unknown reasons (Duckworth *et al*. 2006).

Yellow-throated Marten *Martes flavigula*

Martens were found under a wide range of disturbances including logging activities, shifting cultivation and hunting pressure. As in India (Choudhury 1997) and Myanmar (Than Zaw *et al*. 2008), it occupied a wide elevation range. It was found twice in the middle canopy of trees, and thrice on the ground, in the morning and dusk, reflecting its mainly diurnal nature (Grassman *et al*. 2005, Than Zaw *et al*. 2008). Animals were detected as singletons, duos or trios, as elsewhere (Parr & Duckworth 2007). Line transects recorded more encounters than did camera-traps.

Otters

Otters were found only thrice, through tracks not identified to species. Very little is known about the different species of otters in Sarawak. Oriental Small-clawed Otter *Aonyx cinereus* may be the widest-ranging otter in the state (Payne *et al*. 1985) and is

Table 1. Survey sites, their relative levels of disturbance and survey techniques employed.

Site	Logging regime		Hunting pressure	Elevation	Proximity to logging roads	Proximity to slash and burn fields and settlements	Degree of contiguous forest	Line transect (km)	Sign survey (km)	Camera-trap (trap-nights)
Coupe 1 Block 8 (A and B)	Logged <5 years ago by RIL	Before logging	M	M	M	M	H	73.8	40	Not conducted
		After logging	M	M	M	M	M	76.425	34.025	Not conducted
Coupe 1 Block 4 (C and D)	Logged 5–10 years ago by RIL		H	L	H	H	L	138.575	74.275	All spoilt
Coupe 1 Blocks 5, 6 and 11	Logged <10 years ago by RIL		H	L/M	H	H	L	Not conducted	Not conducted	461
Coupe 9 Block 14 (E and F)	Logged > 15 years ago by CL, then subject to silviculture treatment		H	L	M	M	M	79.425	42.675	All spoilt
Protected Zone (H, I and J)	Not to be logged		L	H	L	M	H	94.45	48.55	1,280
Coupe 5 (K and L)	Logged >15 years ago by CL, subsequently***		H	L	H	H	L	16.0	8.0	All spoilt
Selungo	Unlogged; surrounded by burnt areas		H	L	M	H	M	Not conducted	Not conducted	641
Sebuloh	Unlogged		H	M	L	H	M	88.75	8.0	Not conducted
Beripun	Unlogged		L	M	L	L	H	56.0	4.0	546
Semali	Unlogged,		L	H	L	L	H	85.5	9.75	1,199
Long Lellang*	Unlogged		H	L	H	H	L	2.85	1.225	312
Long Sabai**	Unlogged		M	M	L	M	M	Not conducted	Not conducted	469
Selunok	Unlogged		M	M	L	M	H	Not conducted	Not conducted	344
Long Datih	Unlogged		H	L	L	M	M	39.6	7.0	Not conducted

Relative levels (L=low, M=medium, H=high) of hunting pressure, proximity to logging roads, proximity to slash and burn fields + settlements and forest contiguity were assessed qualitatively through the surveyors' observations. Elevation: low = average elevation <600 m above sea level; medium = average elevation 600–900 m a.s.l; high = average elevation >900 m a.s.l.

CL = Conventional Logging; RIL = Reduced Impact Logging.

*Kelabit settlement; **Penan settlement; *** subsequently burnt during El Niño fires 10 years ago; now subject to reforestation and shifting cultivation

known from the Kelabit Highlands, as is Hairy-nosed Otter *Lutra sumatrana* (Davis 1958). Although Smooth-coated Otter *Lutrogale perspicillata* is widely distributed on Borneo, it has so far not been recorded in these highlands. Otter signs were found only in unlogged sites within the Sela'an-Linau FMU, but further survey is needed to determine whether this reflects chance or a genuine pattern of habitat use.

Banded Linsang *Prionodon linsang*

A single linsang was camera-trapped on the ground, off an animal track, at 00h34 on 18 May 2005 in the Protected Zone at 1,100 m (3°17′32″N, 115°06′15″E).

Malay Civet *Viverra tangalunga*

This civet was the most frequently found small carnivore, photographed twelve times and detected by its apparent signs nine times, in three sites at medium to low elevation, with various levels of hunting pressure and disturbance from shifting cultivation and logging activities, in fairly contiguous forest. Images were at early night, midnight, late night, dusk, and, mostly, dawn, suggesting a more crepuscular nature with some nocturnal activity, as found by Colón (2002) and Jennings *et al.* (2006). All images were of singletons; except one adult with an infant on 25 December 2005 at 18h26, in low elevation forest, close to old slash and burn fields (03°14′58″N, 115°10′20″E; altitude 530 m).

Common Palm Civet *Paradoxurus hermaphroditus*

This civet was detected thrice, always singly, this low detection no doubt reflecting its partly arboreal and nocturnal nature (Payne *et al*. 1985). Records came from lower elevation forest with high hunting pressure, rather close to logging roads and slash and burn fields. The sighting was in the morning in treetops; camera-trap images were at midnight and late night, in line with past information that this species is overwhelmingly nocturnal with occasional daylight activity.

Masked Palm Civet *Paguma larvata*

This civet was found once by line transects and six times by camera-traps. The single sighting was of a duo at about 11h00 on 14 May 2008, at altitude of about 690 m: the lowest encounter. Camera-trap images were all of singletons**,** at early night, midnight and late night, suggesting the species is nocturnal with occasional day-

Table 2. Carnivores detected by all survey methods at all sites.

Species	Sites with corresponding number of independent observations at each site																
	Coupe 1 Block 8		Coupe 1 Block 4	Coupe 1 Blocks 5, 6, 11	Coupe 9 Block 14	Protected Zone	Coupe 5	Selungoh	Sebuloh	Beripun	Semali	Long Lellang	Long Sabai	Selunok	Long Datih	Total no. of sites detected	IUCN Red List Status
	Before logging	After logging															
Malay Weasel	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	2	LC
Yellow-throated Marten	1	0	1	0	0	1	0	0	0	1	1	0	0	0	0	5	LC
Otter (Lutrinae)	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	3	**
Banded Linsang	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	LC
Malay Civet	8	1	0	0	0	0	0	12	0	1	0	0	0	0	0	3	LC
Common Palm Civet	0	0	0	0	0	0	0	2	0	0	0	0	0	0	1	2	LC
Masked Palm Civet	0	0	0	0	0	4	0	1	2	0	0	0	0	0	0	3	LC
Binturong	1	0	0	0	1	2	0	3	0	0	0	0	0	0	0	4	VU
Hose's Civet	0	0	0	0	0	9	0	0	0	0	2	1	0	0	0	3	VU
Banded Civet	0	0	0	0	0	3	0	2	0	0	1	0	0	0	0	3	VU
Collared Mongoose	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	1	DD
Short-tailed Mongoose	0	0	1	0	0	1	0	2	0	0	0	0	0	0	0	3	LC
Marbled Cat	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	VU
Leopard Cat	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	LC
Total number of species detected at each site	3 *m	1	2 *c	0	2 *m	9	0	7	3	3	4 *c	1	0	0	1		
Sun Bear	10	4	4	0	2	15	0	5	5	4	5	1	*	*	1	12	VU
Sunda Clouded Leopard	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	1	VU

'Independent observations' are defined in the text. Total number of sites where each species was detected and total number of small carnivores detected at each site is given, with corresponding IUCN Red list status (LC=Least concern, DD=Data deficient, VU=Vulnerable, EN=Endangered). Legal protection status in Sarawak is discussed in the text.

* Signs recorded incidentally at these sites, but not during formal transects.**All possible species are at least Near-Threatened (see text).*c Tracks of unidentified civets were recorded at these sites.*m Tracks of unidentified mongooses were recorded at these sites.

light activity, in line with previous studies (e.g. Than Zaw *et al*. 2008). This civet's semi-arboreal nature (Than Zaw *et al*. 2008) may have contributed to the relatively few photographs.

Binturong *Arctictis binturong*

Binturongs were detected four times by camera-trap and thrice by line transects. Direct sightings were all in trees whereas camera-trap images were on the ground, suggesting that though this species may be generally arboreal, it may have to descend to the ground frequently when moving between trees, due to its heavy build (Than Zaw *et al*. 2008). It was encountered fairly close to slash and burn fields and in forests with elevation and hunting pressure ranging from low to high. This suggests that in this concession, hunting may not be a serious threat for this species. Records were consistently in forests with medium to high contiguity, and not near logging roads; the sole logged site with a record had been logged more than 15 years ago. Direct sightings were all by morning, whereas camera-trap images were from morning, early night, midnight and late night, corroborating reports that Binturongs are regularly active by day (Nettelbeck 1997), and contrary to statements they are mostly nocturnal (e.g. Rozhnov 1994). Ground-level camera-trapping is an excellent tool for determining activity patterns of ground-dwelling species, but for those largely arboreal its results need triangulation with methods able to detect the species at all heights in the habitat, in case visits to the ground are not spread randomly through the animal's activity cycle. This remains unknown in the case of Binturongs.

Table 3. Sightings of Malay Weasel Mustela nudipes.

Site	Lat (N)	Long (E)	Altitude (m)	Date	Time	Nº animals
Sebuloh	3˚25.824′	115˚10.533′	673	30 Oct 2004	10h07	2
Coupe 9 Block 14	3˚16.512′	115˚3.634′	*	23 Sept 2006	07h17	1

* unknown precisely; low or medium elevation

Table 4. Camera-trap encounters of Hose's Civet Diplogale hosei and Collared Mongoose Herpestes semitorquatus.

Species	Site	Lat (N)	Long (E)	Altitude (m)	Date	Time	Other notes
Hose's Civet	Semali	3˚25.302′	115˚13.602′	945	6 Sept 2005	22h59	
	Semali	3˚25.302′	115˚13.602′	945	26 Sept 2005	23h10	
	Long Lellang	3˚25.807′	115˚08.094′	731	3 Nov 2005	18h33	
	PZ	3˚17.538′	115˚06.308′	1650	6 July 2005	19h40	Animal track off Trail H
	PZ	3˚17.538′	115˚06.308′	1650	17 April 2005	22h22	Animal track off Trail H
	PZ	3˚18.201′	115˚05.194′	1300	23 May 2005	02h34	Animal track on ridge off Trail J
	PZ	3˚17.963′	115˚05.243′	969	20 Nov 2005	19h17	Animal track on ridge
	PZ	3˚17.963′	115˚05.243′	969	22 Nov 2005	19h06	Animal track on ridge
	PZ	3˚17.963′	115˚05.243′	969	1 Dec 2005	05h04	Animal track on ridge
	PZ	3˚17.526′	115˚06.252′	1083	20 April 2005	22h53	Animal track near ridge, off Trail H
	PZ	3˚17.551′	115˚07.025′	>1000	29 Sept 2005	00h46	Animal track on ridge in mossy forest; little undergrowth
	PZ	3˚17.551′	115˚07.025′	>1000	4 Oct 2005	01h34	Animal track on ridge in mossy forest; little undergrowth
Collared Mongoose	Selungo	3˚13.430′	115˚10.859′	356	12 May 2005	unknown	
	Selungo	3˚14.325′	115˚10.724′	300	12 May 2005	16h47	

Table 5. Number of independent observations of each carnivore species using each method.

Species	Number of independent observations			
	Line transect	Sign survey	Camera-trap	Total
Malay Weasel	2	0	0	2
Yellow-throated Marten	4	0	1	5
Otter	0	3	0	3
Banded Linsang	0	0	1	1
Malay Civet	0	9	12	21
Common Palm Civet	1	0	2	3
Masked Palm Civet	1	0	6	7
Binturong	3	0	4	7
Hose's Civet	0	0	12	12
Banded Civet	0	0	6	6
Collared Mongoose	0	0	2	2
Short-tailed Mongoose	2	0	2	4
Marbled Cat	0	0	1	1
Leopard Cat	0	0	1	1
Large carnivores				
Sun Bear	4	45	7	56
Sunda Clouded Leopard	0	0	3	3

Survey effort is quantified in the text; 'total' refers here only to records by these three survey methods.

Hose's Civet *Diplogale hosei*

Hose's Civet was detected in three sites, only by camera-traps. The number of individuals involved is unknown. Being a plain-coated species, identification of Hose's Civet photographs to individual is more challenging than with patterned species. The 12 images were spread across the night (Table 4), suggesting the species is crepuscular and nocturnal. All images were from unlogged forests, all but one from montane forests with low hunting pressure, far from logging roads; these forests had high contiguity and were not close to slash and burn fields. One image, however, came from low elevation forests (the camera site itself was at 731 m a.s.l.), with high hunting pressure, near logging roads (but not with logging activities per se), and fragmented by slash and burn fields. Whether this is a dispersing animal or whether Hose's Civet can subsist in these more encroached areas, is unclear.

The Sela'an-Linau FMU may be the only place where camera-trapping found this little-known species regularly, let alone as one of the two most commonly trapped small carnivores (Van Rompaey & Azlan 2004, J. W. Duckworth verbally 2009). Moreover, the area providing the biggest series of collected specimens was the nearby Kelabit Highlands (Davis 1958): perhaps this part of Sarawak is the species's prime habitat. The conservation needs of Hose's Civet are entirely unknown (Van Rompaey & Azlan 2004, Yasuma 2004). Outside Sarawak, this species has been recorded only in Sabah (e.g. Wells *et al*. 2005) and Brunei (e.g. Yasuma 2004).

Banded Civet *Hemigalus derbyanus*

This civet was recorded seven times, six as singletons by camera-traps. Its higher photograph rate than palm civets may reflect a more ground-dwelling nature. All images were at midnight or late night, corroborating its exclusively nocturnal nature (Davis 1962). Coat colour varies much in northern Borneo (Davis 1962). All images were of buffy-grey animals with black bars across back and face, and this may be the predominant colour form over Sarawak (examination of about 15 skins in Sarawak Museum in 2009). A local hunter killed a rich reddish brown animal (as shown in Payne *et al*. 1985) in early 2004 in Sebuloh, an unlogged area at medium elevation, close to slash and burn fields, indicating that this colour form also inhabits the area.

More camera-trapping is required to clarify this civet's status, particularly its use of disturbed habitats. Its IUCN Red Listing as Vulnerable is based on declines inferred from habitat change; there seems to remain no empirical study of its adaptability to encroachment and change in land-use patterns.

Collared Mongoose *Herpestes semitorquatus*

Collared Mongoose was camera-trapped at only one site; one im-

age came from an animal track near a logging road in secondary forest (dense undergrowth), surrounded by burnt area, with the other from an animal track in a burnt area (Table 4).

Short-tailed Mongoose *Herpestes brachyurus*
This mongoose was encountered in three sites, twice each by camera-trap and line transects. Sites, always fairly close to slash and burn fields, varied in hunting pressure, elevation, proximity to logging roads and forest contiguity. It may be a widespread opportunist, tolerant of disturbance. All records were of singletons on the ground. Sightings were in the morning, photographs in the morning and by day, indicating at least mainly diurnal activity.

Marbled Cat *Pardofelis marmorata*
A Marbled Cat was camera-trapped on an animal track in the Protected Zone (3°17′32″N, 115°06′18″E, altitude 1,650 m), on the ground, at 05h49 on 22 April 2005.

Leopard Cat *Prionailurus bengalensis*
A Leopard Cat was camera-trapped in the Protected Zone in the early night.

Concluding discussion

Camera-trapping was the best survey method for small carnivores (Table 5): of 14 species recorded, 12 were detected by camera-traps, only six by line transects, and, given ambiguous species identification, sign surveys were useful only for Malay Civet, Sun Bear and otters. Sun Bear was the most widely found carnivore, in 12 of the 14 sites (Table 2). This is, however, to be expected: Sun Bear and Malay Civet are the only species identifiable by signs, increasing recording efficiency. Small carnivores were mostly sparsely recorded. Yellow-throated Marten was the most widely encountered, at five sites (35.7%), perhaps reflecting its position as one of the few carnivores recorded during line transects, rather than it genuinely being more widespread than all other species. Binturong, Masked Palm Civet, Common Palm Civet, Banded Civet and Short-tailed Mongoose are also probably widespread within the FMU. Hose's Civet and Malay Civet, though two of the most commonly found small carnivores, were found at few sites. Malay Civet may occur mainly below 900 m a.s.l. and Hose's Civet may be more common between 600 to 1,800 m a.s.l. Banded Linsang, Marbled Cat and Leopard Cat were detected in just one site each (7.1%). All these patterns, however, require verification through more records.

Comparison with results for muntjac *Muntiacus* spp. over the same period, using the same criteria for independent observations, highlights the effort needed for small carnivore records, and how comparisons between species might well just reflect differences in survey methodology effectiveness. At least 170 independent images of muntjac were obtained (a conservative estimate: some images could not be identified precisely, and many lacked the time print, hindering tallying of independent images) compared with the peak of 12 for any small carnivore (both Hose's Civet and Malay Civet). Line transects gave 140 independent muntjac observations, compared with four each for Yellow-throated Marten and Short-tailed Mongoose, the most recorded small carnivores. Sign surveys gave 163 independent muntjac observations, compared with the maximum of nine for any small carnivore (Malay Civet).

At least 19 species of small carnivore are expected in the Upper Baram region, of which 14 were found in the Sela'an-Linau FMU during 54 months of line transects, sign surveys and camera-trapping. These 14 include four species listed as Vulnerable by the *IUCN Red List of Threatened Species* (IUCN 2009): Hose's Civet (endemic to Borneo), Binturong, Banded Civet and Marbled Cat. Otters were not identified to species, but are also red-listed. One species, Collared Mongoose is Data Deficient on the Red List.

The otter species present in the FMU remain unclear; Davis (1958) recorded two in the nearby Kelabit Highlands (see above). At least four more species of small carnivore plausibly in the Upper Baram were not found by this survey. Small-toothed Palm Civet *Arctogalidia trivirgata* (IUCN Least Concern) was recorded in the Kelabit Highlands by Davis (1958) and reported by local people in the FMU. It is strongly nocturnal and arboreal (Payne *et al*. 1985), and no survey methods suitable to find it were used (see Wilting *et al*. 2010). Local hunters' reports suggested that two IUCN Endangered species, Bay Cat, endemic to Borneo and one of the rarest cats in the world (Mohd-Azlan & Sanderson 2007), and Otter Civet *Cynogale bennettii*, previously seen in the Kelabit Highlands by Harrisson (Medway 1977), occurred in the FMU. Reports dated from before logging operations were wide scale. Another species, the Sunda Stink-badger (Malay Badger) *Mydaus javanensis* (IUCN Least Concern), has been collected several times in the Kelabit Highlands (Davis 1958). This highly distinctive species seemed unknown to local people, so it may have never inhabited the FMU.

The main threats to small carnivores in the FMU remain unclear. Local hunters do not actively seek them, and some species were found in areas of high hunting pressure. Hunting in the FMU usually (but not always) involves dogs, which accompany local hunters in their search for ungulates, especially Bearded Pig *Sus barbatus*, muntjacs and Sambar *Cervus unicolor*. Primates, especially macaques *Macaca* and langurs *Presbytis*, and rodents are hunted to a lesser extent. At least Sun Bear, Binturong and other palm civets are taken as encountered, but hunters do not set out to hunt them. Local hunters usually use home-made guns, spears and blowpipes, and hunt both by day and night. Snares are much used, targeting pheasants, rodents and chevrotains (mousedeer) *Tragulus*, although often, civets, particularly Malay Civet, fall victim.

Many small carnivores were found in areas affected by logging, but the latter may constrain Binturong range. Otters in mainland South-east Asia are in heavy decline, through greatly increased trade-driven hunting (e.g. Than Zaw *et al*. 2008), but this seems not to occur in Sarawak. Instead, here, shrinking habitat, pollution and siltation of rivers, the use of chemicals and explosives/electricity when fishing, resulting in severe depletion of the prey base of otters, may be problematic (see SAMD 2006). Shifting cultivation might be a threat to small carnivores mainly through the temporary loss of the areas under cultivation at any given time: most species were found near slash and burn fields. However, the ability for populations to persist in landscapes with extensive such conversion may differ greatly from the ability of individuals resident in adjacent tall forest to use small degraded patches.

Urgently required now are studies specifically of small carnivores to determine distribution and conservation status within the Sela'an-Linau FMU. Encounter rates are very low and many species nocturnal and crepuscular: line transects yield few data. Sign

surveys are useful only for few species. Night-spotting may be an option, but there are no roads in unlogged areas and uneven terrain makes passage on foot noisy. Moreover, it is risky to the surveyors: hunters regularly use firearms at night in the FMU. Camera-traps seem best to study these animals, except those species mostly arboreal. Modifications to the selection of sites for camera-traps so far used here could include aiming cameras towards fallen trees, and, in particular, using odours/scents in canisters resistant to rain (see Giman *et al*. 2007). Otters may require camera placement nearer rivers and streams, which would also allow consideration of Otter Civet status. Knowledge of local guides is invaluable in selecting sites: that the Selungoh site yielded many species and records in part reflects that the main guide was from this area. Wider use in camera-trapping surveys of hunters knowledgeable of each site could boost small carnivore encounter rates. It is also suggested that a record be kept of animals hunted by local hunters, with detailed description of where they were hunted.

In conservation terms, Hose's Civet stands out from the other species recorded, because it has a much smaller known range, and no protected area is known to hold a large population. Fuller survey of montane northern Borneo to allow an assessment of overall status is imperative. For detailed research on Hose's Civet conservation needs, Sela'an-Linau FMU may be invaluable, because the species seems to be common there. Thus far, nobody has attempted any autecological research on it because no suitable site was previously known. Currently, the basic factors likely to determine its long-term future, such as population densities, dependency level on old-growth forest (if any), ranging and dispersal patterns, and others, are entirely unknown. Specific conservation measures (if indeed any are needed) are thus presently impossible. Its naturally highly localised distribution (i.e. one not bounded by coasts or other physical barriers) implies it is a habitat specialist that perhaps may be under great threat. Thus, such research is urgent.

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Diversity of Bornean viverrids and other small carnivores in Deramakot Forest Reserve, Sabah, Malaysia

Andreas WILTING[1], Hiromitsu SAMEJIMA[2] and Azlan MOHAMED[3,4]

Abstract

We used camera-trapping and night spotlight surveys to investigate carnivores in a lowland tropical rainforest in Borneo. Here we report records of 14 small carnivore species from Deramakot, a commercial forest reserve, where a reduced impact selective logging system is practised. Some of the recorded species like the Otter Civet *Cynogale bennettii* or the Hairy-nosed Otter *Lutra sumatrana* have rarely or never been recorded with camera-traps in Borneo. The observed very high diversity of carnivores, especially of globally threatened wetland species, highlights the importance of this lowland forest complex and suggests that even commercially used forests may harbour a high diversity of carnivores.

Keywords: Viverridae, Mustelidae, lowland tropical rainforest, camera-trapping, spotlight surveys

Kepelbagaian Viverridae dan haiwan karnivor kecil Borneo di Hutan Rizab Deramakot, Sabah, Malaysia

Abstrak

Kaedah kamera perangkap dan tinjauan malam telah digunakan untuk mengkaji karnivor di hutan hujan tropika tanah rendah di Borneo. Empat belas spesies karnivor kecil daripada kawasan hutan simpan komersial Deramakot, di mana sistem pembalakan berimpak rendah secara terpilih dijalankan, telah direkodkan. Sesetengah spesies yang direkodkan seperti musang memerang *Cynogale bennettii* dan memerang hidung berbulu *Lutra sumatrana* sangat jarang atau belum pernah direkodkan sebelum ini dengan menggunakan kamera perangkap di Borneo. Kepelbagaian karnivor yang tinggi yang diperhatikan, terutamanya spesies tanah lembap yang semakin terancam menekankan kepentingan kompleks hutan tanah rendah ini dan seterusnya mencadangkan bahawa hutan simpan komersial juga berkemungkinan memiliki kepelbagaian karnivor yang tinggi.

Kata-kata kunci: Viverridae, Mustelidae, hutan hujan tropika tanah rendah, kamera perangkap, tinjauan malam

Introduction

The project Conservation of Carnivores in Sabah (ConCaSa) of AW and AM investigates the consequences of different forest management strategies on two carnivore families, Felidae and Viverridae, in the Malaysian part of Borneo. Little is known about small carnivores, in particular viverrids, on Borneo and most previous research focussed on completely protected areas of primary or older secondary forests. It is likely that long-term survival of some carnivore species in Sabah will depend on the sustainable management of the large, commercially used areas beyond completely protected sites. We therefore investigate and compare the diversity, abundance and occupancy of mainly felids and viverrids in three commercially used forests (Deramakot Forest Reserve (FR), Tangkulap FR and Segaliud Lokan FR) which followed different management regimes in the past.

Here we report our preliminary findings on viverrids and provide short notes on other small carnivores, Herpestidae, Mustelidae and Prionodontidae, from Deramakot FR (5°22′N, 117°25′E). This forest reserve, encompassing approximately 550 km², is the flagship of the Sabah Forestry Department, as the first natural forest in Southeast Asia to receive Forest Stewardship Council certification as a "well managed" forest in 1997 (Lagan *et al.* 2007). All logging practices in Deramakot follow a strategy of reduced impact logging and hunting is strictly forbidden (Lagan *et al.* 2007).

From July 2008 until January 2009 the ConCaSa project conducted field work in north-western Deramakot FR in an area of about 112 km² (altitude between 60 m and 250 m a.s.l.). A map locating the study site is in Mohamed *et al*. (2009). The investigated section was harvested by conventional selective logging in the 1980s and partly again using the reduced impact selective logging system during 1995–2007. A grid of camera-traps with two units at each station had 48 camera-trap locations with the camera pair placed for 42 days at each location. This led to a total of 1,916 useable trap nights (full 24 hours) of systematic camera-trapping. The mean distance between the camera-traps was 1.7 km (range 1.2 – 2.4 km) and cameras were set at a height of about 30-40 cm above the ground along roads, former skid or wildlife trails. We did not use any lures or baits, because this might bias capture probabilities of different individuals or species. We also performed night spotlight surveys from the back of a pickup car, as strictly arboreal species were unlikely to be detected with the ground-based cameras. During 45 night spotlight surveys we covered 615 km (41 km repeated 15 times). Parallel to this project, HS conducts another research project in Deramakot with a different camera-trapping approach, with 60 single cameras set up in 20 different compartments through the entire forest reserve.

Diversity of viverrids

Our surveys recorded six out of eight Bornean viverrid species in Deramakot FR (Table 1). The only two not recorded were Hose's Civet *Diplogale hosei* and Masked Palm Civet *Paguma larvata*.

Table 1. Camera-trapping and night survey results for small-carnivores from Deramakot Forest Reserve.

Species	N° photos	N° occasions	N° trap nights / n° captures	N° sightings during 45 night surveys
Yellow-throated Marten	1	1	1,916	1
Hairy-nosed Otter[1]	1[3]	1[3]	-	-
Smooth-coated Otter[1]	5	3	-	-
Small-clawed Otter[1]	1	1	-	-
Sunda Stink-badger	107	69	27.8	1
Banded Linsang	6[2]	-	-	-
Malay Civet	326	222	8.6	12
Common Palm Civet	225	156	12.2	26
Binturong	1	1	1,916	6
Small-toothed Palm Civet	-	-	-	23
Banded Civet	44	35	54.7	2
Otter Civet	10	9	212.9	1 + 1[3]
Short-tailed Mongoose	30	25	76.6	-
Collared Mongoose	17	11	174.2	-

[1]Due to the difficulties in the identification of otter species, a few other photographs could not be assigned to one of the species with high certainty and were excluded, so the given numbers are minimum numbers.

[2]Only recorded by HS; HS's records are not included in the other species' totals.

[3]Photographs or sightings were made before or after the systematic camera-trapping or night survey efforts.

Hose's Civet, endemic to Borneo, is assumed to occur only in montane regions (Yasuma 2004) or nearby (Wells *et al*. 2005). It might be also the case that Masked Palm Civets are generally rarer at low altitudes in Borneo, because for example Boonratana (2010) never encountered this species during his surveys at the Kinabatangan River in Sabah.

All other six Bornean viverrid species were recorded either by camera-trapping and/or by night spotlight surveys. Of these six species, three are classified as globally threatened by the *IUCN Red List of Threatened Species* (IUCN 2008). Due to the rapid loss of forested areas in Southeast Asia, the Binturong *Arctictis binturong* and the Banded Civet *Hemigalus derbyanus* were reclassified in 2008 from Least Concern to Vulnerable. The most endangered civet in Southeast Asia is the Otter Civet *Cynogale bennettii* which is a lowland and wetland dependent species, areas which suffer from large scale habitat transformation in Southeast Asia (Wilting *et al*. in press). So far only in Way Kambas National Park, along Sumatra's south-east coast have a higher number of records (59 camera-trapping photographs between 1996 and 1998) been reported than at Deramakot FR; other records were incidental sightings or consisted of only a few camera-trapping pictures (e.g. Veron *et al*. 2006, Cheyne *et al*. 2010). During the systematic camera-trapping surveys, the ConCaSa project photographed this species on ten occasions (Fig. 1A) and observed it on two night spotlight surveys. All photographs were from the northwestern part of our study site, a flat area with numerous ponds and streams. As all camera-trapping locations that recorded the Otter Civet were close to water resources, our records support the assumption of high association with wetlands. On one of two direct sightings, two Otter Civets were observed along an old logging road and one fed on an insect (Video 1). The high number of Otter Civet records suggests that the northwestern part of Deramakot FR is a good habitat for this species.

The two most common viverrid species during the ConCaSa surveys were the Malay Civet *Viverra tangalunga* and the Common Palm Civet *Paradoxurus hermaphroditus* (Table 1). Both species were recorded throughout the entire study area and often observed during spotlight surveys. Generally these two species are the most abundant and commonly seen civets in logged forest throughout Sabah (J. Payne *in litt.* 2010). Especially the Malay Civet was recorded in all kinds of habitats; along roads (Video 2) in a more open habitat, as well as with camera-traps inside the forest (Fig. 1B). Although the Common Palm Civet was also recorded inside the forest, most of the photos were taken along the roads. On several photographs, the Common Palm Civet scent-marked the road; this behaviour was also repeatedly observed during spotlight surveys. Several Common Palm Civets in Deramakot had a white or yellowish tip of the tail (see Fig. 1C; Video 3). Although this feature is regularly reported for the Brown Palm Civet *Paradoxurus jerdoni*, which is endemic to the Western Ghats in India, and the Masked Palm Civet, it is only patchily reported for the Common Palm Civet. It was described for Bornean Common Palm Civets in Banks (1931), but later mammal guides for Borneo do not mention that this feature is present in Common Palm Civets and not unique for the Masked Palm Civet on Borneo (Medway 1977, Payne & Francis 1985, Yasuma & Andau 2000). Davis (1962: 107) wrote in his comprehensive summary of the north Bornean mammals about the tail of Common Palm Civets "uniformly very dark brown to the tip" and later guidebooks might be solely based on his description. Therefore the white or yellowish tip of the tail has been used in the past as a trait to differentiate Masked Palm Civets from similar looking species on Borneo, and might have let to false Masked Palm Civet records and an overestimation of its Bornean distribution, especially in lowlands. Our camera-trapped animals show some characteristics such as spots or stripes and a darker face with small white or pale grey patches that clearly distinguish them from Masked Palm Civets. Altogether on 22 occasions (14 % of the total) Common Palm Civets with a white tip were recorded. Records derive from just two stations, separated by 9 km, indicating at least two individuals in Deramakot have such a white tip.

The Banded Civet was also regularly photographed (35 occasions) by the ConCaSa project, but not as often as the previous two species (Fig. 1D). Almost all photographs of this species were

obtained in closed canopy forest and only few pictures were captured along the secondary or logging roads. This secretive behaviour illustrates why this species could only be encountered twice during the night spotlight surveys which were performed exclusively along roads (Video 4). Although this species was observed climbing a tree next to the road after being brightly spotlit, our findings support Medway's (1969) assumption that this species is almost confined to the ground under a tall canopy, and are consistent with observations during 1980s wildlife surveys, when the Banded Civet was always recorded on or near the ground in closed forests (J. Payne *in litt*. 2010).

The Small-toothed Palm Civet *Arctogalidia trivirgata* was frequently observed during the night surveys but never camera-trapped. During most observations the animals were feeding on fruits in the treetops (Video 5). Their strictly arboreal behaviour explains why this species was not even once photographed with our ground-based cameras. This finding is consistent with previous studies suggesting spotlighting as the only appropriate method to survey this species (Walston & Duckworth 2003, Duckworth & Nettelbeck 2007). Similar to the Small-toothed Palm Civet, the Binturong was encountered climbing in the treetops, but during two night surveys a Binturong was also observed on and next to the road (Fig. 1E; Video 6).

Notes on other small carnivores

One of the most common carnivores is the Sunda Stink-badger *Mydaus javanensis* (Fig. 1F), regularly photo-trapped and also recorded during night surveys (Video 7). We recorded two species of mongoose; the very common Short-tailed Mongoose *Herpestes brachyurus* and the Collared Mongoose *H. semitorquatus* (Figs 1G, 1H). So far very little is known about the distribution and ecology of the Collared Mongoose, thus leading to an IUCN (2008) classification of Data Deficient. Only one camera-trap station recorded both species, whereas the Short-tailed Mongoose was recorded in eleven other stations and the Collared Mongoose in five others. Further investigations of vegetation around the camera-trap localities will hopefully identify key habitat parameters which might explain their different occurrences. Almost all pictures of the Short-tailed Mongoose were taken during dusk or daytime, whereas the Collared Mongoose was recorded mainly at dusk and dawn, but sometimes also during the middle of the night or day. We also photographed Yellow-throated Martens *Martes flavigula* and during one spotlight survey a mother with a young was observed high up in a tree (Fig. 1I). In addition HS recorded six pictures of the Banded Linsang *Prionodon linsang* in other parts of Deramakot (Fig. 1J).

During our surveys we most likely recorded all three Bornean otter species. Otters are very hard to differentiate and especially on camera-trap pictures the size and the general body shape are hard to estimate. Therefore we sent a series of photographs for identification to several people. General agreement was that Fig. 1K shows a Smooth-coated Otter *Lutrogale perspicillata*, which seems the most common otter species in Deramakot FR on several occasions a group was recorded. Fig. 1L was generally attributed to Asian Small-clawed Otters *Aonyx cinereus*, consistent with other records showing this species occurring in larger groups (e.g. Wayre 1978). Fig. 1M shows a clearly distinct otter species, with a flatter and longer head, a white throat and darker fur. Therefore, we are convinced that this photograph shows the Endangered Hairy-nosed Otter *Lutra sumatrana*, a species not apparently recorded in Borneo within the last ten years (Sasaki *et al.* 2009). The only known recent record might be a road kill in Brunei in 1997 and the last record from Sabah may date back over 100 years, although historically, it was recorded at several localities in northern Borneo (Sasaki *et al*. 2009). This paucity of records might reflect difficulties in distinguishing otter species, but might also reflect a general rarity. Although the Hairy-nosed Otter may be sympatric with the Asian Small-clawed Otter or the Smooth-coated Otter at other places, Deramakot FR seems to be the first known area where all three co-exist: all records are within 2.5 km². This spot is in north-western Deramakot, where the otter civets were photographed. As well as ponds, a stream runs through this area; there are no large (> 5 m) rivers there.

Conclusions

Our results show the effectiveness of camera-traps to assess small carnivores. However, our findings also demonstrate the importance of night surveys because some viverrid species (such as, Small-toothed Palm Civet and Binturong) are more difficult or almost impossible to detect with camera-traps, even with a large number of cameras installed. We therefore recommend spotlight surveys in conjunction with a camera-trapping approach to ensure that arboreal small carnivores are recorded. Altogether a high diversity of small carnivores (14 species) were recorded during our seven months of surveys. Beside these, all five Bornean wild cat species (Mohamed *et al*. 2009) and the Sun Bear *Helarctos malayanus* were recorded, giving Deramakot FR at least 20 carnivore species. The records of globally threatened wetland species (Otter Civet, Flat-headed Cat *Prionailurus planiceps* and the three species of otters, including the Hairy-nosed Otter) emphasise the importance of this lowland forest complex. The observations reported here show that 'well-managed' dipterocarp forests, where a low-impact selective logging system is practised, may harbour a high diversity of small carnivores.

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Photographs on back cover

Fig. 1. Camera-trapping pictures from Deramakot Forest Reserve in Sabah, Malaysia (see back cover). Photos by Wilting & Mohamed unless otherwise indicated.
(A) Otter Civet Cynogale bennettii *(5°24'N, 117°22'E), (B) Malay Civet* Viverra tangalunga *(5°25'N, 117°24'E), (C) Common Palm Civet* Paradoxurus hermaphoditus *(5°22'N, 117°27'E), (D) Banded Civet* Hemigalus derbyanus *(5°23'N, 117°22'E), (E) Binturong* Arctictis binturong *(5°20'N, 117°23'E) (Photo: Samejima), (F) Sunda Stink-badger* Mydaus javanensis *(5°21'N, 117°29'E), (G) Collared Mongoose* Herpestes semitorquatus *(5°24'N, 117°23'E), (H) Short-tailed Mongoose* Herpestes brachyurus *(5°26'N, 117°22'E), (I) Yellow-throated Marten* Martes flavigula *(5°23'N, 117°32'E) (Photo: Samejima), (J) Banded Linsang* Prionodon linsang *(5°16'N, 117°23'E) (Photo: Samejima), (K) Smooth-coated Otter* Lutrogale perspicillata *(5°25'N, 117°24'E), (L) Asian Small-clawed Otter* Aonyx cinereus *(5°25'N, 117°22'E), (M) Hairy-nosed Otter* Lutra sumatrana *(5°26'N, 117°25'E)*

Electronic supplementary material

Videos filmed during night spotlight surveys in Deramakot Forest Reserve, Sabah Malaysia (Videos by Wilting & Mohamed)
1. Otter Civet Cynogale bennettii
<http://www.youtube.com/watch?v=jXyjmfDgXGY>
2. Malay Civet Viverra tangalunga
< http://www.youtube.com/watch?v=JLLuts5NhmI >
3. Common Palm Civet Paradoxurus hermaphoditus
< http://www.youtube.com/watch?v=HQuppZqf6LY >
4. Banded Civet Hemigalus derbyanus
< http://www.youtube.com/watch?v=eIngMRzZn3U >
5. Small-toothed Palm Civet Arctogalidia trivirgata
< http://www.youtube.com/watch?v=Kcmh46LuFQQ >
6. Binturong Arctictis binturong
< http://www.youtube.com/watch?v=uVllHbMZMac >
7. Sunda Stink-badger Mydaus javanensis
< http://www.youtube.com/watch?v=gMbHm_N1nTE >

Density, habitat selection and observations of South American Coati *Nasua nasua* in the central region of the Brazilian Pantanal wetland

Arnaud Léonard Jean DESBIEZ [1, 2] and Paulo André Lima BORGES [3]

Abstract

The South American Coati *Nasua nasua* occurs almost throughout South America. This study took place in the central Brazilian Pantanal wetland. Using line transects and direct observations, densities and habitat selection were analysed and behaviour observed. Coati densities were highest in the forests (16.5 individuals/km²) and lowest in the floodplains (9.0 individuals/km²). Coatis were found to select the forest and forest edge and avoid open grasslands and scrub grasslands. Group size was similar throughout the three landscapes, averaging 6.6 animals per group. From line transects between sunrise and mid-day, 89% of Coati sightings were on the ground and 11% in trees; 30.5% were of Coatis travelling, 55.1% of them foraging and 14.4 % of them resting. Coatis were found to consume over 15 different species of fruit. Nesting females were observed twice, both during peak fruiting season. Results from this study predict that current intensification of cattle ranching and changes in land use practice will be detrimental to South American Coatis in the Pantanal.

Keywords: carnivore, frugivore, Neotropical, Procyonidae

Densidade Populacional, Seleção de Habitat e Observações Gerais sobre o Quati Sul-Americano na Região Central do Pantanal Brasileiro

Resumo

O quati sul-americano – *Nasua nasua* – ocorre por toda a América do Sul. O presente estudo foi realizado na região central do Pantanal Brasileiro. Densidade populacional e seleção de habitat, bem como observações gerais sobre comportamento dos quatis, foram estudadas através de transectos lineares e observações diretas. As densidades populacionais mais altas foram observadas em paisagens florestais (16,5 indivíduos/ km²) e as mais baixas em paisagens de planícies alagadas e vazantes (9,0 indivíduos/km²). Os quatis demonstraram selecionar significativamente habitats de floresta e borda florestal e evitar áreas de campo limpo e campo sujo. Tamanho de grupo foi similar para os três diferentes tipos de paisagem, resultando em uma média de 6,6 animais por grupo. Através do uso de transectos lineares entre o nascer do sol e meio-dia, 89% dos quatis foram avistados no chão, 11% em árvores, 30,5% estavam em deslocamento, 55,1% estavam se alimentando e 14,4% estavam em descanso. Os quatis consumiram mais de 15 diferentes espécies de frutos. Fêmeas com filhotes em ninhos foram observadas em duas ocasiões, ambas durante o pico da estação de frutificação. Resultados deste estudo indicam que a presente intensificação das práticas de manejo de gado bovino e mudanças nas práticas de uso da terra terão um grande impacto sobre as populações do quati sul-americano no Pantanal.

Palavras-Chave: carnívoro, frugívoro, Neotropical, Procionídeo

Introduction

Coatis *Nasua* are widespread, medium-sized, gregarious procyonids living in habitats ranging from arid environments to humid tropical rainforests, from southern USA to northern Argentina (Gompper 1995, Gompper & Decker 1998). The South American Coati *Nasua nasua* (Figs 1–3) can be found from Colombia and Venezuela to Northern Uruguay and Argentina (Gompper & Decker 1998). Published studies on South American Coatis exist mostly for the Atlantic forest of Brazil (Alves-Costa *et al.* 2004, Beisiegel & Mantovani 2006, Hirsch 2009) with none for the Pantanal biome where the species is widespread and abundant (Schaller 1983, Rodrigues *et al.* 2002).

Until recently the Brazilian Pantanal wetland was rather pristine. Private ranches with the main economic activity of cattle production occupy approximately 95% of the area (Harris *et al.* 2005). Under traditional management practices that consist of the seasonal movement of herds among patches of native savannas, cattle ranching is considered to have a low environmental impact (Santos *et al.* 2002, 2004). However, this is rapidly changing. Ranching is intensifying and modifying the landscape. The goal of this study was to evaluate South American Coati densities in different landscapes of the Pantanal and evaluate which habitat the animals selected. Results were used to hypothesise impacts the changes in cattle ranching may have on Pantanal Coati populations. Observations of the species's behaviour are also reported here.

Materials and methods

Study area

This study took place in a 200 km² area which included six traditionally managed cattle ranches in central Pantanal (18º59′S, 56º39′W). Such ranches mostly comprise of native vegetation. Cattle range freely within large grazing areas, and human densities and anthropogenic impacts are considered limited. Mortality of South American Coati in the region due to anthropogenic activity is low because native mammals are seldom hunted (Desbiez *et al*. in press b) and there are no roads (most travel is by horse) and therefore no road kill. The study area includes three different landscapes typical of the region: (1) floodplains, dominated by seasonally flooded grasslands; (2) forests, characterised by strips

Fig. 1. South American Coati Nasua nasua *eating the flower of Bromelia balansae.*

and patches of semi-deciduous forest; and (3) cerrado, covered by scrub forest and open scrub grasslands. Further details of the study area are in Desbiez (2007) and Soriano *et al*. (1997).

Density estimations

Twenty one transects 3½–5 km long and marked at 50 m intervals were randomly placed within the study area with no previous knowledge of animal distribution: seven in the forest landscape, six in the cerrado landscape and eight in the floodplain. In total, 2,174 km of transects were walked (848 km in the forest landscape, 906 in the cerrado landscape and 420 km in the floodplain landscape). Surveys took place between July 2002 and October 2004. Transects were walked alone by the same observer (first author), except in the floodplains 200 km of which were walked alone by another trained observer (second author). Transects were cleaned bi-monthly to ensure detection of animals on the line and to avoid noise while walking. Transect census began at sunrise and usually finished before noon; no nocturnal surveys were conducted. In both forest and cerrado landscapes, transects were walked at approximately 1–2 km/h, followed by a minimum one hour wait in a location 500 m from the end of the transect, and then data was collected on the walk back as well. In the floodplain, transects were walked at 2–4 km/h and, at the end of the trail, the observer stopped data collection, walked to a parallel transect 1 km away, and walked back along it collecting data. In the floodplain, transects were walked slightly faster because most of this landscape is open grasslands and animals are quickly sighted, whereas in the forest detection is more difficult. For detections to remain as independent events, Coatis were grouped into clusters and group sightings were considered as single detections (Buckland *et al*.

Figs 2 & 3. South American Coati Nasua nasua.

2001). Date, time of the day, species, perpendicular distance from the transect to the centre of the group, habitat type, group size and activity were registered for each sighting. Perpendicular distances were estimated to the nearest meter with a measuring tape or using a GPS.

Densities were estimated using DISTANCE software (Thomas *et al.* 2006). Multiple Covariates Distance Sampling (MCDS) methods (Marques & Buckland 2003) were applied to estimate densities because the Pantanal is an extremely heterogeneous environment, where landscapes are composed of a mosaic of exceptionally different habitats. This means that, on the same line-transect, the observer may walk through a forested environment with a maximum visibility of 25 m and later find him-/herself in open grasslands, where the maximum visibility is well over 250 m. In MCDS, the detection function is modelled as a function of both distance and one or more additional covariates, in this case habitat visibility. Habitat types were grouped in two categories, closed and open, according to the visibility within the habitat, and were entered as factorial covariates. Closed habitats included semi-deciduous and scrub forests where visibility was restricted by the vegetation. Open habitats included grasslands and scrub grasslands where visibility was greater. Effort in each habitat type on each trail was quantified. The study area was divided into three strata based on landscape: floodplain, forest, cerrado. A global detection function and stratum-specific encounter rates were used to obtain density estimates for each landscape. Distance data from repeat transect visits were pooled. The detection function was modelled using the half-normal, uniform and hazard rate key functions and cosine, simple and hermite polynomial series adjustments. The Akaike's Information Criterion (AIC) was used to select the combination that produced the best fit. Model fit and the fit of the estimated detection functions to the empirical histograms of distance data were assessed through the Qq-plot and the Chi-square goodness-of-fit, Kolmogorov–Smirnov and Cramer–von Mises tests reported by DISTANCE.

Habitat use and availability

Encounter rates of Coati groups for habitats from the three landscapes were calculated. Each 50 m portion of the 21 transects was categorised into five different habitats: 1) open grasslands, 2) scrub grasslands, 3) scrub forest, 4) semi-deciduous forest, and 5) forest edge. Each landscape has different proportions of each habitat. For each 50 m portion of all transects, the encounter rates for each species within 8 m from the trail was determined. This fixed width (8 m) is the effective strip width calculated by DISTANCE and it is assumed that all animals regardless of habitat are sighted at this distance. The frequency of sightings took into account the number of times each section was sampled to standardise the frequency of sightings. By grouping the encounter rate in each habitat category, habitat use was then determined. Habitat availability was estimated from the total proportion of 50 m habitat segments from the 21 transects.

Habitat selection

Manly's standardised habitat selection index for constant resources was used to compare habitat selection in the different landscapes. The index is based on the selection ratio w_i. This is the proportional use divided by the proportional availability of each resource, $w_i = o_i / \pi_i$, where: o_i = proportion of the sample of used resource units in category i (encounter rate); π_i = proportion of available resource units in category i (available habitat). A w_i value larger than 1 indicates a positive selection for the resource and a value less than 1 indicates avoidance; a value around 1 indicates that the resource was used in proportion to its availability, implying no resource selection. The preference/avoidance of each species for each resource was calculated from the selection ratio w_i and tested for each species in each habitat using a chi-square test adjusted by Bonferroni. Calculations were made with the extension *adehabitat* in the statistical package R (Ihaka & Gentleman 1996, Calenge 2006).

Results

In total 305 observations of single individuals or groups of South American Coatis were made (Tables 1 and 2). Over 1,310 individual animals were seen. Density was highest in the forest landscape and lowest in the floodplain landscape (Table 1). When considering the habitats across the three landscapes, encounter rates of groups of South American Coatis were highest in the forest (Table 2). Coatis were found significantly to select the forest and forest edge and avoid open and scrub grasslands (Table 3). Group size was fairly similar throughout the three landscapes, around 6–7 animals, but ranged from two to 27 (Table 1). Even larger groups, thought to exceed 40 animals, were sighted opportunistically during the dry season around drying ponds. Coatis were sighted either alone or in groups. In the forest landscape Coatis were seen singly 57 times and 94 times in groups, in the cerrado landscape they were seen 44 times alone and 57 times in groups, while in the floodplain landscape they were sighted 20 times alone and 22 times in groups. It was not always possible to decide the sex of animals sighted, but singletons were predominantly large males, while groups were composed predominantly of females, immature males and juveniles.

South American Coati groups travel in loose formations and there can be over 50 m between the first individual and the last.

Table 1. Density estimates (D) (individuals/km²), standard error (SE) of densities calculated using DISTANCE and mean (M), standard error (SE), maximum (max) and minimum (min) values of group sizes of South American Coati from central Pantanal between July 2002 and October 2004.

Parameter	Floodplain	Forest	Cerrado
D±SE	9.09 ± 5.00	16.66 ± 2.94	10.47 ± 1.88
M±SE	6.5 ± 1.1	6.6 ± 0.5	6.7 ± 0.7
(max; min)	(27; 2)	(27; 2)	(20; 2)

Table 2. Encounter rates (sightings/100km) of groups of South American Coatis in different habitats from the centre of the Pantanal between October 2002 and November 2004 up to 8 m from the trail (N=160).

Habitat	Sightings/100 km
Open grasslands	4.47
Scrub grasslands	2.64
Scrub forest	6.01
Forest	18.07
Forest edges	12.00

They usually travel on the ground but are agile climbers and can travel through the canopy, particularly through *Attalea phalerata* palms which occur in high-density aggregations scattered around the landscape. Coatis are often observed resting in these palms. In general they were usually observed to rest high in the canopy, rather than on the ground. From the transect, 89% (N=291) of Coati sightings were on the ground and 11% were in trees (N=36). A group with some individuals in trees and some on the ground was counted as both a ground and an arboreal observation. Furthermore 30.5% of the sightings from the trail were of Coatis travelling (N=93), 55.1% of them foraging (N=168) and 14.4 % of them resting (N=14.4).

When travelling in groups Coatis constantly communicate by chirping and whistling. In the open grasslands they raise their tails vertically, seemingly to communicate their position. Single individuals are usually silent and travel with their tails lowered. When startled or sensing a danger the group makes alarm grunting sounds and runs up trees. These alarm calls are well known by other animals, and we have observed Collared Peccaries *Pecari tajacu* and South American Brown Brockets (Grey Brockets) *Mazama gouazoubira* react to alarm calls from Coati groups.

Coatis were observed to forage in leaf litter to consume invertebrates. They dig characteristic 5–10 cm narrow holes into which they poke their snouts. They also search for invertebrates at the base of the palm leaves of *A. phalerata* and dig around the crown of the palm. They upturn or scratch at rotting logs. One Coati was observed eating termites. They are avid fruit consumers and were observed, directly or through their tracks, to consume over 15 different species of fruit (Table 4). They were observed to spit out seeds of large fruit such as *A. phalerata*, *Ximenia americana*, *Vitex cymosa*, *Hancornia speciosa* and *Dipteryx alata*. Seeds are usually dropped at or near the base of the tree. However, Coatis may be capable of swallowing and potentially dispersing smaller seeds such as *Ficus* spp. or *Alibertia* spp. Coatis consumed fruit both from the ground and directly in the trees. Often some individuals fed in the tree while others foraged beneath it, eating fruits dropped and dislodged by other Coatis. Several times Collared Peccaries were seen foraging on fruits dropped by Coatis. Coatis were never observed to eat carrion, but tracks were observed near a cow carcass.

Nesting females were observed twice, in November 2003 and in December 2002; both sightings are at the height of the fruiting season. The first female was nesting in a tree hole and had two tiny pups; another female Coati was near her. The second observation was a single female in a crown of *A. phalerata* with three pups. Females seem to isolate themselves and rejoin their group when the cubs are old enough to travel.

Discussion

The use of MCDS methods enables the analysis of line transect data collected in a mosaic landscape such as the Pantanal. Line transects were found to be an appropriate method to analyse Coati densities in the different landscapes because encounter rates were high and all habitats in the study area were used. Densities of Coatis in the Pantanal are high compared with other studies. In another study on the south-western ridge of the Pantanal, Schaller (1983) reported 2.14 individuals/km². In several Atlantic forest fragments, Cullen *et al*. (2001) found densities of 3.11–5.20 individuals/km². Finally in a secondary forest in northeastern Brazilian Amazonia, Parry (2004) found densities of 15.4 individuals/km². In part of the area where the present study was conducted Alho *et al*. (1988) recorded frequency of encounter of species sighted while horse-riding to the ranch: South American Coatis were the most sighted mammal in the ranch. There are few Coatis deaths from anthropogenic causes in the study area, so densities there may have reached carrying capacity.

South American Coatis are widely reported to consume invertebrates and fruits (Gompper & Decker 1998, Alves-Costa *et al.* 2004, Beisiegel & Mantovani 2006, Hirsch 2009). The observation of Collared Peccaries foraging alongside South American Coatis, detailed in Desbiez *et al*. (in press a) is the first report of a foraging association between coatis and another mammal. Birds have already been reported to benefit from following foraging coatis (Booth-Binczik *et al.* 2004, Beisiegel 2007).

In the Pantanal, cattle ranching is becoming increasingly competitive and many land owners are now either selling their properties or intensifying ranching practices (Seidl *et al.* 2001 Santos *et al.* 2002). Since the early 1970s, ranchers are clearing land and planting pastures of exotic grasses to increase the carrying capacity for livestock. Ranchers tend to plant pastures on the highest grounds available in their ranch since these are not subject to regular flooding: these areas are usually forested (Comastri Filho & Pott 1996, Seidl *et al.* 2001). Deforestation in the Pantanal is on the increase: more than 40% of forest and savanna habitats have already been altered for cattle ranching by introduction of exotic grass species (Padovani *et al.* 2004). Forested landscapes had the highest densities of Coatis and semi-deciduous forest and forest edge were the habitats most selected by the species. In addition, fruits, an important resource for Coatis, are mostly found in forested areas. These habitats have the lowest carrying capacity for cattle (Santos *et al*. 2002), so are the primary targets for deforestation. Results from this study predict that current intensification and changes in land use practices will be detrimental to South American Coatis.

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Camera-trap evidence of Large-spotted Civet *Viverra megaspila* in Khao Ang Rue Nai Wildlife Sanctuary and Khao Yai National Park, Thailand

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Abstract

Large-spotted Civet *Viverra megaspila* records warrant documentation with publicly verifiable evidence because the species is currently IUCN Red-Listed as Vulnerable. We present camera-trapping and habitat records of the species from two protected areas lacking previous verifiable records. Locations support past suggestions that it is a lowland forest species; given the heavy clearance of plains forest in Thailand, it is likely to be genuinely very localised in the country now.

Keywords: evergreen forest, Large Indian Civet, Lowland forests, *Viverra zibetha*

การใช้กล้องดักถ่ายชะมดสันหางดำในเขตรักษาพันธุ์สัตว์ป่าเขาอ่างฤาไนและอุทยานแห่งชาติเขาใหญ่ ประเทศไทย

บทคัดย่อ

ชะมดแผงสันหางดำได้ถูกบันทึกลงเอกสารที่มีการรับรองและเปิดเผยได้ต่อสาธารณชนเพราะเป็นสัตว์ที่พบว่าใกล้สูญพันธุ์ตาม ที่ IUCN ได้ประกาศไว้ การศึกษาวิจัยในครั้งนี้ได้แสดงถิ่นที่อยู่อาศัยและการติดตั้งกล้องดักถ่ายภาพสัตว์ในบริเวณป่าอนุรักษ์สองแห่งที่ไม่มีข้อมูลการปรากฏแน่ชัดของสัตว์ชนิดนี้ และพบว่าผืนป่าบริเวณที่ราบลุ่มเป็นแหล่งที่อยู่อาศัยที่เหมาะสมของสัตว์ชนิดนี้ แต่ป่าบริเวณที่ราบลุ่มยังมีอยู่อย่างจำกัดในประเทศไทยในปัจจุบัน

คำสำคัญ: การยกระดับให้สูงขึ้น , ป่าไม่ผลัดใบ, ชะมดแผงหางปล้อง , การสร้างป่าอนุรักษ์ , *Viverra zibetha*

Introduction

There are few published data on the status and patterns of geographic variation of the Large-spotted Civet *Viverra megaspila*. Across its range in Cambodia, Laos, Myanmar, Thailand, Vietnam, West Malaysia, and southern China, *V. megaspila* occurs mainly in fragmented populations in lowland evergreen forests (Francis 2008). Lynam *et al*. (2005), reviewing some recent records, found that most were from below 300 m elevation. Large-spotted Civet is listed as Vulnerable on the IUCN Red List (IUCN 2009), and the Action Plan of the [then] IUCN/SSC Mustelid and Viverrid Specialist Group (Schreiber *et al.* 1989) recommended field studies focusing on causes of the "natural scarcity" of the species, specifically noting a lack of records from the generally well-studied Khao Yai National Park (KYNP), Thailand.

In Thailand, despite several carnivore studies (e.g. Srikosamatara 1993, Austin 2002, Lynam *et al.* 2003, Grassman *et al.* 2005a, 2005b), there are published recent records only of an unverified sighting by staff in Huay Kha Khaeng Wildlife Sanctuary in the Western Forest Complex (Rabinowitz & Walker 1991) and photographs from two locations in Tapraya National Park on the eastern edge of the Dong Phayayen–Khao Yai Forest Complex (Lynam *et al.* 2005). A record from KYNP of a Large-spotted Civet camera-trapped during 2000–2002 gave no evidence of how the photograph was identified (Suzuki *et al*. 2006). The species's localised distribution and current threat categorisation urge documentation of occurrences with public evidence. Here, we present camera-trapping records of the species and habitat data from two protected areas in Thailand.

Methods

We conducted camera-trapping surveys in KYNP and Khao Ang Rue Nai Wildlife Sanctuary (KARN) using passive infra-red sensors for heat and motion (CamTrakker® CamTrak South, Inc., Watkinsville, GA 30677 USA). Cameras are effective in covering a wide area to document, verifiably, species presence (e.g. Griffiths & van Schaik 1993, Carbone *et al.* 2001, Moruzzi *et al.* 2002). Cameras were set approximately 50 cm above ground, 10–20 m from the intended monitoring area, camouflaged with foliage, and, in some locations in KARN baited with commercial scent lures (Minnesota Trapline Products, Pennock, MN 56279 USA) or Sambar *Rusa unicolor* road kill. Photographs of *V. megaspila* clearly show lines of relatively large, bold, and boldly edged spots on the flank and a black dorsal stripe to the tail (Fig. 1) which are the most easily seen body features to differentiate between *V. megaspila* and Large Indian Civet *V. zibetha* (Duckworth 1994).

Study Site and Records

Field surveys in KYNP (2,168 km², 14º05–15′N; 101º05–50′E) in south-central Thailand covered each of the 22 management zones

Fig. 1. Large-spotted Civet Viverra megaspila in dry evergreen forest in northeastern Khao Yai National Park, Thailand.

Table 1. Camera-trap records of Large-spotted Civet in Khao Yai National Park, Thailand.

Location of camera-trap	Date	Time	Elevation (m)	Habitat
14°20′N, 101°43′E Zone KY04 (Klongpa Gung); north of Khao Kamphaeng along the Lam Phra Phloeng River	22 Oct 2006*	18h31	470	Dry evergreen forest
	22 Oct 2006*	18h32		
14°21′N, 101°43′E Approx. 250 m outside the park boundary of Zone KY04; along the Lam Phra Phloeng River	20 Oct 2006	02h18	460	Patchy dry evergreen forest/agricultural area
	29 Oct 2006	18h41		

*same individual, as identified by coat pattern
Elevation was estimated from a Thailand 1:50,000 topographic map, edition: 3_RTSD, series L7017, sheet and year unknown.

of the park (Lynam *et al.* 2003) at least once. Cameras were set at elevations of 40–1,340 m in a wide range of habitats: tropical rainforest, dry evergreen forest, hill evergreen forest, mixed deciduous forest, dry dipterocarp forest, and grassland. Camera-trapping ran from October 2003 until March 2007 during all seasons of the year. From 6,253 total trap nights in the park, four photos of Large-spotted Civet were recorded at two locations near the park boundary of zone KY04 (Table 1; Fig. 1). Both locations were within 350 m of the nearest stream and the park boundary, and separated by 890 m.

KARN (1,079 km²; 13°00′–13°32′N, 101°40′–102°09′E), in eastern Thailand, encompasses the country's last remaining lowland rainforest. Elevations from 0 m to 170 m were camera-trapped in KARN from January 2008 to September 2009. From 3,650 trap nights, 23 photos (at eight locations) of Large-spotted Civets (Table 2) were recorded. All sites excluding one detecting Large-spotted Civet were within 2 km of Ban Phu Thai, the location of the Chachoengsao Wildlife Research Station in secondary forest. All sites are on waterways and two were near Samsao Canal, a permanent water source. Six out of 14 camera sessions that yielded Large-spotted Civet photos included a scent lure/bait: All Call, Pro's Choice, or Old Yeller lures were used, but not repeatedly enough to confirm whether or not they are specifically effective for attracting Large-spotted Civets.

Table 2. Camera-trap records of Large-spotted Civets in Khao Ang Rue Nai Wildlife Sanctuary, Thailand.

Location of camera-trap	Elevation (m)	Date	Time	Habitat
13°29′N, 101°52′E	105	31 Apr 08	21h24	A
13°25′N, 101°53′E	120	14 May 08	18h51	DEF
		13 Aug 08	22h02	
13°25′N, 101°52′E	100	9 Oct 08	02h47	TP
13°24′N, 101°53′E	105	5 Dec 08	01h45	DEF
		9 Dec 08*	23h03	
		10 Dec 08	00h43	
13°23′N, 101°52′E	100	11 Dec 08	05h15	TP
		11 Dec 08	20h35	
		19 Dec 08*	00h23	
13°24′N, 101°52′E	100	30 Dec 08	21h13	TP
13°25′N, 101°53′E	115	23 Jun 09	19h51	DEF
		4 Aug 09	21h07	
		14 Aug 09	06h15	
		27 Aug 09*	05h46	
		4 Sep 09	06h09	
		13 Sep 09	04h36	
		14 Sep 09	02h06	
		24 Sep 09	03h52	
		2 Oct 09*	04h51	
		8 Oct 09	19h57	
		16 Oct 09	19h53	
13°24′N, 101°54′E	120	1 Oct 09	20h10	DEF

*same individual, as identified by coat pattern. The total number of animals involved in the other photographs is not known.
Habitats: A, Agricultural area; DEF, Dry evergreen forest; TP, Teak plantation
Elevation was estimated from a Thailand 1:50,000 topographic map, edition: 3_RTSD, series L7017, sheet: 53351, year: 1991.

Discussion

These records verify the presence of Large-spotted Civet in KYNP where there has been no recent confirmation of its presence (Lynam *et al.* 2003, but see Suzuki *et al*. 2006). We speculate that we detected Large-spotted Civet when previous camera-trapping (Lynam *et al.* 2006) did not because our intensive sampling went beyond the park's core area to include all zones and edges; some camera locations were a few hundred meters lower than the general study area of Khao Yai where most surveyors spend their time.

Even so, the records from KYNP are from slightly higher than the 300 m general cutoff suggested by Lynam *et al*. (2005), albeit based on rather few records and locally exceeded (e.g. Holden & Neang Thy 2009). There is no other low-elevation habitat in the surroundings: south is a high-elevation ridge and in the north lies human habitation and agricultural lands, still above 400 m. The area is scrubby dry evergreen forest close to the border of the National Park in an area of high human use. One camera-trap also photographed hunters carrying small-animal traps, recalling Large-spotted Civet records from Tapraya National Park (Lynam *et al*. 2005), corroborating that the species is not particularly sensitive to edge/degraded areas (Duckworth 1994, Austin 1999).

It was not possible to determine if photographs at KYNP were of the same individual because only the left flank was recorded at one site and only the right flank at the other. Large Indian Civets reportedly average 1.7 km in daily movements (Rabinowitz 1991), so both camera locations could be within the home range of one individual Large-spotted Civet. The record of one Large-spotted Civet contrasts with the many (n=42) Large Indian Civets photographed throughout KYNP.

In dry evergreen lowlands of KARN, Large-spotted Civet was more commonly found than Large Indian Civet (n=7) with no camera-trap location recording both. Our data agree with previous assessments of Large-spotted Civet as a lowland species able

to cope with degraded habitat (Austin 1999, Lynam *et al*. 2005, Francis 2008). The lower detection of Large Indian Civet in predominantly lowland KARN, where populations of Large-spotted Civet seem higher, (see also Austin 1999) contrasts with other, higher-altitude protected areas, such as KYNP, where the reverse is true. We would expect this if Large-spotted Civet is dominant at lower elevations. Further research with exclusion experiments would help determine the level of direct competition, and what causes Large-spotted Civet to be more successful in the lowland forests. Given that most of the lowland forest in Thailand has been converted to agricultural areas (Hirsch 1990), the outlook for the country's Large-spotted Civets is grim.

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Sighting of the Bornean Ferret Badger *Melogale everetti* in the Kinabatangan floodplains, and implications of its lowland distribution

Ramesh BOONRATANA

Abstract

I report a sighting of the Bornean Ferret Badger *Melogale everetti* in the Kinabatangan floodplains of north Borneo. Supported by another sighting in the same general area and the discovery of subfossil remains in the Niah Caves in southwestern Borneo, this extremely rare observation in the lowlands challenges known distribution of the species, which reportedly occurs between 1,070 m and 3,000 m, and is known only from Mount Kinabalu and its environs. I describe the two sightings made in the Kinabatangan floodplains and discuss possible reasons for the species's rarity in the lowlands.

Keywords: altitudinal range, rarity, Sabah, sight-record, Sukau

Pemerhatian Bornean Ferret Badger *Melogale everetti* di dataran banjir Kinabatangan, dan implikasi terhadap pengedarannya di dataran rendah

Abstrak

Saya melaporkan satu pemerhatian keatas Bornean Ferret Badger *Melogale everetti* dari dataran banjir Kinabatangan di bahagian utara Borneo. Pemerhatian spesies ini di dataran rendah merupakan satu cabaran kepada edaran semasa spesies ini, yang setakat ini terhad di antara 1,070 m dan 3,000 m, dan hanya di kenali dari Gunung Kinabalu dan sekitarnya. Walaubagaimanapun, ianya di dukungi dengan pemerhatian lain di kawasan yang sama dan juga penemuan fosil separa di Gua Niah di barat daya Borneo. Dalam naskah ini, saya melaporkan kedua-dua permahatian di dataran banjir Kinabatangan, dan membincangkan beberapa kemungkinan sebab-sebabnya mengapa spesies ini langka di dataran rendah.

Kata-kata kunci: jarak ketinggian dari paras laut, kelangkaan, rekod permerhatian, Sabah, Sukau

The Bornean Ferret Badger *Melogale everetti*, also known as Kinabalu Ferret Badger and Everett's Ferret Badger, was described as *Helictis everetti* by Thomas in 1895 (Schreiber *et al*. 1989). Sometimes considered a subspecies of the Javan Ferret Badger *M. orientalis* or of the Large-toothed Ferret Badger *M. personata* (e.g. Payne *et al*. 1985), most modern authors follow Long (1992) and treat it as a distinct species.

The Bornean Ferret Badger is reportedly known only from Mount Kinabalu in the Sabah state of Malaysian Borneo, occurring between 1,070 m and 3,000 m, with a note that it might also occur on Mount Tambayukon to the north of Mount Kinabalu (Payne *et al*. 1985). Schreiber *et al*. (1989) found this restricted distribution difficult to explain given that other ferret badger species are widespread and use a variety of habitats. In addition, museum specimens reportedly from Penampang (spelt Penem Pang in Duckworth & Azlan 2008) and Tuaran (Majuakim 1999) are perhaps from lower-lying areas that would be atypical (Duckworth & Azlan 2008). A. Wilting (*in litt*. 2009) visited the Sabah Museum collection in late 2009 and found that Bornean Ferret Badger was the most numerous small carnivore there, with 57 skins, one collected in 1969 and the others between June and December 1971 (the period when most of the collection's mammal specimens were collected). All are from Penampang and Tuaran districts, and have village names or road-mile numbers as localities. They do not have details neither altitudes nor methods of collection. The two districts lie in western Sabah and run from the coast inland to over 1,000 m, making it difficult to infer likely altitudes from which the specimens came without locating the individual villages. These are, in Penampang district, Bambangan (5 specimens), Mile 30 Sunsuran (Sunsuron) Road (7), Mile 28 Sunsuran Road (2), Togudon (18), Kalanggaan (Kalangaan) (2), Kambau (2) and Penampang district without further information (1); and in Tuaran District, Lebodon (16) and Mangkaladong (4).

Consistent with these potential lowland specimens, a Bornean Ferret Badger was observed and recorded along the Menanggul River on 22 August 1991. This river (a tributary of the Kinabatangan River) is located in the Sukau area on the east coast of Sabah. The brief observation (lasting no more than a minute) was made at 08h32, slightly over 2½ hours after dawn, at approximately 5°30′07″N, 118°16′23″E (Fig. 1) and about 14 m above msl in a logged-over flood-prone riverine forest. The observed animal had the distinctive blackish brown and white head pattern, and brownish body as described in Payne *et al*. (1985). However, the tail appeared to have a dull yellowish tinge instead of being entirely brown, but this could have been due to the strong morning light coming in through the rather open forest canopy. When first observed, the individual appeared to be foraging, but upon detecting the observer, it quickly moved away with a gait resembling a half-trot.

The principal forest types in the flood-prone areas of the Sukau area comprise riverine forest and freshwater swamp forest, with some open reed swamp. In the flood-free zone, there are remnants of pristine lowland dipterocarp forest, logged-over swamp forest and burnt lowland dipterocarp forest, and cocoa and oil palm plantations (Boonratana 1993, Boonratana & Sharma 1997). In terms of topography, Sukau and much of the east coast of Sabah comprise undulating lowland basins. The only significant area of land above 1,070 m is about 180 km to the west of Sukau: the

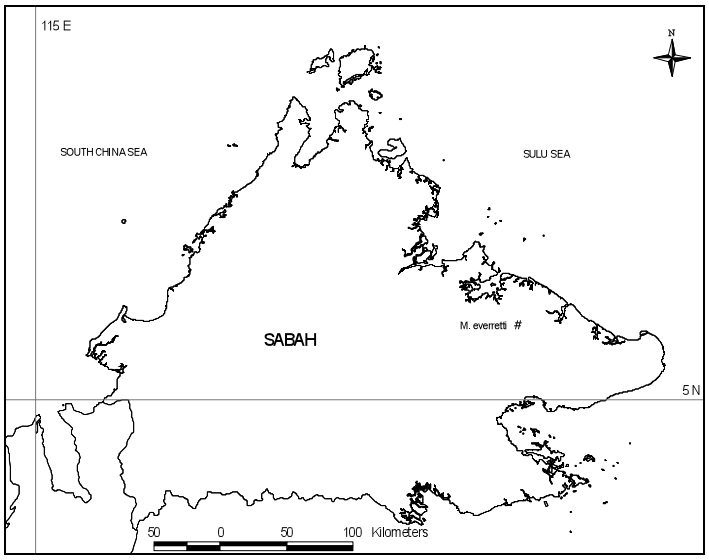

Fig. 1. Location of Melogale everetti *sightings in lowland Sabah, Malaysia.*

mountain range on the west coast of Sabah that runs from the north to the south-west.

This was the only sighting of the Bornean Ferret Badger I made during my two-year field study of Proboscis Monkey *Nasalis larvatus* in the Lower Kinabatangan area, carried out from January 1990 to December 1991 (Boonratana 1993). During the study, the presence of wild fauna was recorded both opportunistically (during full-day follows for Proboscis Monkeys, and during day and night river surveys) and systematically (during monthly wildlife surveys along ten 1-kilometer straight-line transects), and results were reported in Boonratana (1993) and Boonratana & Sharma (1997).

From 1994 to 1996, I carried out a field study at various locations and habitats throughout Sabah, but failed to record the species, although I covered 1,920 km of trails and 62 km of straight-line transects, and employed remote photography (Boonratana 1997). Likewise, extensive surveys and fieldwork by a number of specialists and naturalists within the last decade throughout many parts of Sabah did not reveal any record of the Bornean Ferret Badger, despite the fact that almost all the known lowland mammal species of this size-class were recorded using remote photography (Siew Te Wong *in litt*. 2009). Furthermore, enquiries by Marc Ancrenaz (a long-term resident conservation worker at Sukau) with local villagers and others working in the area traced no reliable record of this species in Sukau or other parts of the Lower Kinabatangan (Siew Te Wong *in litt*. 2009).

The species's known restricted distribution and the low possibility, in this era of remote photography, that it might be common but overlooked initially raised my doubts as to the validity of the sighting. Yet the chances that I could have mistaken it for any other species are remote. The tail length, head pattern, and body pelage were nowhere close to the Sunda Stink-badger *Mydaus javanensis*, which I observed a number of time at the same site and in the later study. The animal sighted was too small, and its tail much too short, for a Masked Palm Civet *Paguma larvata*, with which I am familiar from field and zoo experience in Thailand, although it was not detected during the two-year Sukau study. Likewise, the Short-tailed Mongoose *Herpestes brachyurus*, also observed at Sukau, lacks the distinctive head markings shown by the Bornean Ferret Badger.

Moreover, Ikki Matsuda (*in litt*. 2009) reported another sighting of the Bornean Ferret Badger by his field assistant, Ahmad bin Arsih (a local resident), in January 2008, also along the Mennangul River. Ahmad spotted the species at about 08h00, approximately 6.4 km upriver, when he brought a group of tourists in with his boat. The individual was first spotted when it was apparently startled by the boat's engine, ran for a short distance, but stopped when Ahmad stopped the boat's engine. It fled into the forest as soon as Ahmad (at the tourists' insistence) tried to get the boat closer. Ahmad estimated that the observation lasted about five minutes. Further enquiries revealed that although Ahmad had never previously seen a Bornean Ferret Badger, he was confident that the animal was some sort of badger, and realised that it was the Bornean Ferret Badger upon being shown an illustration (Ikki Matsuda *in litt*. 2009). Ikki Matsuda (*in litt*. 2009) is confident of Ahmad's species identification skills, and that he (Ahmad) is familiar with the more common Sunda Stink-badger, remarking that it is common in the Menanggul area, to have mistaken it for the Bornean Ferret Badger.

Hence, despite these extremely few sightings, the species's distribution is apparently not as restricted as previously thought. Furthermore, the discovery of the species's bones associated with excavations of human settlements in the Niah Caves (3°48′N, 113°47′E) in eastern Sarawak (west Borneo), that date back to about 40,000 years ago (Harrison 1996), evince that the species was formerly more widely distributed. Harrison (1996), however, suggested that establishment of present-day climatic regime during the Holocene epoch and the development of ever-wet tropical rainforest might have caused the decline or extinctions of populations of the purportedly cooler early Quaternary. Wozencraft (2005) stated that the species inhabits Sarawak and Kalimantan, as well as Sabah, but cited no evidence for this, and I traced none, other than the above sub-fossil remains.

Thus, there are a few issues to consider. First, that the species's verifiable distribution is restricted to Mount Kinabalu and adjacent similarly high elevations. Second, the only significant area of land above 1,070 m is about 180 km to the west of Sukau, to a mountain range running from the north to the south-west of Sabah. Third, only two sight-records and some specimens of perhaps questionable locality of origin and no camera-trap photographs of the species in the lowlands exist, despite the survey efforts.

A possible explanation for the lack of other records is that the individuals sighted at Sukau might be some of the last Bornean Ferret Badgers occurring in the lowlands, i.e. before much of the lowland habitats were converted into oil palm plantations (Siew Te Wong *in litt*. 2009). Human modification of natural habitats is known to have directly resulted in rarity in some species, aggravating those with already restricted distributions, reducing those with already low population densities, and/or greatly reducing and isolating populations that were once widely distributed (Cody 1986). Modifications to natural habitats could also lead to the addition of one or more species previously not occurring in those communities, causing a decline in one or more of the native species (Cody 1986). The possibility that it was outcompeted or displaced by another species competing for the shared resources that were reduced by stochastic natural causes (Cody 1986), might explain the species's rarity prior to the habitat conversion and other modifications, or in other relatively intact lowland habitats.

Whatever the reasons, the Sukau records indicate that the

species is possibly not restricted to Mount Kinabalu and environs, but is also found in the lowlands. Any other lowland records would be of the greatest interest, and an investigation into the locality documentation of the lowland specimens is clearly a priority. However, it is important to bear in mind that any investigation relying on verbal enquiries from local residents should take into account that local residents might not know the species by the common name(s); might know the species by a different local name; or might collectively know the species by a name that applies to other members of the same taxonomic group or similar-looking species.

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This manuscript would not have materialised if it were not for the constant 'badgering' by William Duckworth, who first highlighted the significance of my observation. I also owe many thanks to Ikki Matsuda (Primate Research Institute, Kyoto University) for his repeated and patient enquiries with the residents of Sukau; and to Siew Te Wong (Bornean Sun Bear Conservation Centre) for generously making enquiries from the various specialists and naturalists in Sabah.

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First Otter Civet *Cynogale bennettii* photographed in Sabangau Peat-swamp Forest, Indonesian Borneo

Susan M. CHEYNE[1,2], Simon J. HUSSON[2,3] and David W. MACDONALD[1]

Abstract

Otter Civet *Cynogale bennettii* was photographed twice in the Sabangau Peat-swamp Forest, Central Kalimantan, Indonesia, in May 2009, an area with records of several other threatened species of carnivores.

Keywords: camera-trap, lowland forests

Foto Pertama Musang Air *Cynogale bennettii* di Hutan Gambut Sabangau, Borneo, Indonesia

Abstrak

Musang Air *Cynogale bennettii* berhasil difoto dua kali pada bulan Mei 2009 di hutan gambut Sabangau, Kalimantan Tengah, Indonesia, kawasan yang tercatat memiliki beberapa jenis karnifora langka lainnya.

Kata-kata kunci: distribusi; kamera-trap; tanah rendah

Very little is known about Otter Civet *Cynogale bennettii* across its range, other than that its distribution is patchy and restricted to wetlands. The destruction, degradation and drying out of wetlands is likely to be the biggest threat to this little-known carnivore (Duckworth *et al*. 2008). Otter Civets have previously been thought to inhabit predominantly peat-swamp forests and primary forest. They have been recorded in logged and secondary forests as well (Heydon & Bulloh 1996, Wilting *et al*. 2010). Much remains to be discovered about the life history and ecology of this species. Veron *et al*. (2006) reported six sightings from Indonesia, with only two from Indonesian Borneo, none from Central Kalimantan. Of seven museum specimens collected from Indonesian Borneo, only one came from Central Kalimantan.

The Sabangau Felid Project was established in 2008 in the Sabangau Peat-swamp Forest, Central Kalimantan; Cheyne *et al*. (2009) described the site. Cameras are set in pairs using Cuddeback Expert units and cover 15 km² in the core study area. Cameras are placed on man-made trails and around old logging canals where they form a more accessible route for the animals (Fig. 1). Camera-trapping confirmed the presence of Sunda Clouded Leopard *Neofelis diardi* (BBC 2008, Cheyne & Macdonald *in press*), Flat-headed Cat *Prionailurus planiceps* (Cheyne *et al*. 2009) and

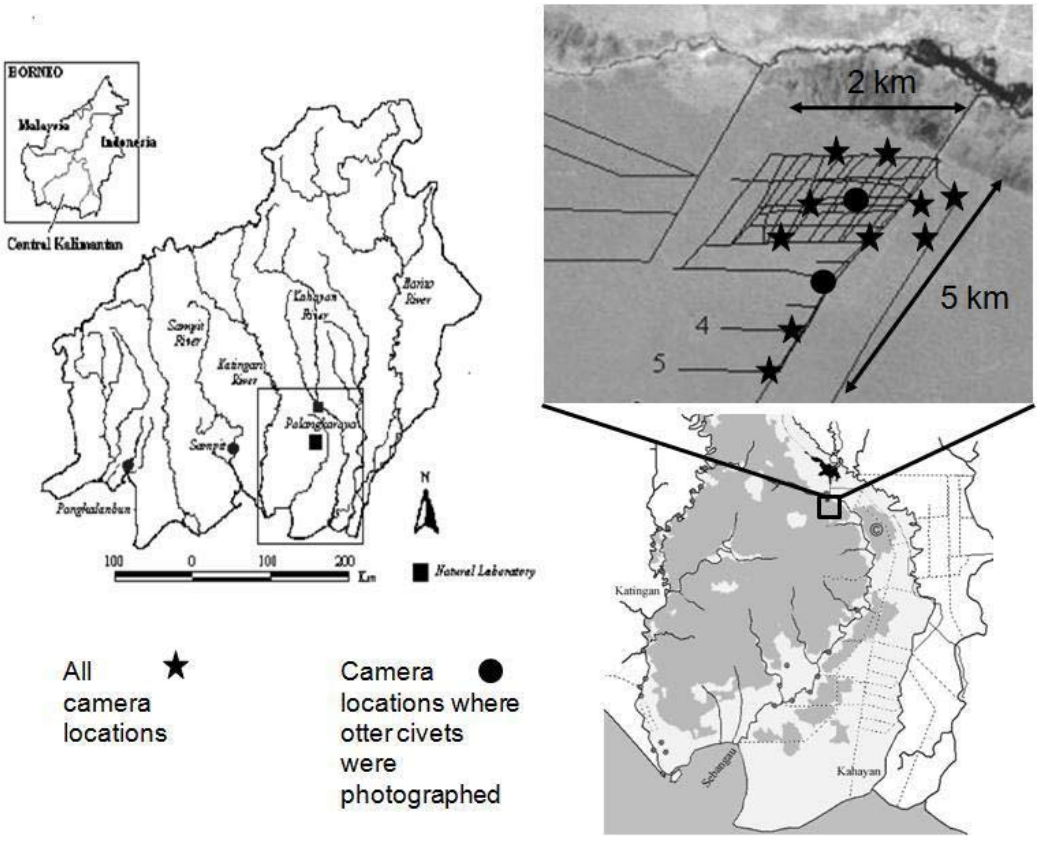

Fig. 1. Study site in north-eastern corner of Sabangau forest showing locations of cameras where Otter Civets were photographed (Fig. 2). Numbers on transects refer to transect names.

Fig. 2. Otter Civet Cynogale bennettii *(A) taken at 02h17 on 3 May 2009 on cameras set about 3 km south of the Setia Alam base camp (2°33'S, 113°89'E) and about 4.5 km south of the Sabangau River; (B) taken at 21h27 on 26 May 2009 on cameras set 3.5 km south-west of the first photo (2°32'S, 113°89'E) and about 2.5 km south of the Sabangau River.*

Leopard Cat *P. bengalensis*. Otter Civet had not been reported in this area.

Two individuals have been photographed since May 2008 (Fig. 2). The cameras on which the Sabangau animal was photographed have been in location since July 2008; 602 trap-nights were required to obtain two photos of the Otter Civet, compared with 85 for Malay Civet *Viverra tangalunga*, 182 for Yellow-throated Marten *Martes flavigula*, 204 for Short-tailed Mongoose *Herpestes brachyurus* and 258 for Collared Mongoose *H. semitorquatus*. All cameras are set in mixed-swamp forest at an elevation of about 11 m a.s.l. Cameras on which the Otter Civets were camera-trapped, other wildlife including Clouded Leopard, Malay Civet and Sun Bear *Helarctos malayanus* were also photographed. Only one location was near a semi-permanent source of water. Elsewhere, Veron *et al*. (2006) reported 59 pictures of Otter Civets from lowland forests of Way Kambas National Park, Sumatra (January 1996 – December 1998) in 3,920 camera-trap days.

Acknowledgements

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The trade in Viverridae and Prionodontidae in Peninsular Malaysia with notes on conservation and legislation

Chris R. SHEPHERD[1] and Loretta Ann SHEPHERD[2]

Abstract

Illegal hunting and trade in viverrids in Peninsular Malaysia, to supply international and local demand for meat, appears to be common and widespread. National legislative protection under the Protection of Wild Life Act 1972 is largely adequate to protect viverrids, but illegal trade continues, as evinced by a number of seizures. Further research is needed to assess the impact of illegal hunting and trade and to assist in improving the efficiency of legislation protecting these species.

Keywords: CITES, civet, hunting, linsang, wildlife trade

Perdagangan terhadap Viverridae dan Prionodontidae di Semenanjung Malaysia berserta maklumat mengenai pemuliharaan dan perundangan

Abstrak

Pemburuan dan perdagangan haram viverrid di Semenanjung Malaysia, sebagai penawaran kepada permintaan daging eksotik di peringkat antarabangsa dan tempatan, adalah umum dan berlaku di merata tempat. Perundangan perlindungan kebangsaan di bawah Akta Perlindungan Hidupan Liar 1972 adalah agak mencukupi untuk melindungi viverrid, namun perdagangan haram masih berterusan seperti yang dapat disaksikan daripada bilangan rampasan. Kajian lebih lanjut adalah perlu untuk menilai kesan pemburuan dan perdagangan haram serta untuk membantu memperbaiki keberkesanan perundangan untuk melindungi spesies ini.

Kata-kata kunci: CITES, musang, pemburuan, perdagangan hidupan liar

Introduction

In December 2008, an Orang Asli (aboriginal) man was fined MYR (Malaysian Ringgit) 3,000 (USD 857) for being in possession 68 frozen Common Palm Civets *Paradoxurus hermaphroditus* in his home in Rompin, in the southern state of Johor. The civets were found in the 52-year-old man's refrigerator by enforcement officers of the Department of Wildlife and National Parks Peninsular Malaysia. The man said the civets were hunted from forest reserves and oil palm plantations.

Domestic legal protection

The primary wildlife legislation for Peninsular Malaysia is the Protection of Wild Life Act 1972 (Act No. 76), which is enforced by the Department of Wildlife and National Parks Peninsular Malaysia. Separate laws enforced by different authorities protect wildlife occurring on Malaysian Borneo, which are not discussed here.

Common Palm Civets are protected under Schedule 2 of the Protection of Wild Life Act 1972 (as revised 2007). Of the 11 viverrids and linsangs (now generally placed in their own family, Prionodontidae) occurring in Peninsular Malaysia (Francis 2008), legal hunting is permissible of only this species and the Malay Civet *Viverra tangalunga* (Table 1). The remaining nine are classified as totally protected species under the Act. Totally protected animals are species which shall not be killed, taken, or held in possession by anyone. Protected animals are those which may be shot, killed or taken or held in possession by a licensed hunter, licensed dealer or others as provided by the Act, and the conditions prescribed in the licence must be met. Anyone found guilty of unlawfully shooting, killing or taking any of the nine totally protected viverrid or linsang species contravenes Section 64 of the Act, which provides for a maximum fine of MYR 5,000 (USD 1,429) or for a term of imprisonment not exceeding three years, or both. Further, Section 64(2) provides for a fine up to MYR 3,000 (USD 857) and/or imprisonment of up to two years for those found guilty of possession or of carrying on the business of a dealer or taxidermist of totally protected species.

Penalties are higher if the offence involves females and juveniles than if it involves only adult males. Unlawfully shooting, killing or taking of juveniles provides for a maximum fine of MYR 6,000 (USD 1,714) or to a term of imprisonment not exceeding six years, or both, under Section 65. Section 66 covers unlawful shooting, killing or taking of females, providing for a maximum fine of MYR 10,000 (USD 2,857) or for a term of imprisonment not exceeding 10 years, or both.

To hunt Common Palm Civets and Malay Civets, hunting licences must be obtained from the Department of Wildlife and National Parks Peninsular Malaysia. There is no hunting season imposed; hunting is permitted throughout the year. Each licence costs MYR 50 (USD 14) and enables five individuals to be hunted each month. This means the maximum number a single person can hunt in a year is 60 individuals.

In this case, however, the man was arrested and prosecuted for having no such licence for any of the animals found in his possession. Anyone found guilty of unlawfully shooting, killing, taking, or in possession of either Common Palm Civet or Malay

Table 1. Status of Viverridae and Prionodontidae in Peninsular Malaysia.

Species	Protection of Wildlife Act	IUCN Red List	CITES
Banded Linsang *Prionodon linsang*	Totally protected	Least Concern	II
Malay Civet *Viverra tangalunga*	Protected	Least Concern	-
Large-spotted Civet *V. megaspila*	Totally protected	Vulnerable	-
Large Indian Civet *V. zibetha*	Totally protected	Near-threatened	III (IN)
Small Indian Civet *Viverricula indica*	Totally protected	Least Concern	III (IN)
Common Palm Civet *Paradoxurus hermaphroditus*	Protected	Least Concern	III (IN)
Masked Palm Civet *Paguma larvata*	Totally protected	Least Concern	III (IN)
Binturong *Arctictis binturong*	Totally protected	Vulnerable	III (IN)
Small-toothed Palm Civet *Arctogalidia trivirgata*	Totally protected	Least Concern	-
Banded Civet *Hemigalus derbyanus*	Totally protected	Vulnerable	II
Otter Civet *Cynogale bennettii*	Totally protected	Endanagered	II

Civet without a licence, or in excess of the numbers permitted, violates Section 68 of the Act, entailing a maximum fine of MYR 3,000 (USD 857) or to a term of imprisonment not exceeding three years, or both. The man in this case received the maximum fine, but was not incarcerated.

The Act is currently being revised, but it is unknown if any clauses specifically relating to viverrids or linsangs will change, although the relevant authorities have assured that the proposed amendments will generally invoke higher penalties and wider protection of species.

International legal protection

In addition to national legislation, Malaysia has also committed to further protection of wildlife and regulation of wildlife trade through the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Of the 11 viverrids and linsangs, three are regulated by this Convention and are listed in Appendix II, including Banded Linsang *Prionodon linsang*, Banded Civet *Hemigalus derbyanus* and Otter Civet *Cynogale bennettii* (Table 1). This means that international trade in these species is permitted only with the required CITES permits, and if carried out in accordance with national legislation. A further five species have been listed in Appendix III by India, which means that permits are required for export of these species from India, and certificates of origin from other exporting states.

Of significant conservation concern are three species listed as Vulnerable, and one listed as Endangered, by the IUCN Red List of Threatened Species (IUCN 2008) (Table 1).

Hunting and trade

Viverrids are hunted and traded for local and international consumption throughout Southeast Asia (Schreiber *et al*. 1989, Corlett 2007, Shepherd 2008), and this indeed appears to be the case in Malaysia. The wild meat trade is the primary driver for the demand in viverrids. However, very little is known of the extent of hunting of these species in Malaysia, or the impact that hunting (legal and illegal) has on wild populations.

Over the years, numerous seizures involving viverrids indicate the hunting pressure they are under in Peninsular Malaysia. Some examples of seizures between 2002 and 2008 are highlighted in Table 2.

Discussion

This particular case is considered extremely unusual: aboriginal people are rarely prosecuted for wildlife offences, because they are allowed to hunt species that are not totally protected for their own consumption. To hunt for commercial purposes, then they too need licences from the authorities. The aboriginal people, however, are often sought after by middlemen for their hunting skills, and the latter use them to poach a wide variety of species, from Tigers *Panthera tigris* and Leopards *P. pardus* to pangolins *Manis* and all species of freshwater turtles that occur.

Illegal hunting and trade in viverrids in Peninsular Malaysia seems to be common and widespread, for domestic consumption, as wild meat restaurants within Peninsular Malaysia commonly offer civet meat. The demand for viverrid meat abroad is illustrated by seizures at or near border exit points.

Viverrids and linsangs are afforded a high legal protection under the Protection of Wild Life Act 1972, despite this legislation being outdated and requiring a major revamp to plug many other legal loopholes. Further, the permitted hunting of two species (Common Palm Civet and Malay Civet) is regulated through the Department of Wildlife and National Parks licensing system. If there is scientific evidence to suggest that wild populations of these two species are declining and therefore cannot be harvested sustainably, then recommendations should be made for these to be upgraded to Totally Protected species, or perhaps, for a temporary hunting moratorium, after which their status can be reassessed. Research and monitoring efforts would be highly useful to assist in providing timely supporting data for determining policy with regard to the legal protection of viverrids and linsangs.

While legal protection, in theory, of viverrids is strong, enforcement efforts need to be intensified to prevent illegal hunting, and legal hunting should be effectively policed. Research and monitoring should be implemented to assist enforcement activities, and to better understand the trade dynamics and potential negative impacts on the conservation of viverrids in the wild.

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Table 2. Examples of seizures involving viverrids in Peninsular Malaysia between 2002 and 2008.

Details	Source
Civet meat of unknown quantity seized in shipment of 676 monitor lizards *Varanus* at Kuala Lumpur International Airport	The Star, 21 Dec 2008
Man fined MYR 5,000 (USD 1,429) and jailed for two weeks for possessing various species, including four dead Common Palm Civets	New Straits Times, 24 Dec 2007
Illegal possession of various species, including 9 dead Common Palm Civets; offender sentenced to MYR 6,000 (USD 1,714) fine or two months imprisonment on non-payment of fine	Department of Wildlife and National Parks Annual Report 2007
One dead Common Palm Civet and one dead Malay Civet seized along with various other species in a shipment heading for the Malaysia – Thailand border	New Straits Times, 19 July 2007
Mini-zoo fined MYR 6,000 (USD 1,714) for possessing various species, including one Common Palm Civet and a second Mini-zoo found with various species without permits, including three Binturongs, two Malay Civets and one Masked Palm Civet	The Star, 27 March 2007
Illegal possession various species, including four skinned civets; offender fined MYR 5,500 (USD 1,571)	Department of Wildlife and National Parks Annual Report 2005
Illegal possession of various species, including three civets; offender compounded MYR 3,500 (USD 1,000)	Department of Wildlife and National Parks Annual Report 2005
204.5 kg of wild meat (including serow *Capricornis* and Sun Bear *Ursus malayanus*) seized in a wild meat restaurant; 24.5kg identified as civet meat	Utusan Malaysia, 18 Jan 2003
Several confiscations totalling 287 skinned Common Palm Civets	Department of Wildlife and National Parks Annual Report 2002

(Source: Department of Wildlife and National Parks' Annual Reports and media reports)

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Anon. 2007c. Police foil smuggling of meat. *New Straits Times*, 19 July 2007, Malaysia.

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Hodgson named the Spotted Linsang *Prionodon pardicolor* in 1841

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Abstract

The scientific name of Spotted Linsang *Prionodon pardicolor* Hodgson has variably been dated to 1841 or, mostly, 1842. Investigation of contemporary sources indicates that the former is correct.

Keywords: date of description, nomenclature, scientific name, year of publication

Brian Hodgson was a prolific zoological author who, as one of the first western naturalists to reside in the Himalayas, came across dozens of vertebrate taxa not then described to science (Cocker & Inskipp 1988, Datta & Inskipp 2004, Inskipp 2004). One of these is Spotted Linsang, for which the name in current use, *Prionodon pardicolor*, is generally credited to Hodgson, 1842 but sometimes to Hodgson, 1841. The present note untangles this inconsistency.

Hodgson lived in a remote area in an era of uneven communication reliability and efficiency, well before modern concepts of type specimens and name availability. He referred to the linsang in three articles with similar imprint dates. The original description, a tract devoted to the species in the *Calcutta Journal of Natural History* (*CJNH* 2: 57–60), is usually dated as 1842 (by, e.g., Blanford 1888, Sclater 1891, Wroughton 1916, Osgood 1932, Pocock 1933, 1939, Ellerman & Morrison-Scott 1951, Lekagul & McNeely 1977, Wozencraft 1993, 2005, Wang Yingxiang 2002, Gaubert 2009), but Ellerman & Morrison-Scott (1966), Corbet & Hill (1992) and Datta (2004) all dated it as 1841.

CJNH 2: 57–60 was in part 5 of the journal. This, the first part of volume 2, has an imprint date of April 1841. Four strands of circumstantial evidence suggest part 5 was indeed printed in 1841. (1) None of the above-cited sources dating it as 1842 provides even a footnote as to why a course contrary to the imprint date was taken. (2) Two other Hodgson names still in current use today and from the same volume of *CJNH*, the mole *Euroscaptor micrura* (p. 221) and Lesser Bamboo Rat *Cannomys badius* (p. 60), are generally dated as 1841, and in page sequence come after the introduction of the linsang's name; the mole was even in part 6. (3) Hodgson (1847: 40) himself wrote that "To this genus [*Prionodon*] no second species was added until 1841, when I described another proper to the Sub-Himalayas in the 5th No. of this journal [*CJNH*]". (4) In the original description, he wrote that "in my catalogue of Nepalese mammals, drawn up for the Linnæan Society, and in my descriptions of new species in the Journal of the Asiatic Society, I have omitted all mention of a very beautiful little animal...", which allows some indirect triangulation of the date of *CJNH* (2: 57–60).

In 1841, he wrote two more versions, in which he did mention the linsang, of his 'Classified catalogue of mammals of Nepal, corrected to end of…': to '1840' for that published in *CJNH* (2: 212–221), and to '1841' for that in the *Journal of the Asiatic Society of Bengal* (*JASB* 10: 907–916). These versions were evidently not published by the time he wrote the original description, because in the latter he referred only to the earlier, Linnæan Society, incarnation of his catalogue. He signed off *CJNH* 2: 212–221 from the "valley of Nepal, March 1841", and *JASB* 10: 907–916 (in high dudgeon over one of his detracting colleagues) from the "Valley of Nipal, Dec. 1841". Both versions accompanied his name for the linsang (*Prionodon pardicolor*) with essentially the same concise text, in the latter (p. 909) reading: "32. *Prionodon*.—1. Sp. new. Pardicolor Nobis, H. C. and N."; 32 is the species's sequence number, 'nobis' indicates his authorship of the name, and 'H. C. and N' is a habitat and distribution coding. Although the use of 'new' makes the account look, to modern readers, like the first introduction of the name, this is not so. Hodgson used this word widely in his catalogues, and on p. 915 of *JASB* 10: 907–916, he summed up that "probably 55 to 60 [mammal species] are new. Their descriptions, with four or five exceptions only, are to be found in the Journal of Bengal Asiatic Society, and in that of Mr. McClelland [= *CJNH*]. The remaining four or five yet unpublished are forthcoming shortly". He did not, however, cite in his catalogues the original descriptions for each name nor did he specify which names remained then unpublished; this leaves an ambiguity that *Prionodon pardicolor* might have been one of them.

Without doubt, therefore, Hodgson wrote *CJNH* 2: 57–60 first, then *CJNH* 2: 212–221, and finally *JASB* 10: 907–916; but it does not follow that they were published in this order, and it is the date of publication, not of writing, that needs clarification. Had *CJNH* 2: 57–60 been published in 1842, it must have had a nine (or more) -month delay in printing, and there must also have been a delay in *JASB*. The latter is quite possible: *JASB* 10: 907–916 falls in part 119, with an imprint date of November 1841, but this year has not universally been accepted as the year of printing. Peters (1940) suspected an actual publication date of 1842 for the directly following article (which includes the original description of '*Phoenicophaus longicaudatus*' (= Green-billed Malkoha *Phaenicophaeus tristis*), and indeed *JASB* was often published later than the imprint date (Dickinson & Pittie 2006). These latter found no reasons to uphold Peters's suspicions over part 119, but E. C. Dickinson *in litt*. (2007) cautioned that they were unaware of Hodgson's date-line on the mammal catalogue. It seems unlikely that with this December sign-off in Nepal, part 119 could have been printed (in Calcutta) in that year, but the date of printing cannot be resolved without further investigation.

Such investigation is a major undertaking and does not always allow resolution (e.g. Dickinson & Pittie 2006). E. C. Dickinson (*in litt*. 2007) knows of no-one having explored *CJNH* for evidence of printing delays, but the circumstantial evidence, above, gives no grounds for an 1842 date of publication of the original description. The wide use of the latter may simply reflect that the final part of volume 2 of *CJNH*, part 8, had indeed an imprint date of 1842 (January): perhaps someone a long time ago (no later than 1888!) erroneously assumed that this date applied to the entire volume. Uncritical repetition then bedded in this error. In this context it is noteworthy that Corbet & Hill (1992: 12) checked the original sources of most names for "bibliographic accuracy",

a labour undertaken systematically by few other list compilers. Even more telling is that Ellerman & Morrison-Scott noticed the correct date between their first (1951) and second (1966) editions, and amended their text from 1842 to 1841 in both relevant places (both on p. 285); but they did not flag this change, and few have picked up on it.

As a final footnote, the original description (*CJNH* 2: 57–60) spelt the name as *Prionodon pardicotor* in the only place in which it occurred, the title, and *CJNH* 2: 212–221 spelt it as *pardicolar*. These spellings give meaningless words, whereas *pardicolor*, as finally printed in *JASB* 10: 907–916, refers to the Leopard *Panthera pardus*-like colour and pattern of the animal. Subsequent authors, including Ellerman & Morrison-Scott (1951, 1966), Corbet & Hill (1992), Van Rompaey (1995: 10) and Datta (2004), all of whom noted the original form, have used the emended spelling and there are no grounds to reinstate *pardicotor*, which was clearly a printer's error.

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A field record of Small-toothed Ferret Badger *Melogale moschata* in Central Laos, and other recent records of ferret badgers from the country

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Abstract

A Small-toothed Ferret Badger *Melogale moschata* found in March 2009, in a snare in southern Nakai–Nam Theun National Protected Area, extends the species's known Lao range southeast by about 280 km, is one of its most southerly records in the world, and together with a recent record of Large-toothed Ferret Badger *Melogale personata* from about 100 km to the west, means that the two ferret badger species in Laos may overlap in at least latitudinal distribution. Recent field and trade records of unidentified ferret badgers come from at least eight areas but identification difficulties mean the respective Lao distributions of the two species remain imperfectly known.

Keywords: distribution, Large-toothed Ferret Badger, *Melogale personata*, Nakai–Nam Theun NPA, range extension, snare

The meagre historical collection record of mammals in Laos contains two series of Small-toothed Ferret Badger *Melogale moschata* records: J. Delacour and colleagues collected eight specimens in Xiangkhouang province in 1925–1926 (Thomas 1927), and the Kelley–Roosevelts' Expedition collected five around Phongsali in 1929 (Osgood 1932), which came probably from about 5 km south-east of Phongsali town, from around Ban Khomen (Fuchs *et al*. 2007). Duckworth (1997) traced no subsequent Lao records of the species and (*in litt*. 2009) still knows of none.

Ferret badgers or their parts have been seen recently in local wild-meat markets or in the forest at various Lao locations (Fig. 1), including at least Louang-Namtha market, Louang-Namtha province; Nam Et–Phou Louey National Protected Area (NPA); Sangthong district, Vientiane province; a menagerie in Ban Lak-20 (= Ban Lak Xao), Bolikhamxai province; Nakai–Nam Theun NPA; the Nakai plateau, Khammouan province; Vilabouli district, Savannakhet province (Duckworth *et al*. 1999, Johnson & Johnston 2007, Dersu & Associates 2008, Johnson *et al*. 2009, WCS in press); and Ban Namthon, Bolikhamxai province (pers. obs.). However, the difficulty of distinguishing Small-toothed Ferret Badger from Large-toothed Ferret Badger *M. personata* without access to the skull (Schank *et al*. 2009) means these records must remain unidentified to species.

On 14 March 2009, a combined team of wildlife surveyors, patrol rangers and village guides, fielded by the Government of Lao PDR's Nam Theun 2 Watershed Management and Protection Authority, encountered and destroyed a line of wire snares in the southern end of Nakai–Nam Theun NPA, Nakai district, Khammouan province, central Laos. In one snare was the carcass of a decomposed ferret badger, at 17º45′20″N, 105º37′05″E (Magellan GPSMAP 60CSX GPS, WGS84 India-Thailand datum); this location is at 980 m asl, according to 1985–1987 1:100,000 topographic maps of the *RDP Lao Service Geographique d'Etat*. The skull was collected (Fig. 2), but has not yet been deposited with a collection. It was determined to be that of *M. moschata* by comparison with skull line drawings in Pocock (1941). Salient features of identification include (1) the outer edge of pm^4 is mildly concave, not convex; (2) pm^2, while larger than pm^1, is not disproportionately so; and (3) the muzzle widens markedly aback of the posterior root of pm^4. In *M. personata* the jaw widens anterior to this tooth, so as to accommodate its massive size,. The photographs were shown to A. Abramov, B. Long, R. J. Timmins and J. W. Duckworth who concurred with the identification.

The animal was found in a remote, mountainous area of little-degraded, closed-canopy broadleaf evergreen forest (interspersed with occasional conifers, e.g. *Keteleeria*), with a fairly open understorey. This is the first known record of the species in Laos since the mid 20th century, and the first ever record from the country with precise locality and elevation. It is substantially the southernmost record of the species in Laos (about 280 km south-east of the former Xiangkhouang town). It is by far the most southern world record of the species except from Vietnam, where Vu Ngoc Thanh (in Long & Minh Hoang 2006) collected an individual (also found in a hunters' trap-line) from Macooih commune, Dong Giang district, Quang Nam province, at 15°47′56″N.

It is impossible to speculate on the species's abundance in Nakai–Nam Theun NPA, but camera-trapping in 2006–2008 provided some information about the genus. Johnson & Johnston (2007)

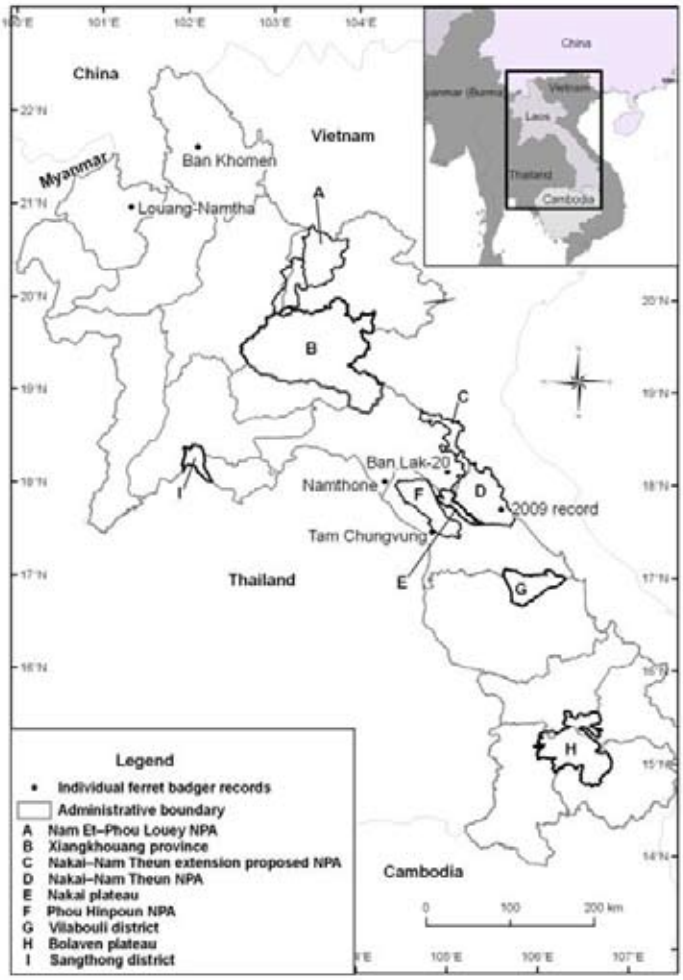

Fig. 1. Ferret badger Melogale *records from Lao, and other localities mentioned in the text.*

covered the results of two blocks of such survey, in 2006–2007. In one block comprising 200 km² of Khamkeut district in the northwest of the protected area over an elevation range of 550–1,950 m, there were about 50 photographs of ferret badgers from 4,334 camera-trap-days, whereas 3,356 camera-trap-days in a block of 200 km² over 550–1,000 m in the Nam On sector in the southeast of the protected area yielded about a dozen photographs. A cluster of addtional camera-trap records over several days, from one camera and probably of the same animal, came in March 2008 from the base of non-calcerous cliff amid extensive forest on the Phou Vang massif, at 17°48′35″N, 105°33′40″E (1,220 m asl). By contrast, intensive spotlighting in 1996 in one part of the same protected area (above Ban Navang; outside these recent camera-trapping areas) comprising little-encroached evergreen forest over 700–1,300 m failed to detect the genus at all (Duckworth 1998). Given the many other species seen then, this negative result suggests that in this general area of Laos the genus is either difficult to detect by conventional spotlighting or is only patchily distributed within the hill forests.

In 1998, a skull of Large-toothed Ferret Badger *M. personata* was found in Phou Hin Poun NPA (formerly called Khammouan Limestone National Biodiversity Conservation Area), about 100 km almost due west of the present specimen, but in radically different habitat: a cave (Tam Chungvung; 17°30′40″N, 104°50′15″E) amid karst, at about 200 m (Robinson & Webber 1998; M. Robinson *in litt*. 2010) and thus at significantly lower elevation than the Nakai–Nam Theun NPA record. Previous Lao records of *M. personata* came only from about 400 km to the south, on the Bolaven plateau, where Delacour and colleagues collected five in winter 1931–1932 (Osgood 1932), and the Legendre Indochina Expedition collected 11 further specimens during 29 January–12 February 1932 (D. P. Lunde *in litt*. to J. W. Duckworth

Fig. 2. Skull of Small-toothed Ferret Badger Melogale moschata *from Nakai–Nam Theun NPA, Central Laos; three views of the same skull.*

2007). These latter lack precise locality and most or all probably came via purchase from local people (Legendre 1936).

Prior to these records, then, all records of *Melogale* identifiable to species in the north of Laos were *M. moschata*, while all from the south, and both those from Cambodia, the next country south (Schank *et al.* 2009) are *M. personata*. These records indicate that both species occur in central Laos. There remain too few records to speculate responsibly on the true respective distributions of each species. Therefore, further records validated to species by examination of the teeth and with accurate location and altitude are strongly encouraged.

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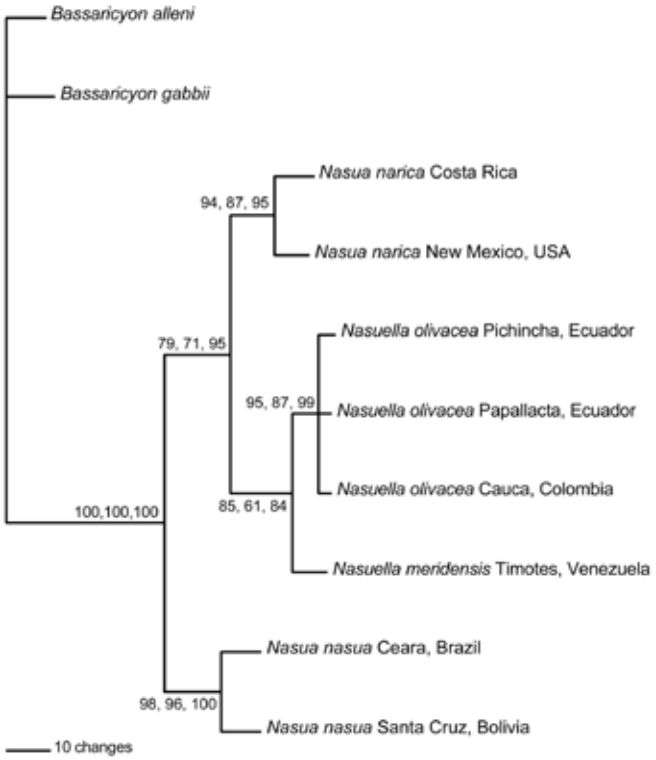
ERRATUM

Helgen, K. M., Kays, R., Helgen, L. E., Tsuchiya-Jerep, M. T. N., Pinto, C. M., Koepfli, K. P., Eizirik, E. & Maldonado, J. E. 2009. Taxonomic boundaries and geographic distributions revealed by an integrative systematic overview of the mountain coatis, *Nasuella* (Carnivora: Procyonidae). *Small Carnivore Conservation* 41: 65–74.

Fig. 3 (page 70) revised. Molecular relationships of coatis based on partial cytochrome b sequences. One of three most parsimonious trees (length = 167, retention index = 0.763, consistency index =0.760) from the partial sequence of the cyt b gene (366 bp). This comparison allows for the inclusion of the short sequence generated from DNA extracted from the turbinate bones of a specimen of N. meridensis. Branch support values represent maximum parsimony and maximum likelihood bootstrap support, followed by Bayesian posterior probabilities values, respectively.



The bootstrap support values for the maximum likelihood estimate were incorrect in the original article. Our overall taxonomic conclusions remain unchanged.

Fig. 1. Camera-trapping pictures from Deramakot Forest Reserve in Sabah, Malaysia. Photos by Wilting & Mohamed unless otherwise indicated (see Wilting *et al.*, pages 10 – 13).

(A) Otter Civet *Cynogale bennettii*
(B) Malay Civet *Viverra tangalunga*
(C) Common Palm Civet *Paradoxurus hermaphoditus*
(D) Banded Civet *Hemigalus derbyanus*
(E) Binturong *Arctictis binturong* (Photo: Samejima)
(F) Sunda Stink-badger *Mydaus javanensis*
(G) Short-tailed Mongoose *Herpestes brachyurus*
(H) Collared Mongoose *Herpestes semitorquatus*
(I) Yellow-throated Marten *Martes flavigula* (Photo: Samejima)
(J) Banded Linsang *Prionodon linsang* (Photo: Samejima)
(K) Smooth-coated Otter *Lutrogale perspicillata*
(L) Asian Small-clawed Otter *Aonyx cinereus*
(M) Hairy-nosed Otter *Lutra sumatrana*

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