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

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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 >