

Diversity and activity of small carnivores of the Sabangau Peat-swamp Forest, Indonesian Borneo

Susan M. CHEYNE^{1,2}, Simon J. HUSSON², Reychell J. CHADWICK² and David W. MACDONALD¹

Abstract

As part of an ongoing project to identify and assess the distribution and population status of Bornean cats in the Sabangau Peat-swamp forest, Central Kalimantan, Indonesia, data were collected on eight other species of small carnivore as part of the general remit, including the Collared Mongoose *Herpestes semitorquatus*. The activity patterns of small carnivores in Sabangau generally resembled those reported elsewhere, but suggest some behavioural flexibility of the Common Palm Civet *Paradoxurus hermaphroditus*. Of equal interest are the species not sighted despite >6,000 trap-nights including Sunda Stink-badger *Mydaus javanensis*, Masked Palm Civet *Paguma larvata* and Banded Civet *Hemigalus derbyanus*, thus highlighting possible implications for the distributions of these species.

Keywords: activity cycles, camera-trapping, Collared Mongoose, *Herpestes semitorquatus*, species community

Keanekaragaman dan kegiatan karnivora kecil dari Sabangau-rawa Hutan Gambut di Kalimantan,

Indonesia

Abstrak

Sebagai salah satu bagian dari penelitian yang sedang berjalan untuk mengetahui dan menilai distribusi dan status populasi dari kucing hutan Kalimantan di hutan rawa Sebangau, Kalimantan Tengah, Indonesia, maka data telah dikumpulkan untuk delapan spesies karnivora kecil termasuk musang *Herpestes semitorquatus*. Data ditampilkan pada keanekaragaman spesies dan pola aktifitas. Pola aktifitas dari karnivora kecil di Sebangau secara umum serupa dengan aktifitas karnivora yang ada pada habitat lainnya, akan tetapi ada fleksibilitas tingkah laku pada musang *Paradoxurus hermaphroditus*. Perhatian yang sama juga pada juga pada spesies yang jarang tertangkap oleh perangkap malam yang termasuk juga luak *Mydaus javanensis*, musang *Paguma larvata* dan musang *Hemigalus derbyanus*, sehingga perlu ada penekanan untuk implikasi yang mungkin terhadap distribusi dari spesies ini.

Kata-kata kunci: siklus kegiatan, kamera perangkap, Musang (berkerah), *Herpestes semitorquatus*, komunitas spesies

Introduction

Asian tropical forest communities are notable for the high species richness of sympatric mammalian carnivores. The Asian Region supports a total of 80 species in the order Carnivora, and the less-degraded lowland forests support high numbers of species (15–25), especially in sites with extensive closed-canopy forest. Different forest types support up to six cats, six civets (plus *Priodonton*), three mongooses, eight mustelids (including otters), two canids and two bears per site (Corlett 2007). Despite this interesting and valuable species richness, there are few data on many of these carnivores, and the guilds they form.

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) and the important role of Indonesian Peat-swamp Forest as a carbon store and reservoir of floral and faunal diversity is now widely recognised. While tropical peat-swamp forest fires are not new, recent and continuing human disturbances, including water table drainage, deforestation/changes in land use and changes in the El Niño Southern Oscillation weather system, as a result of global warming, have led to increased frequency, incidence and severity of burning (Siegert *et al.* 2001, Harrison *et al.* 2007). This increased burning has serious negative impacts on forest cover (Page 2002, Fuller

et al. 2004), tree mortality (Siegert *et al.* 2001), peat structure/stability, CO₂ release (Page *et al.* 1999), human health (Kunii *et al.* 2002), economy (Varma 2003) and wildlife conservation (Singleton *et al.* 2004). Peatlands are critical for biodiversity conservation and support many specialised species and unique ecosystem types, and can provide a refuge for species that are extirpated from non-peatland areas affected by degradation and climate change (Parish *et al.* 2008). The main threats to such Bornean habitat, and in particular small carnivores, are summarised in Table 1.

Study Site

This study was conducted from the Natural Laboratory for the Study of Peat Swamp Forest (NLPSF), Sabangau catchment, Central Kalimantan, Indonesia (2°19'S, 113°54'E; Fig. 1). The area is peat-swamp forest (Mixed-Swamp Forest sub-type) and was logged under a selective concession system from 1991 to 1997 followed by illegal logging from 1997 to 2004. The site is at an altitude of about 10 m a.s.l. More detailed overviews on the study site can be found in Cheyne *et al.* (2010) and Cheyne & Macdonald (in press).

Methods

A total of 32 cameras was set at permanent locations for the duration of the study (Appendix 1). In addition, 12 roving cameras were in place for 45-day cycles in two additional areas to enlarge

Table 1. Threats to Borneo's forests and small carnivores (based on Cheyne 2010).

Threat	Notes
Oil palm and acacia plantations	Forested land is cleared for plantations
Legal logging	Legal logging is often unsustainable
Illegal logging	Uncontrolled logging in protected (and unprotected areas)
Fire	Fires destroy forest, especially peat-swamp forest, and create palls of smoke that can last for several months and are detrimental to animal health (and to humans).
Habitat fragmentation	Small carnivores might be unable to disperse from small fragments, and inbreeding depression or local extinctions through demographic factors become more likely.
Pet trade	Unknown impact on small carnivores.
Mining	Forest is cleared to expose large areas of land for open-cast mining and oil drilling.
Global warming and climate change	Indirect effects through increased intensity of fires and direct effects through unpredictable food availability.
Clearing forest for urban expansion	Forest habitat is being encroached upon to allow expansion of villages, towns and cities. Status of protected habitat is changed to allow for urban expansion.
Hunting (not for pet trade)	Small carnivores are hunted by local communities for bush meat.
Harvest of non-timber forest products	Small carnivore habitat is encroached upon by people gathering orchids, hunting flying-foxes <i>Pteropus</i> and collecting gemur tree <i>Aleodaphne coriacea</i> (Lauraceae; anti-malarial properties) and agarwood <i>Aquilaria</i> .
Dam development for electricity	Small carnivore habitat is flooded when dams are built.

the surveyed area. All 44 cameras (22 Cuddeback Expert® and 22 Cuddeback Capture IR® Cuddeback Digital, Non-Typical Inc., WI, USA) were placed in pairs about 50–60 cm above ground along established human-made trails (>4 years old) and, where possible, watering areas, to maximise capture rate. The cameras were set to operate during the full 24-hr cycle and no baits or lures were used. Activity times were collated as 06h00–12h00, 12h00–18h00, 18h00–00h00 and 00h00–06h00 to account for average dawn and dusk times in Sabangau, which is situated almost on the equator.

Results

The Orangutan Tropical Peatland Project (OuTrop) and the Wildlife Conservation Research Unit (WildCRU), University of Oxford, UK, initiated the Sabangau Cat Project in May 2008. Until October 2009, we accumulated data from a total of 6,025 trap-nights, giving

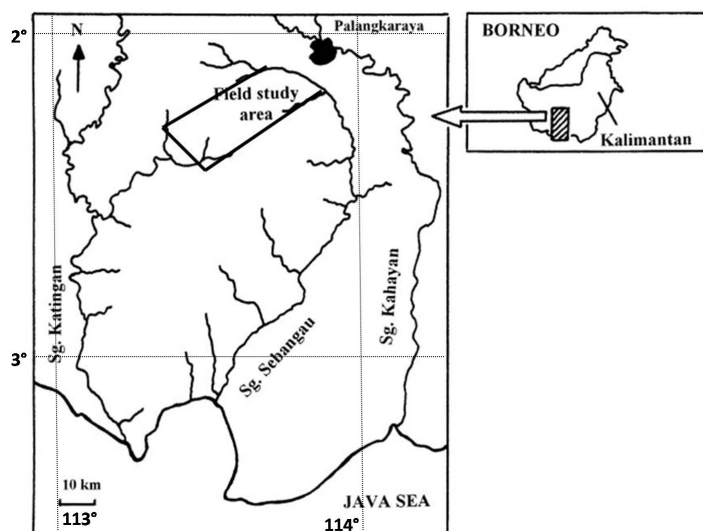


Fig. 1. The study site, in the north-east Sabangau catchment.

845 individual wildlife photos. Species could not be determined in only 1.4% of the photographs (due to poor focus, poor angle or an insufficient proportion of the animal being in the frame).

Small carnivores comprised 53 photographs (6.27% of total wildlife photographs) and represent eight species (Table 2; Appendix 1). All photograph counts given here represent independent events, i.e. sequential photographs of the same animal were not counted. The number of photographs is small, and we carried out cross-checking of identifications with several Indonesian researchers, Santiano, Twentinolosa, Ramadan (Dewa), Yudhi Kuswanto and Adul, and among SMC, RJC and SJH.

Our records indicate a split in active time between species (Fig. 2): Malay Civet was photographed only from dusk to dawn, whereas Short-tailed Mongoose, Collared Mongoose (Table 3) and Yellow-throated Marten were predominantly recorded between dawn and dusk. All four Common Palm Civet records were by day (Table 4). The few records of Banded Linsang (18h23), Otter Civet (21h27 and 02h17) and Small-clawed Otter (08h13 and 16h28) are not included in Fig. 2: there were too few photographs for meaningful comment.

Species sighted but not photographed

Two to three species of small carnivores sighted in Sabangau have not yet been photographed. Binturong *Arctictis binturong* was encountered in the early daylight (before 10h00) in 2008 and a provisional identification of Small-toothed Palm Civet *Arctogalidia trivirgata* was also in the early daylight. The Malay Weasel *Mustela nudipes* was seen during the day once each in 2002 and 2004 by local people in an area where we are now using our camera-traps (Page *et al.* 1997, Duckworth *et al.* 2006, Husson *et al.* 2009).

Discussion

Banded Linsang

That we only once photographed a Banded Linsang (Fig. 3) is consistent with several other studies (Azlan & Lading 2006, Wiltzing *et al.* 2010), which failed to find or rarely recorded this spe-

Table 2. Small carnivore species found in Sabangau.

Species	Scientific name	Number of photographs	% of photographs	Number of independent locations where animal photographed	Number of independent events	IUCN Red List 2010 Status
Banded Linsang	<i>Prionodon linsang</i>	1	1.92	1	1	Least Concern
Otter Civet	<i>Cynogale bennettii</i>	2	3.85	2	2	Endangered
Asian Small-clawed Otter	<i>Aonyx cinereus</i>	2	3.85	2	2	Vulnerable
Yellow-throated Marten	<i>Martes flavigula</i>	5	9.62	3	4	Least Concern
Common Palm Civet	<i>Paradoxurus hermaphroditus</i>	5	9.62	3	4	Least Concern
Collared Mongoose	<i>Herpestes semitorquatus</i>	8	15.38	2	6	Data Deficient
Short-tailed Mongoose	<i>Herpestes brachyurus</i>	14	26.92	3	10	Least Concern
Malay Civet	<i>Viverra zibetha</i>	16	30.77	6	10	Least Concern
Total photographs		53		Total events	40	

cies. Several reasons might be responsible why this species appears generally rather rarely on ground-based camera traps: (1) they may be ambush predators, thus do not move around much and therefore have a lower basic probability of being photographed than animals on the move more of the time, and (2) they spend most of their time in thick understorey tangles, and camera traps are (as in the present study) generally placed on more open trails. The fact that they are arboreal may not be that important as they are, apparently, often only a few feet above the ground (J. W. Duckworth *in litt.* 2010). These suggestions are supported by observations of Spotted Linsang *P. pardicolor* summarised in Van Rompaey (1995). The only photo of the Banded Linsang was taken about 1½ hours after dusk, agreeing with other data that this animal is nocturnal (Lim 1973, Azlan 2003).

Otters and Otter Civet

Asian Small-clawed Otter is reported as diurnal (Foster-Turley 1992), and both photos from Sabangau were indeed taken after dawn. The two photos of Otter Civet are both nocturnal, although it is active throughout the day (Veron *et al.* 2006).

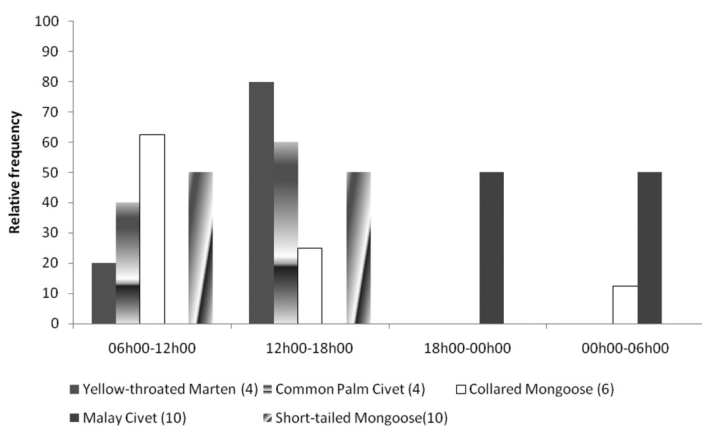


Fig. 2. Active periods of small carnivores (only species with >3 independent events are included).

Malay Civet, Common Palm Civet and Binturong

Our data support the findings from Malaysian Borneo of the Malay Civet as a nocturnal species with activity times in Danum Valley ranging from 18h00 to 07h00 (Macdonald & Wise 1979, Colón 2002). Data from Sulawesi show a significant activity by day (Jennings *et al.* 2006), but Sulawesi has no true diurnal small carnivore species at all, thus offering an explanation for differences in Malay Civet activity patterns between Borneo and Sulawesi. Common Palm Civet seems to be predominantly diurnal in Sabangau (based on the four events), although it is generally regarded as a nocturnal (Dhungel & Edge 1985, Joshi *et al.* 1995, Duckworth 1997, Johnson *et al.* 2009, Wilting *et al.* 2010) or crepuscular species (Azlan 2003). The Sabangau records are all roughly the same time of year (August and September, i.e.

Table 3. Records of Collared Mongoose *Herpestes semitorquatus* at Sabangau.

Month	Time	Number of animals	Number of events
Dec-08	05h13	2	1
Dec-08	08h03	1	1
Dec-08	09h24	1	1
Dec-08	15h51	2	1
Feb-09	15h44	1	1
Mar-09	10h43	1	1
Apr-09	11h50	1	1
May-09	08h05	1	1

Table 4. Records of Common Palm Civet *Paradoxurus hermaphroditus* at Sabangau.

Month	Time	Number of animals	Number of events
Sep-08	08h23	2	1
Sep-08	13h34	1	1
Aug-09	09h45	1	1
Sep-09	10h34	1	1



Fig. 3. Banded Linsang *Prionodon linsang* photographed on 25 October 2009 at an altitude of 11 m a.s.l., about 1.6 km south of the Setia Alam base camp (2°20'S, 113°53'E) and about 2.8 km south of the Sabangau River.

mid to end of the dry season). While they might reflect a change in foraging behaviour due to increased food demands for lactating or pregnancy, this would not explain why there are no records at night (J. W. Duckworth *in litt.* 2010). Why there would be this difference from other sites is unclear for now. Binturongs are likely to have been under-recorded due to the placing of cameras on human-made trails.

Yellow-throated Marten and mongooses

Yellow-throated Marten is primarily diurnal (e.g. Duckworth 1997, Grassman *et al.* 2005), a behaviour pattern which is supported by data from Sabangau. Bornean species of mongoose are also reported as diurnal (Belden *et al.* 2007) with all Sabangau sightings being between 06h00 and 18h00. However Wilting *et al.* (2010) recorded Collared Mongoose mainly around at dawn and dusk, with occasional night records, and Payne *et al.* (1985) considered this species nocturnal and crepuscular. It is possible that the presence of other carnivores in the guild in different areas will affect the activity periods of these species.

Species not found

Several species of Bornean small carnivore were not sighted, photographed, or reported by local people: Hose's Civet *Diplogale hosei* and Bornean Ferret Badger *Melogale everetti* would not be expected based on known distribution and habitat use (see Payne *et al.* 1985, Yasuma 2004, Wells *et al.* 2005, Boonratana 2010, Mathai *et al.* 2010). The lack of records of Sunda Stink-badger *Mydaus javanensis* is interesting as it was one of the most common carnivores photographed in lowland (<250 m a.s.l.) forest in Sabah (Wilting *et al.* 2010) but was not photographed in a similar study in Sarawak (>300 m a.s.l. (Mathai *et al.* 2010). If the data from the present study reflect a genuine absence of this animal in lowland peat forest this lends weight to suggestions that the Stink-badger is highly patchy in its distribution (Mathai *et al.* 2010).

Masked Palm Civet *Paguma larvata* has recently been suggested to be perhaps rarer in lowland Borneo than hitherto assumed (Wilting *et al.* 2010). Despite reasonable effort in this study, it was not found, adding another such lowland site.

The lack of records of Banded Civet *Hemigalus derbyanus* is

particularly important, as this is one of few Globally Threatened (IUCN 2010) small carnivores in South-east Asia. In some areas of Malaysian Borneo it apparently remains common (Mathai *et al.* 2010; Wilting *et al.* 2010) but some other recent studies in its historical geographic range have failed to find it (Holden 2006, Than Zaw *et al.* 2008). IUCN (2010) suggests that this species primarily lives in lowland forest, and it has been reported in peat-swamp forest in Malaysia. Sabangau has been affected by logging and has seasonal flooding, so this may perhaps not be the best habitat, for a species that moves mainly on the ground. Alternatively, Wilting *et al.* (2010) concluded that it is active mainly off trails and so the camera deployment here was probably not particularly well suited to pick it up.

The Small-toothed Palm Civet is nocturnal and arboreal so not susceptible to camera-trapping, and there were no spotlight surveys such as are almost necessary to find this animal (e.g., Belden *et al.* 2007, Wilting *et al.* 2010).

Cameras are placed on human trails, not set in good sites for otters such as by the water's edge, particularly at slides, holts and sprouting sites, so assessing their true status in the site is difficult. Sasaki *et al.* (2009) traced no records of Hairy-nosed Otter *Lutra sumatrana*, globally the rarest of the Bornean species, from Central Kalimantan, and it cannot be speculated whether it occurs at Sabangau.

Concluding remarks

Camera traps are frequently deployed to obtain photos of specific target animals or guilds (in this case, Sunda Clouded Leopard *Neofelis diardi*); thus encounters of animals with differing home-range size or other aspects of natural history may be few. Longer-term camera-trap data increases opportunities for photographing non-target animals, and so enhances biodiversity data for the area. Careful thought about natural history of each potentially 'missing' species, and then actively positioning cameras for them, is probably a better way to maximise species found; but such flexibility is rarely practicable when one or two focal species drive camera-trap deployment.

The NLPSF underwent sustained disturbance up to 2002. All cameras are placed on trails for maximising captures of Clouded Leopards; this may bias against captures of small carnivore species preferring dense undergrowth and avoiding open trails. Ongoing investigations of micro-habitat vegetation characteristics around the camera-trap localities will hopefully identify key habitat parameters which might explain the different species occurrences. Absence of certain species from the photographs, despite >6,000 trap nights, cannot conclusively prove that a species is absent. Conversely, the specialised peat-swamp habitat and the seasonal flooding (8–9 months each year) perhaps limit the number of species present in this habitat. Equally, the drainage of the peat through logging canals and the increasing fire events are causing ongoing and extreme disturbance to the ecology of Sabangau. The impacts of this disturbance on small carnivores are hard to predict, highlighting the need for more long-term studies specifically targeting this poorly studied group of animals. For all these species, bar Malay Civet and Common Palm Civet, the activity data, distribution and coarse abundance data from Borneo are poor, and from Indonesian Borneo are almost non-existent.

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**¹Wildlife Conservation Research Unit (WildCRU),
Department of Zoology, University of Oxford, The Recanati-
Kaplan Centre, Tubney House, Abingdon Road, Tubney,
Oxon, OX13 5QL, U.K.**

Email: susan.cheyne@zoo.ox.ac.uk

**²Orang-utan Tropical Peatland Project, Centre for the
International Cooperation in Management of Tropical
Peatlands (CIMTROP), University of Palangka Raya,
Indonesia.**

APPENDIX 1. Positions of cameras and species recorded at each.

Location number	Name of location	Latitude South	Longitude East	Yellow-throated Marten	Common Palm Civet	Malay Civet	Otter Civet	Small clawed Otter	Collard Mongoose	Short-tailed Mongoose	Banded Linsang
1	KM3 x RLWY	2°20'	113°53'	0	0	0	1	0	0	0	0
2	KM2 x RLWY	2°20'	113°54'	0	0	0	0	0	0	0	0
3	T1.6 x TF (Pondok Owa-Owa)	2°20'	113°53'	0	0	1	0	0	0	0	1
4	T2 x TD	2°20'	113°53'	0	0	0	0	0	0	0	0
5	TD x Jelutung Pondok	2°19'	113°53'	0	0	2	1	0	1	0	0
6	Km4 x RLWY	2°21'	113°53'	2	1	2	0	1	0	2	0
7	Km3.8 x RLWY	2°20'	113°46'	0	0	0	0	0	0	2	0
8	T1A x RLWY 1012m	2°19'	113°54'	0	0	0	0	1	0	0	0
9	Old Railway 400m	2°19'	113°55'	0	0	0	0	0	0	0	0
10	Km5 x RLWY	2°21'	113°53'	2	1	7	0	0	7	10	0
11	Tower Path	2°19'	113°54'	1	3	2	0	0	0	0	0
12	T.0 x T.C	2°19'	113°54'	0	0	2	0	0	0	0	0
13	T0 x TD	2°19'	113°54'	0	0	0	0	0	0	0	0
14	T0 x TH	2°19'	113°53'	0	0	0	0	0	0	0	0
15	T0.8 x THH	2°19'	113°53'	0	0	0	0	0	0	0	0
16	T2 x THH	2°20'	113°53'	0	0	0	0	0	0	0	0
17	OR 1150m	2°20'	113°55'	0	0	0	0	0	0	0	0
18	Canal I 200m	2°19'	113°53'	0	0	0	0	0	0	0	0
19	Canal I 1200m	2°19'	113°53'	0	0	0	0	0	0	0	0
20	Forest edge Canal I W	2°19'	113°53'	0	0	0	0	0	0	0	0
21	Interior Canal I SE	2°19'	113°53'	0	0	0	0	0	0	0	0
22	Interior canal I x TJ	2°19'	113°53'	0	0	0	0	0	0	0	0
23	Jelutung TA 0m	2°18'	113°50'	0	0	0	0	0	0	0	0
24	Jelutung TA 1200m	2°19'	113°50'	0	0	0	0	0	0	0	0
25	Jelutung TB 1000m	2°19'	113°51'	0	0	0	0	0	0	0	0
26	Jelutung TC 1000m	2°19'	113°50'	0	0	0	0	0	0	0	0
27	JB Edge	2°19'	113°51'	0	0	0	0	0	0	0	0
28	JC edge	2°18'	113°50'	0	0	0	0	0	0	0	0
29	Secret Transect	2°19'	113°54'	0	0	0	0	0	0	0	0
30	T2xTB	2°20'	113°53'	0	0	0	0	0	0	0	0
31	Otter cam	2°19'	113°51'	0	0	0	0	0	0	0	0
32	Canal Bahan	2°18'	113°52'	0	0	0	0	0	0	0	0

Numbers represent the number of photographs obtained.