

# Occurrence and conservation status of small carnivores in two protected areas in Arunachal Pradesh, north-east India

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## Abstract

The rainforests of north-east India harbour a diverse assemblage of mustelids, viverrids and herpestids, many of which are hunted. Yet, very little information exists on their ecology, distribution, abundance, and conservation status. A camera-trapping survey was carried out in two protected areas (Namdapha National Park and Pakke Wildlife Sanctuary) in Arunachal Pradesh between 2005 and 2007 as part of a wildlife monitoring programme. The two areas are believed to hold 13–15 species of forest-dwelling small carnivores, apart from three otter species. We recorded seven species in 2,240 trap-nights in Namdapha, and four species in 231 trap-nights in Pakke. Direct sightings and indirect evidence confirmed the occurrence of additional small carnivore species apart from those recorded during the camera-trap surveys in both areas. Photo-capture rates of four species recorded were high in Namdapha relative to those in three sites in South-east Asia. Capture rates of the Large Indian Civet *Viverra zibetha* were relatively high in Namdapha compared with other species, and this species, along with the Yellow-throated Marten *Martes flavigula*, appears to be common. Species such as the Binturong *Arctictis binturong*, Spotted Linsang *Prionodon pardicolor* and Stripe-backed Weasel *Mustela strigidorsa* were not recorded by camera-traps, although other evidences of their presence were recorded. Incidental or retaliatory hunting was recorded for most species; otters are highly threatened in Namdapha due to considerable hunting for skins which have high market value.

**Keywords:** camera-trapping, Eastern Himalaya, herpestid, hunting, mustelid, viverrid, wildlife monitoring

## Introduction

Small carnivore species richness in the Indian subcontinent is centred in two major regions, the Eastern Himalaya and North-east Hills, and the Western Ghats (Sterndale 1884, Pocock 1939, 1941, Nowak 1999). There are 33 species of small carnivores (only the viverrids, mustelids and herpestids) in India (Corbet & Hill 1992), with more than 50% occurring in north-east India (Mudappa in press).

The high diversity of small carnivores in north-east India is due to the region lying at the confluence of three important biogeographical realms, with several species being unique to the region within India, although all have a wider distribution in South-east Asia. Within India, the Spotted Linsang *Prionodon pardicolor*, Binturong *Arctictis binturong*, Crab-eating Mongoose *Herpestes urva*, Hog Badger *Arctonyx collaris*, Stripe-backed Weasel *Mustela strigidorsa* and two species of ferret badgers *Melogale* spp. are all restricted to the north-east, while several other civets range into other parts of India, and the Yellow-throated Marten *Martes flavigula* and other mustelids into the western Himalaya. Small carnivore diversity is high in the state of Arunachal Pradesh not only due to the wide altitudinal range resulting in a high diversity of habitat types from lowland forests to alpine areas, but also contiguity of evergreen forest areas and their proximity to forests of South-east Asia rich in small carnivores.

Among the diverse small carnivore assemblage in north-east India, viverrids are the most species-rich. Many small carnivore species are hunted in this region, yet very little information exists on their status, distribution, abundance, and ecology throughout their range in north-east India (Choudhury 1997a, 1997b, 2003, Datta 1999) and South-east Asia, apart from general status reviews of small carnivores or single species in specific countries based on largely anecdotal information (e.g. Van Rompaey 1995, Duckworth 1997, Azlan 2003, Holden 2006, Long & Minh Hoang 2006). Much of the modern information comes from sighting

records (e.g. Nettelbeck 1997).

Because most species are rarely sighted and several are nocturnal, camera-trapping is preferred to observational studies to document species richness and assess status, although it is inefficient for species that are largely arboreal and for some others e.g., apparently, weasels *Mustela* spp. (Duckworth *et al.* 2006, Abramov *et al.* 2008, Duckworth & Nettelbeck 2008). However, very few studies have used this method specifically to survey small carnivores (e.g. Mudappa 1998); most often, camera-trap surveys designed for other species have obtained additional information on richness and abundance of small carnivores (Grassman 2003, Kawanishi & Sunquist 2004, Johnson *et al.* 2006, Than Zaw *et al.* 2008). Many studies on small carnivores have used night walks along established trails to estimate encounter rates or densities, however these are time-consuming and labour-intensive and may have restricted spatial coverage.

Density and abundance estimates vary based on habitat type. In South-east Asian forests, estimates suggest high densities of 31.5/km<sup>2</sup> for eight civet species in undisturbed primary forest (Heydon & Bulloh 1996), although encounter rates for most species declined in logged forests. A few studies have used radio-telemetry to determine ranging patterns of small carnivores (Rabinowitz 1991, Joshi *et al.* 1995, Grassman 1998, Mudappa 2001, Grassman *et al.* 2005), while effects of habitat fragmentation have been studied in the Western Ghats of India (Mudappa *et al.* 2007).

The Namdapha National Park and Pakke Wildlife Sanctuary are two important protected areas in Arunachal Pradesh that are believed to harbour 13 species of forest-dwelling small carnivores, excluding the three species of otters. In addition, Namdapha also possibly holds the Yellow-bellied Weasel *Mustela kathiah* and the Stone Marten *Martes foina* in the subtropical, temperate and alpine areas (Ghosh 1987). The Small-toothed Palm Civet *Arctogalidia trivirgata* is also reported to occur in eastern Arunachal Pradesh (Choudhury 2003), but has not been confirmed. The Red Panda

*Ailurus fulgens* (often included with small carnivores), reported from subtropical and temperate forests above 2,000 m (Corbet & Hill 1992), also occurs in Namdapha.

In this paper, we report the diversity and photo-capture rates of small carnivore species that occur in the evergreen and semi-evergreen forests below 2,000 m asl based on camera-trapping surveys carried out from 2005 to 2007 and opportunistic sightings and indirect evidence at the two sites. We also discuss threats to the species, their conservation status and compare their capture rates with reports from other tropical forests in South-east Asia holding similar species assemblages.

### Study sites

#### *Namdapha National Park and Tiger Reserve*

The study was conducted within the 1,985 km<sup>2</sup> Namdapha National Park (27°23'30"–27°39'40"N, 96°15'02"–96°58'33"E; Fig. 1), in Changlang District of Arunachal Pradesh, north-east India. The site harbours some of the northernmost tropical rainforests in the world (Proctor et al. 1998) and extensive dipterocarp forests. The elevation ranges from 200 m to 4,571 m above sea level,

resulting in high habitat diversity from subtropical broad-leaved forests, subtropical pine forests, temperate broad-leaved forests, alpine meadows and perennial snow. Though primary forests cover most of the park, there are extensive bamboo and secondary forests. The park lies within the Himalaya and the Indo-Burma global biodiversity hotspots (Myers et al. 2000, Conservation International 2005) at the junction of the Palaearctic and Malayan bio-geographic realms resulting in a highly diverse mammalian assemblage. At least 90 mammal species are reported, including nine species of felids, two bear species, two canids, about 20 viverrids, mustelids and herpestids (including all high-altitude species), one ailurid, 11 ungulates and seven primates (Ghosh 1987).

Several indigenous tribes and other communities reside in and around the park; those that are primarily dependent on the park for forest resources are the Lisu, Chakma, and the Miju Mishmi (Datta 2007). Hunting is the biggest threat to wildlife here, and is prevalent among all tribal groups. At least 34 species of mammals are hunted, as evinced by skins and skulls seen in villages in the area. While ungulates and primates are the main targets of subsistence hunting, there is also commercial hunting for Asian Elephant *Elephas maximus*, musk deer *Moschus*, bears

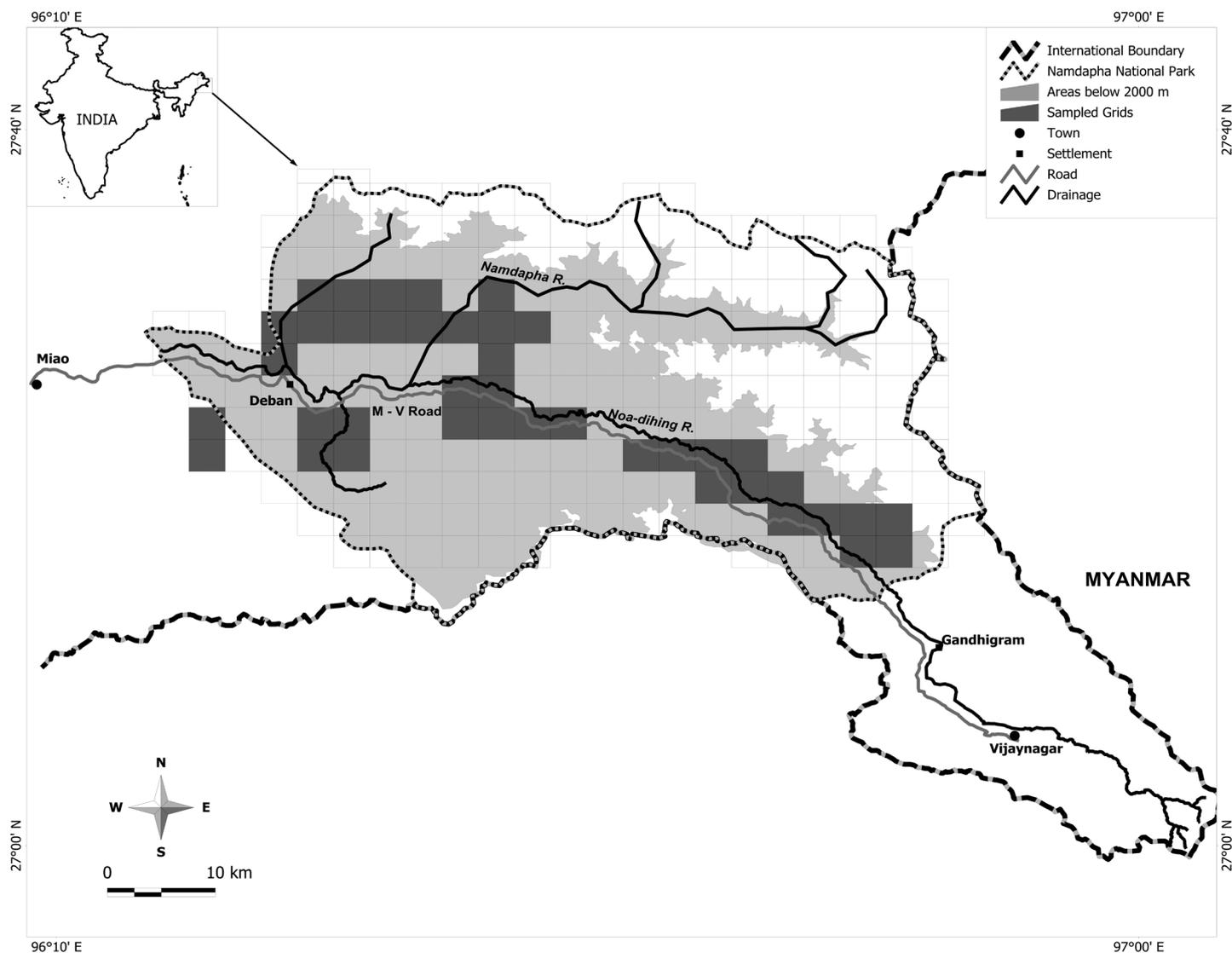


Fig. 1. Namdapha National Park, showing 3x3 km grid used for sampling. Areas shaded in light grey represent tropical forests below 2,000 m asl. Dark grey squares represent the 40 sampled grid-cells.

(Ursidae), otters (Lutrinae), Tiger *Panthera tigris* and other cats (Felidae; Datta 2002, 2007). Deliberate hunting incidents of most small carnivores are in retaliation to killing of poultry around villages. There are also records of accidental or opportunistic killing of these species when they are caught in snares or traps set for other animals. Hunters use guns, cross-bows and a variety of indigenous traps and snares.

#### *Pakke Wildlife Sanctuary and Tiger Reserve*

Pakke (= Pakhui) Wildlife Sanctuary (862 km<sup>2</sup>, 26°54'–27°16'N, 92°36'–93°09'E) lies in the foothills of the Eastern Himalaya in the East Kameng District of Arunachal Pradesh bordering the state of Assam. It was declared a sanctuary in 1977, and has been recently declared a Tiger Reserve.

The park is surrounded by contiguous forests on most sides and bounded by rivers in the east, west, and north. The terrain is undulating and hilly, with altitude ranging from 150 m to about 2,000 m above sea level. The area has a tropical climate, with cooler weather from November to February. The vegetation of the reserve is classified as Assam Valley tropical semi-evergreen forest 2B/C1 (Champion & Seth 1968). The forests are multi-storied and rich in epiphytic flora, woody lianas and climbers with a high representation of Euphorbiaceae and Lauraceae (Datta 2001). Subtropical broad-leaved forests occur at higher elevations, while bamboo, rattans and palms are common near perennial streams. Along larger streams and rivers in the valley, there are patches of tall grassland.

At least 60 mammal species are reported from the park, including 7–8 species of felids, one bear and two canid species, 16 viverrids, mustelids and herpestids, seven large herbivores and four primate species.

Thirteen to fifteen villages and small settlements are located near the south-eastern boundary of the park adjacent to the Pakke river with an adult population of about 4,000 people (mostly belonging to the Nishi tribal community). Two small villages are located in the extreme northern end. Hunting, fishing, and collection of non-timber forest products by the Nishi and by villagers from adjoining Assam is prevalent mainly near the southern boundary. A vast portion in the central and northern part of the park is relatively inaccessible due to the dense vegetation, hilly terrain and the lack of trails. Consequently, few people venture into the interior. Hunting in the park appears to have declined since 2002 due to better protection by park authorities and greater awareness of the Nishi community (Datta 2007).

## Methods

### *Camera-trapping*

In a pilot survey in Namdapha National Park, eight camera-trap units (DEERCAM, passive infra-red sensors with Olympus Trip 505 cameras) were deployed at 44 trap locations from November 2005 to February 2006. Camera-trap units were placed at heights of 30–45 cm from the ground on animal trails and paths, near fruiting trees and animal wallows. All trapping effort was inside tropical evergreen forest. Trap locations were in altitudes ranging from 150 m to 1,300 m. Camera numbers, film roll numbers, location names, GPS-derived co-ordinates and altitude, habitat descriptions, set-up and removal dates, number of pictures taken during each session, and presence of animal signs were recorded. Cameras were active for 24 hours per day and trapping sessions

lasted an average of 12 days (8–23 days) at 27 locations, while at 17 locations they were deployed opportunistically for 1–4 nights. Traps could not be deployed for a uniform number of days because of the logistic difficulties in reaching and accessing different sites with only three field staff and limited camera-trap units.

From October 2006 to January 2007, we carried out a more systematic camera-trap survey that focused on an area of 1,200 km<sup>2</sup>, roughly encompassing the moist evergreen habitat below 2,000 m. In order to minimise sampling bias and maximise spatial coverage camera-trap units were deployed in a systematic manner in 40 randomly-selected grid-cells (3 km x 3 km) from a network of ~130 grid cells that were imposed on a map of areas less than 2,000 m above sea level.

We used 42 passive infra-red camera-trap units (38 DEERCAM-300 camera-trap units and four units made by the Centre for Electronic Design and Technology, Indian Institute of Science, Bangalore). In each of 40 sampled grid-cells, two or three camera-traps were deployed. Our survey was designed to capture a range of ground-living mammals, including large carnivores and ungulates; however traps were deployed along animal trails, streambeds, and ridgelines, in locations with evidence of animal movement and were also suitable for recording small carnivores. We recorded the GPS location, altitude and other habitat parameters at each trap-site. A group of highly skilled Lisu trackers assisted in identifying suitable locations for deploying camera-traps. At every location, one passive infra-red camera-trap was placed perpendicular to the expected direction of animal movement. We deployed traps at a height of 20–40 cm from the ground (mean 33 cm), which is fairly appropriate for capturing small carnivores. We maintained a minimum distance of 400–500 m between trap locations. However, on two occasions we placed traps at a distance of 200 m apart, due to inaccessible terrain and lack of suitable sites. The traps were operated continuously and were removed after a period of 15 days. The number of trap-nights was calculated from date of deployment until date of retrieval (if film was not used up) or until date of the final photograph.

Apart from the systematic grid survey, we also had additional trapping effort (124 trap-nights) in January 2007 in community forests to the east of the park (Vijaynagar) and in nine locations inside the park.

In Pakke Wildlife Sanctuary, the trapping effort was low due to limited availability of camera-trap units. Four camera-traps were deployed at 46 trap-sites in short sessions from December 2005 to May 2006. An additional session was carried out in September–October 2006 with five camera-trap units. Trap locations were at altitudes of 150–300 m. Procedures for deploying traps were similar to those followed in Namdapha. All units were set at a height of 30–40 cm from the ground and operated continuously. Trapping sessions lasted for up to five days in 31 locations while at the remaining 15, they varied between five and 25 days.

All camera-traps were located on the ground; therefore small carnivores that are more arboreal will not be captured as frequently as those that are more ground-living, and may even be entirely overlooked.

### *Data analysis*

Photo-capture rates of small carnivore species were obtained, such as are often used as an index of relative abundance (RAI) defined as the number of days required to obtain a photo-capture of a species (Carbone *et al.* 2001). Only independent pictures of

a particular species are counted as valid. Independence of detections was defined, following O'Brien *et al.* (2003), as (1) consecutive photographs of different individuals of the same or different species, (2) consecutive photographs of individuals of the same species taken more than 0.5 h apart and (3) non-consecutive photos of individuals of the same species. Photo-capture rates from the current study were compared with those obtained from studies in geographically and climatically similar forests in three sites in South-east Asia which face lower or comparable hunting pressures (Grassman 2003, Kawanishi & Sunquist 2004, Than Zaw *et al.* 2008). In addition, small carnivore species richness based on camera-trap records was also available from two other sites (Johnson *et al.* 2006, Long & Minh Hoang 2006).

## Results and Discussion

Table 1 lists the evidence used to determine presence, qualitative assessments of status and hunting pressure, and the reasons for hunting for each of the small carnivore species. All the camera-trap records are listed in the Appendix with details of date, time, location, altitude, habitat type, and topographic feature.

### Species richness and relative abundance in Namdapha

We had a combined trapping effort of 2,240 trap-nights in Namdapha (2005–2007) with a total of 44 independent photos of seven species. Of the 17 species of small carnivores in the tropical forests of Namdapha, six species were recorded in 1,537 trap-nights during the systematic survey from November 2006 to January 2007. An additional 215 trap-nights in October–November 2007 yielded one more species (Table 2).

Three civets, the Masked Palm Civet, the Common Palm Civet, and the Large Indian Civet, were photo-captured, as was Crab-eating Mongoose. Ferret badgers were photo-captured in the wild in India for the first time. The two species of ferret badgers known to occur in this region are best differentiated based on dentition with specimens in hand (J. W. Duckworth verbally 2008). The Hog Badger, not recorded in the three-month intensive trapping survey, was recorded once in October 2007. The Yellow-throated Marten, the only small carnivore that is commonly sighted in the daytime, was also recorded on camera-traps.

Only nine of the small carnivores found here are strict rain-forest-dwellers, whereas four (Common Palm Civet, Small Indian Civet, Yellow-throated Marten, and Small Asian Mongoose)

Table 1. Presence, status, hunting pressures on small carnivores in Pakke Wildlife Sanctuary and Namdapha National Park, Arunachal Pradesh.

Species	Namdapha	Pakke	Status	Hunting pressure	Reason for hunting
Red Panda <i>Ailurus fulgens</i>	Local reports, skin	Not present	Rare	Moderate	Skin, accidental
Yellow-throated Marten <i>Martes flavigula</i>	Camera-trap, sightings, skins	Several sightings	Very common	Occasional, low	Retaliatory, accidental (meat not usually eaten)
Stripe-backed Weasel <i>Mustela strigidorsa</i>	Skin, possible sighting	Partial skin? (in 1996)	Rare?	Occasional, low	Retaliatory, accidental
Ferret badger <i>Melogale</i> sp(p).	Camera-trap	Stuffed specimen in 1997 (Datta 1999)	Very rare	Occasional, low	Accidental?
Hog Badger <i>Arctonyx collaris</i>	Camera-trap, local reports, droppings	None	Uncommon	Moderate	Accidental, sport (meat not usually eaten)
Otters (Lutrinae); 2–3 species	2 sightings	Sightings, indirect signs, skin	Threatened in Namdapha	High	Skin for trade
Spotted Linsang <i>Prionodon pardicolor</i>	Skin	Reported by Choudhury (2003)	Rare?	Moderate	Retaliatory, accidental, decorative
Large Indian Civet <i>Viverra zibetha</i>	Camera-trap	Camera-trap	Common	Moderate	Retaliatory, accidental, decorative value
Small Indian Civet <i>Viverricula indica</i>	2 sightings	Camera-trap, sightings	Common (open habitats)	Moderate	Retaliatory, accidental
Common Palm Civet <i>Paradoxurus hermaphroditus</i>	Camera-trap	Camera-trap, sightings	Common (encroached habitats)	Moderate	Retaliatory, accidental
Masked Palm Civet <i>Paguma larvata</i>	Camera-trap, 2 sightings	Local reports	Common	Moderate	Retaliatory, accidental
Binturong <i>Arctictis binturong</i>	Sighting, local reports, droppings?	Sightings	Uncommon	Occasional, low	Accidental?
Small-toothed Palm Civet <i>Arctogalidia trivirgata</i>	Unknown	Unlikely to be present**	Unknown	Unknown	Unknown
Small Asian Mongoose <i>Herpestes javanicus</i>	None*	Sighting, captive animal	Common in open habitats	Occasional, low	Accidental
Crab-eating Mongoose <i>Herpestes urva</i>	Camera-trap, 2 sightings	Camera-trap	Common	Occasional, low	Accidental?

\*Should be present, based on distributional range; \*\*Because apparently never recorded north of the Brahmaputra

Table 2. Photo-capture rates for species recorded on camera-traps in Namdapha National Park from October 2006–January 2007 (calculated only from 1,537 trap-nights).

Species	Total photos	Independent photos	RAI <sub>1</sub>	RAI <sub>2</sub>
Yellow-throated Marten	10	5	307	0.32
Ferret badger	5	4	384	0.26
Large Indian Civet	12	11	140	0.72
Common Palm Civet	11	4	384	0.26
Masked Palm Civet	5	5	307	0.32
Crab-eating Mongoose	4	2	768	0.13
TOTAL	47	31	50	2.02

RAI<sub>1</sub>: number of days required to get a single photo-capture, RAI<sub>2</sub>: number of independent photos per 100 trap-nights.

Trapping sessions between November 2005 and January 2006 yielded six photographs of Common Palm Civet and two of Masked Palm Civet in 364 trap-nights.

Trapping effort of 124 trap-nights in January 2007 yielded one photograph each of Yellow-throated Marten, Large Indian Civet and ferret badger.

Trapping effort of 215 days in October–December 2007 yielded one photograph of Hog Badger and one of Masked Palm Civet.

are found in other habitat types, often in degraded open habitats close to habitation (Mudappa in press). The Small Indian Civet and Small Asian Mongoose were possibly not recorded because sampling was mainly within interior primary forests. Otters were not recorded because only a few trapping locations were close to streams. In addition, they are now rare due to high hunting pressure for skins. The more arboreal Binturong, Spotted Linsang, and the Small-toothed Palm Civet were not captured, nor was the Stripe-backed Weasel.

Capture rates of the Large Indian Civet were relatively high in Namdapha compared with other species; it, along with the Yellow-throated Marten, appears to be common.

Athreya & Johnsingh (1995) recorded three civet species (Binturong, Large Indian Civet, and Masked Palm Civet) in Namdapha during a survey for the Clouded Leopard *Pardofelis nebulosa* using baited camera-traps (fowl or dried fish) with an effort of 113 trap-nights. A camera-trapping survey for the Tiger in 1996–1997 recorded only the Large Indian Civet in 451 trap-nights (Karanth & Nichols 2000, unpubl. data); however cameras were set up higher above ground and located along broader trails during this study and therefore may have been unsuitable for capturing small carnivores.

#### Species richness and relative abundance in Pakke

Of 13 species of small carnivores suspected to inhabit the area, four were recorded with a limited trapping effort of 231 trap-nights spread over six months (Table 3).

Of the six civet species reported from Pakke, the Large Indian Civet, Common Palm Civet, and Small Indian Civet were camera-trapped. It is possible that species such as the Binturong and Spotted Linsang were not captured as they are more arboreal. In Pakke, the Crab-eating Mongoose (photo-captured in India for the first time) and the Large Indian Civet appear to be more abundant based on photo-capture rates, albeit from a limited trapping effort. The diurnal Yellow-throated Marten was not recorded on camera-traps, although it was sighted four times during trail walks in the daytime. This species is relatively common (Datta 1999).

Table 3. Photo-capture rates for species recorded in Pakke WS on camera-traps (231 trap-nights) during December 2005–May 2006 and September–October 2006.

Species	Total photos	Independent photos	RAI <sub>1</sub>	RAI <sub>2</sub>
Large Indian Civet	5	4	58	1.73
Small Indian Civet	1	1	231	0.43
Common Palm Civet	1	1	231	0.43
Crab-eating Mongoose	3	3	77	1.30
TOTAL	10	9	26	3.90

RAI<sub>1</sub>: number of days required to get a single photo-capture, RAI<sub>2</sub>: number of independent photos per 100 trap-nights.

During transect walks between September 2006 and May 2007, there were three further sightings in the daytime. The Binturong is reported to be crepuscular and more arboreal (Nowak 1999, Grassman *et al.* 2005), but feeds often in the daytime (Nettelbeck 1997). All three sightings of Binturong in Pakke were by day, feeding on figs (Datta 1999). In 2006, one was sighted on the ground crossing a stream in the daytime (Rohit Naniwadekar). The Common Palm Civet, Small Indian Civet, and Small Asian Mongoose were also sighted earlier (Datta 1999). A stuffed specimen of a Large-toothed Ferret Badger and the skin of an unidentified otter have been recorded earlier (Datta 1999). A pair of otters (possibly Oriental Small-clawed Otter *Aonyx cinereus*) was seen by day in September 2006 (Rohit Naniwadekar, Taya Tayum). However no evidence was found for Spotted Linsang or Stripe-backed Weasel, although a partial skin/tail was noted earlier in 1996 that could have been of the latter. Given the low trapping effort in Pakke, it is not possible to draw any conclusions on the status of most of these species; however, Large Indian Civet, Crab-eating Mongoose, and Common Palm Civet appear to be common in the area and the number of days required to capture all the three species was low.

#### Species richness and abundance: comparison with other sites

Capture rates of four species in Namdapha were generally higher than in tropical forest sites in South-east Asia (Table 4).

From comparisons with other studies, it appears that very high trapping effort is required to capture many small carnivore species in a given area. In Pakke with an effort of only 231 trap-nights, we captured four species, while in Namdapha; we captured six species with 1,537 trap-nights, while an additional species was captured after 215 more trap-nights. In Thailand, with 1,224 trap-nights, only five species were captured (Grassman 2003). In Laos, with 3,588 trap-nights, 11 small carnivore species were camera-trapped (Johnson *et al.* 2006), and eight were recorded in Vietnam in 6,337 trap-nights (Long & Minh Hoang 2006), although species-specific capture rates are not provided in the last two studies. In the Hukaung Valley, Myanmar, even after 8,836 trap-nights, only ten species were captured (Than Zaw *et al.* 2008). In Malaysia (where the small carnivore assemblage differs somewhat from that in north-east India), only nine small carnivore species were recorded in 14,054 trap-nights. In all these studies, only about half or much less than half (22–62%) of the total small carnivore species assemblage, predicted to be within the camera-trapped area, were captured. Variation in species recorded and capture rates may reflect real differences in abundance among sites but it is difficult to make conclusions, given that most of these studies were

Table 4. Photo-capture rate (number of trap-nights required to get a single photo-capture of a species) derived from camera-trap surveys in Namdapha National Park and three other protected areas in South-east Asia.

Location	Namdapha NP, India	Taman Negara NP, Malaysia	Phu Khieo Wildlife Sanctuary, Thailand	Hukaung Valley, Myanmar
Reference	Present study	Kawanishi & Sunquist 2004	Grassman 2003	Than Zaw et al. 2008
Trap-nights	1537	14054	1224	8836
Yellow-throated Marten	384	2008	1224	492
Ferret badgers	384	NA	-	-
<sup>a</sup> Hog Badger	-	NA	408	4418
<sup>b</sup> Linsang	-	14054	-	2945
Large Indian Civet	140	2008	68	442
Large-spotted Civet	NA	-	-	8836
Small Indian Civet	-	-	-	1767
Common Palm Civet	384	3513	306	353
Masked Palm Civet	307	2342	-	8836
Binturong	-	4685	408	1473
Crab-eating Mongoose	768	NA	-	233
<sup>c</sup> Total species recorded	<b>6</b>	<b>9*</b>	<b>5</b>	<b>10</b>

<sup>a</sup>Hog Badger was recorded in a later trapping session with additional 215 trap-nights in Namdapha in October 2007 (RAI = 1,752).

<sup>b</sup>Banded Linsang *Prionodon linsang* in Malaysia, Spotted Linsang at other sites.

<sup>c</sup>Although some species are shared among the sites, there are differences in species assemblages across these sites.

\*Includes Banded Linsang, Banded Civet *Hemigalus derbyanus*, and Malay Civet *Viverra zibetha* that do not occur in north-east India.

designed primarily for Tigers and other large carnivores. In addition, a few of these represent data from multiple trapping sessions carried out over several years. However, despite these differences among sites, there appears to be a positive correlation (although not statistically significant) between camera-trapping effort and the number of species recorded (Fig. 2). However, the number of species captured appears to reach an asymptote with very high effort. It would be useful to compare the proportion of the total small carnivore species assemblage that is captured in a given area with a trapping effort systematically for small carnivores, and assess other factors such as hunting pressure and habitat quality. This would enable a better understanding of how much trapping effort is required to maximise species captures in a given area.

#### Direct sightings and indirect evidence of small carnivores in Namdapha

Stripe-backed Weasels are often considered to be rare, but Abramov *et al.* (2008) concluded that they are possibly simply “inconspicuous denizens of chronically under-surveyed regions”. There was one potential sighting in 2005 (Charudutt Mishra) and one skin was recorded from a Lisu village inside Namdapha in December 2006. An old skin was also recorded in the museum at Miao maintained by park authorities (Datta 1999). The Binturong, not recorded on camera-traps at either site, was sighted by field assistants in the daytime in October 2007 in Namdapha. The Spotted Linsang is another rarely recorded species. It is solitary, nocturnal, and reported to be equally at home on trees and the ground (Van Rompaey 1995). One skin was recorded from a Lisu village outside Namdapha in December 2005. The animal had been killed in retaliation for killing poultry. Another skin was seen wrapped around a machete worn by a tribal in Miao in 2002. An otter was sighted in October 2007 in a small perennial stream, although the species could not be identified. An otter, possibly an Oriental Small-clawed Otter, was sighted near Deban in June 2007 (Umesh Srinivasan & Japang Pansa). The Crab-eating

Mongoose was sighted on three occasions, once in November 2005 near a river bed (Umesh Srinivasan), once in November 2006 near a perennial stream (M.O. Anand) and once in October 2007 (Aparajita Datta, Akhi Nathany). On the last occasion, the animal was walking along a forest trail and continued for some distance, and disappeared downhill after becoming aware of our presence. This sighting was not near any water source. There were three other sightings of small carnivores on various visits but the animals disappeared quickly into the undergrowth before identity could be confirmed. The Yellow-throated Marten has been sighted eight times since 2003, with four sightings during the trapping survey (October 2006–January 2007). Of the eight sightings, four were close to habitation and in degraded forest. Five sightings were also close to river beds or along large streams. During earlier visits (1996–1999), the species was also sighted four times (Datta 1999). The Masked Palm Civet was once sighted on a tall emergent tree (located by eyeshine with a flashlight) during a night

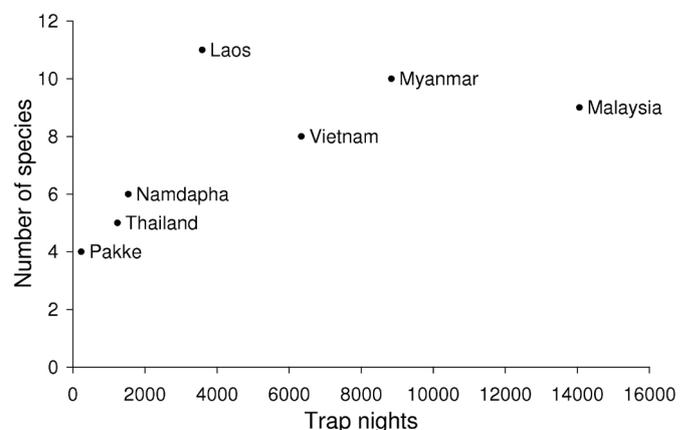


Fig. 2. Scatter plot of camera-trapping effort and number of small carnivore species recorded at seven sites in south and south-east Asia. ( $r_s = 0.75$ ,  $n = 7$ ,  $ns$ ).

walk in May 2003, and once in an early afternoon in November 2007 as it was traversing a liana across a forest trail. This animal was photographed. Although we have never sighted the Hog Badger, it is reportedly common according to some Lisu hunters; and droppings, apparently of the species, were seen several times. The Small Indian Civet was sighted twice at night from vehicles, both times in degraded forest and close to habitation.

#### *Cultural and economic significance of small carnivores*

In Namdapha, hunters kill small carnivores usually in retaliation for killing of poultry, or as by-catch in traps and snares set for other animals. Most species are not targeted for any particular use, although if killed, the meat is eaten. In November 2006, remains of civet species were seen in a Chakma hunter camp inside Namdapha. The meat of some civet species is valued, especially of the Binturong and other palm civets, and these are hunted, even with cross-bows and guns. The Large Indian Civet appears to be mainly targeted for the perineal scent gland which is believed by the Lisu to have medicinal properties in treating sudden illness, epilepsy, and fever. The Yellow-throated Marten is believed to bring bad luck if seen, and its meat is also not eaten, although it is killed in retaliation. The dried skin is reportedly hung up to scare away birds from crop fields. The Hog Badger is another species which is killed without any reason, though the meat is usually not eaten. Some species like the Stripe-backed Weasel and Spotted Linsang may be naturally rare because even some hunters are not familiar with the species or have seen them only occasionally.

Skins/skulls of most species (most civets, Yellow-throated Marten, Stripe-backed Weasel and Spotted Linsang) were seen with hunters in village households. Although we saw no direct or indirect evidence of hunting for Binturong, Hog Badger, or ferret badgers in Namdapha, hunter reports indicate they are killed. However, the only small carnivores that are under severe threat from high commercial hunting pressures are otters, for their skins: these fetch US \$ 250–300 (2004–2006 prices).

In Pakke, civets are hunted for meat, medicine, and for decorative value. The tails are often used to decorate headgear worn by Nishi men. A stuffed Large-toothed Ferret Badger and skins of Large Indian Civet and otter were seen with hunters (Datta 1999). A Binturong skin was gifted by the Nishi community to a dignitary in an official function in 1997 along with other wildlife trophies (A. Datta pers. obs.). Apart from otters and some of the civet species, most species are killed mainly in retaliation or as bycatch.

Table 5 lists the local names used by the Nishi (western Arunachal Pradesh) and the Lisu and Wancho (eastern Arunachal Pradesh) for some of the small carnivores. Lisu and Wancho names were validated by direct sightings, skins, specimens and photographs, while Nishi names were only assigned with photographs and verbal descriptions.

#### *Conservation status*

The most commonly seen species appears to be the Yellow-throated Marten, but this could be because it is diurnal. Among the civets, the Large Indian Civet appears to be more common in the rainforests based on camera-trapping; however the Common Palm Civet and the Small Indian Civet are also quite common especially in degraded forests, while the Masked Palm Civet was captured less often, possibly because it is more arboreal. The Crab-eating Mongoose appears to be fairly common based on camera-trap records and occasional sightings. The Binturong appears to be

Table 5. Local names of small carnivores among three tribes of Arunachal Pradesh.

Common name	Lisu	Wancho	Nishi
Red Panda	Wubi	NA	NA
Yellow-throated Marten	Jela	Langku	Sorchi
Stripe-backed Weasel	Namsolo	?	?
Ferret badgers	Hainwe	?	?
Hog Badger	Mwe-ayi-wu	Gang-bak	?
Otters	Ngwala	Jagam	Seram
Spotted Linsang	Jula	?	?
Large Indian Civet	Shiodu	Kookung	Seeng
Small Indian Civet	Payi	?	Seeng
Common Palm Civet	Payi-maca	Tham	Seeng
Masked Palm Civet	Payi-anna	Tham	Seeng
Binturong	Payi-gulo	?	Seeng
Small Asian Mongoose	Namsolo?	?	?
Crab-eating Mongoose	?	Ju-chayi	?

NA, not present in area; ?, may be present but no name established.

Sources for tribal names:

**Lisu:** Akhi Nathany, Adu-ili-me Yobin, Ngwa-akhi Yobin, Khiyohey Yobin and other members of the Lisu community. The generic name for civets in Lisu is Payi.

**Wancho:** Japang Pansa, Head Mahout, Forest Department staff, Namdapha National Park

**Nishi:** Tana Tapi, Divisional Forest Officer, Pakke WS, Arunachal Pradesh Forest Department.

relatively rare as it was not recorded on camera-traps during these surveys and only occasionally sighted. In addition, arboreal species, if present, will have gone undetected because all our traps were located on the ground.

The species that were recorded only rarely or not at all are the Small-toothed Palm Civet, ferret badger, Spotted Linsang, and the Stripe-backed Weasel. Both the linsang and weasel appear to come close to human habitation because villagers reportedly killed them when they came to raid poultry. The Spotted Linsang (skins, direct sightings) has been reported in the past from several localities in Arunachal Pradesh (Katti *et al.* 1990, Chakraborty & Sen 1991 in Mehao Wildlife Sanctuary in Dibang Valley district, Singh *et al.* 1996 in Mouling National Park in Upper Siang district, Choudhury 2003 in Pakke WS). The species has been recently sighted in Eagle Nest Wildlife Sanctuary (Shashank Dalvi verbally 2008). We cannot comment on the occurrence of the Small-toothed Palm Civet in the area as methods considered more appropriate for this species, such as spotlighting, were not used. Its distribution is reportedly on the south bank of the Brahmaputra and it is reported from the eastern parts of Arunachal, upper Assam, Nagaland, and Manipur (Choudhury 2003). While we obtained camera-trap records for the ferret badger, the species could not be identified and the status of both species is uncertain. The four camera-trap records from Namdapha are the first photos of wild ferret badgers from India. There are no sighting records of either species, while indirect evidence is limited to one skin (Chakraborty & Sen 1991) and one stuffed specimen (Datta 1999) only, which were identified as Large-toothed Ferret Badger. The species has been reportedly recorded in localities in Assam, Arunachal Pradesh, and Meghalaya, although no further information is provided on these records (Choudhury 2003). A freshly killed ferret badger was found on a road that passes through the Gorumara National Park in north Bengal in July 2007 and a photograph is available on the India Na-

ture Watch website (Gourav Purohit on [www.indianaturewatch.net/displayimage.php](http://www.indianaturewatch.net/displayimage.php)).

Although evidence of incidental or retaliatory hunting was recorded for most species these species do not appear to be threatened through anthropogenic factors. By contrast, otters are highly threatened in Namdapha due to considerable hunting for their skin which has high market value. Although otters were recently sighted on two occasions, otter signs are not seen along most of the larger rivers and streams. Fresh otter signs (tracks, spraints) were seen only along one undisturbed smaller perennial stream in October 2007. Hunters from Myanmar as well as local hunters reportedly set traps for otters in most of the area and traders from outside buy these skins.

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*Appendix. Camera-trap records of small carnivores in Namdapha NP and Pakke WS from 2005 to 2007 (Namdapha NP: November 2005 to February 2006 = 364 trap-nights, October 2006 to January 2007 = 1,537 trap-nights, October 2007 to December 2007 = 215 trap-nights; Pakke WS: 231 trap-nights).*

Area	Latitude (N)	Longitude (E)	Altitude (m)	Location type <sup>1</sup>	Forest type <sup>2</sup>	Topographical feature <sup>3</sup>	Time	Date
<b>Yellow-throated Marten</b>								
Namdapha	27°23.74'	96°49.07'	~1,100	AT	Prim	Plat	16h03	17 Dec 06
Namdapha	27°26.46'	96°40.74'	790	AT	Prim	MS	Daytime	Dec 2006
Vijaynagar USF	27°17.17'	96°55.66'	1350	AT	Sec	Plat	10h19	1 Jan 07
Namdapha	27°31.89'	96°34.69'	1130	AT	Prim	MS	11h46	3 Dec 06
Namdapha	27°32.82'	96°32.76'	690	AT	Prim	Plat	08h34	29 Nov 06
<b>Ferret badger sp(p).</b>								
Namdapha	27°27.63'	96°35.83'	510	SB	Sec	Val	18h49	8 Dec 06
Namdapha	27°20.35'	96°53.46'	1040	SB	Prim	Plat	Night	Dec 2006
Namdapha	27°32.94'	96°26.51'	670	SB	Prim	Plat	21h23	*6 Dec 06
Vijaynagar USF	27°17.07'	96°55.57'	1320	AT	Sec	MS	00h49	*29 Dec 06
<b>Hog Badger</b>								
Namdapha	27°27.017	96°23.933	810	AT	Prim	Plat	Night	Oct 2007
<b>Large Indian Civet</b>								
Namdapha	27°31.89'	96°34.69'	1130	AT	Prim	MS	16h42	2 Dec 06
Namdapha	27°31.77'	96°34.86'	1060	SB	Prim	MS	21h16	22 Nov 06
Namdapha	27°24.88'	96°46.37'	990	AT	Prim	Plat	03h04	15 Dec 06
Namdapha	27°32.72'	96°29.41'	930	AT	Prim	SS	05h08	12 Jan 07
Namdapha	27°26.54'	96°24.15'	1150	AT	Prim	Plat	16h11	20 Dec 06
Namdapha	27°31.99'	96°25.51'	580	AT	Prim	Plat	21h08	25 Oct 06
Namdapha	27°33.13'	96°24.02'	480	AT	Prim	Plat	Night	Nov 2006
Namdapha	27°27.67'	96°18.66'	460	AT	Prim	MS	Night	12 Nov 06

Area	Latitude (N)	Longitude (E)	Altitude (m)	Location type <sup>1</sup>	Forest type <sup>2</sup>	Topographical feature <sup>3</sup>	Time	Date
Namdapha	27°27.92'	96°18.84'	680	AT	Prim	MS	Night	3 Nov 06
Namdapha	27°32.24'	96°25.70'	600	AT	Prim	Plat	01h03	13 Nov 06
Namdapha	27°32.92'	96°29.22'	1020	AT	Prim	MS	Night	20 Nov 06
Pakke	26°57.45'	92°59.83'	~200	SB	Prim	Val	02h13	17 May 06
Pakke	26°57.33'	92°58.24'	~200	AT	Prim, DF	Val	021h11	15 May 06
Pakke	26°57.33'	92°58.24'	~200	AT	Prim, DF	Val	01h23	18 May 06
Pakke	27°02.38'	92°48.99'	~200	SB	Edge	Val	Night	22 Apr 06
<b>Small Indian Civet</b>								
Pakke	Not known	Not known	~400	AT	Prim	Plat	02h03	Oct 2006
<b>Common Palm Civet</b>								
Vijaynagar USF	27°16.61'	96°53.28'	~1,000	AT	Sec	MS	Night	Dec 2005
Namdapha	27°23.74'	96°49.07'	1130	AT	Prim	Plat	Night	Jan 2006
Namdapha	27°26.35'	96°40.61'	890	AT	Prim	Ridge	Night	22 Nov 06
Namdapha	27°27.47'	96°36.29'	50	SB	Sec	Val	04h03	7 Dec 06
Namdapha	27°27.63'	96°35.83'	480	SB	Sec	Val	Night	Dec 2006
Namdapha	27°24.19'	96°45.55'	1010	SB	Prim	MS	23h00	11 Dec 06
Pakke	27°1.17'	93°1.00'	not known	AT	Prim	MS	20h11	Sep 2006
<b>Masked Palm Civet</b>								
Namdapha	27°23.26'	96°48.97'	1020	AT	Prim	Plat	Night	Nov 2005
Vijaynagar USF	27°16.61'	96°53.28'	~1,000	AT	Sec	MS	Night	Dec 2005
Namdapha	27°27.63'	96°35.83'	510	SE	Sec	Val	23h45	6 Dec 06
Namdapha	27°22.47'	96°52.09'	1440	SB	Prim	Plat	4h34	31 Dec 06
Namdapha	27°26.37'	96°26.39'	1070	AT	Prim	Ridge	Night	24 Nov 06
Namdapha	27°32.86'	96°33.66'	1030	AT	Prim	Ridge	02h00	22 Nov 06
Namdapha	27°24.82'	96°45.91'	740	AT	Prim	MS	22h53	8 Dec 06
Namdapha	27°23.34'	96°51.74'	1420	SB	Prim	MS	Night	Dec 2007
<b>Crab-eating Mongoose</b>								
Namdapha	27°27.63'	96°35.83'	480	SB	Sec	Val	Daytime	Dec 2006
Namdapha	27°20.33'	96°53.34'	1050	AT	Prim	Plat	Night	28 Dec 06
Pakke	26°57.43'	92°59.67'	~200	Dry SB	DF	Val	15h12	7 Feb 06
Pakke	26°57.79'	92°59.47'	~200	SB	DF	Val	Daytime	Mar–Apr 06
Pakke	26°58.73'	92°55.14'	~200	SB	DF	Val	11h23	25 May 06

USF = Unclassified state forest (essentially, community forest)

\*Only part of animal visible, but reasonably confident of correct identification.

<sup>1</sup>AT = animal trail; SB = stream-bed.

<sup>2</sup> Prim = primary; Sec = secondary; DF = dense forest.

<sup>3</sup> Plat = plateau; MS = moderate slope; SS = steep slope; Val = valley.