

Observations of sympatric small carnivores in Mudumalai Tiger Reserve, Western Ghats, India

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Abstract

Small carnivores were camera-trapped intensively in three major forest types in Mudumalai Tiger Reserve, India, in 2010 and 2011. Direct sightings, opportunistic drives, interviews of local people and forest officials also provided information. Small Indian Civet *Viverricula indica* and Stripe-necked Mongoose *Herpestes vitticollis* had higher encounter rates in deciduous and semi-evergreen forests than in thorn forest, within which the mongoose was recorded only very rarely. Common Palm Civet *Paradoxurus hermaphroditus* encounter rates seemed similar in thorn forest and deciduous forest, but it was never recorded in semi-evergreen forest, whereas Brown Palm Civet *P. jerdoni* was recorded only in semi-evergreen forest. Ruddy Mongoose *H. smithii* and Indian Grey Mongoose *H. edwardsii* were recorded more frequently in thorn forest than in deciduous forest but only exceptionally, or not (respectively) in semi-evergreen forest. Smooth-coated Otter *Lutrogale perspicillata* and Brown Mongoose *H. fuscus* were not camera-trapped, but the former was sighted opportunistically, while the latter was perhaps reported outside the reserve by locals. Conservation priorities for small carnivores in Mudumalai Tiger Reserve and the surrounding landscape involve protection of critical habitats such as riparian and semi-evergreen forests, better control over anthropogenic activities, and reducing local trade in small carnivores if it is confirmed to exist. Extensive surveys should be well designed for naturally rare and/or difficult-to-detect species, which may include other species, not so far recorded in the reserve, to ascertain their status, threat levels and, if any, conservation needs.

Keywords: camera-trapping, encounter rates, forest types, Herpestidae, Mustelidae, South India, Viverridae

Introduction

Many small carnivores are difficult to study being elusive, small, (semi-) arboreal, and crepuscular or nocturnal. Low research interest in them across India reflects their lower popularity and charisma than of larger mammals, and limited perceived use as flagship species. Extensive camera-trapping of carnivores across India has provided little published information on small carnivores, with few systematic surveys specifically for them (Gupta 2011). Variation in small carnivore communities with habitat remains little documented. Recent camera-trapping surveys gathered important ecological data on some species (Datta *et al.* 2008, Nixon *et al.* 2010, Gupta 2011, Prakash *et al.* 2012).

In southern India, the Nilgiri Biosphere Reserve (Nilgiri BR) offers a wide range of habitats from lowland scrub forests to rainforests at high elevations, supporting many species of small carnivores (Yoganand & Kumar 1995). The Western Ghats, within which Nilgiri BR lies, is under serious threat from development activities like human settlements, industries, hydroelectric projects, irrigation dams, mining, and commercial monoculture plantations of Teak *Tectona grandis*, tea, coffee and spices. The small carnivores of Mudumalai Tiger Reserve (Mudumalai TR), part of the Nilgiri BR, have been reported by rapid surveys, opportunistic sightings, sign surveys, live-trapping and radio-telemetry (Kumar & Umapathy 1999, Kumar & Yoganand 1999, Kumara & Singh 2007, Baskaran & Boominathan 2010). However, these studies were restricted in spatial and seasonal coverage, and were mostly not intensive and/or systematic. Furthermore, Ashraf *et al.* (1993) stated that the Brown Palm Civet, which is endemic to South India, is unlikely to be present in Mudumalai TR.

This study reports small carnivores from intensive camera-trap surveys in Mudumalai TR in wet- and dry seasons of 2010 and 2011, supplemented by opportunistic observations

and interviews with local people and forest officials.

Study site

Mudumalai Tiger Reserve (11°32–43'N, 76°22–45'E; Fig. 1), in the state of Tamil Nadu, spans 321 km² and is bounded by Wayanad Wildlife Sanctuary on the west, Bandipur Tiger Reserve in the north and Nilgiri North Forest Division in the south. The protected areas total 3,300 km² of contiguous habitat. Vegetation in Mudumalai TR comprises Southern Tropical Dry Thorn Forest, Southern Tropical Dry Deciduous Forest, Southern Tropical Moist Deciduous Forest, Southern Tropical Semi-evergreen Forest, Moist Bamboo Brakes and Riparian Fringe Forest (see Champion & Seth 1968). Rainfall peaks during May (140–160 mm) and November (180 mm). Terrain is undulating hills interspersed with valleys, ravines, water courses and swamps. Elevation ranges from 854 m to 1,266 m. The mean maximum daily temperature ranged from 22.9 °C to 32.6 °C in the dry season, 24.5 °C to 30 °C in the first wet season, and 22.6 °C to 26.6 °C in the second wet season (Centre for Ecological Sciences, Indian Institute of Science), during the study period.

Cattle grazing, cultivation, pesticide use, settlements, collection of fuel wood and non-timber forest products, fishing, use of domestic dogs for hunting wildlife, illegal resorts and weekend homes, illegal hunting in privately owned plantations fringing the forests (tea, coffee and spices) and annual forest fires (anthropogenic) are believed to be significant threats to Mudumalai TR and its wildlife. The Moundadan Chettie tribe convert natural swamps (locally called 'vayal') into paddy fields. Kurumba, Kattu Naicker and Irula tribes steal carnivore kills, perhaps depleting resources for smaller scavengers like mongooses. Invasive plants such as *Lantana camara*, *Eupatorium odoratum*, *Parthenium hysterophorus* and *Opuntia*

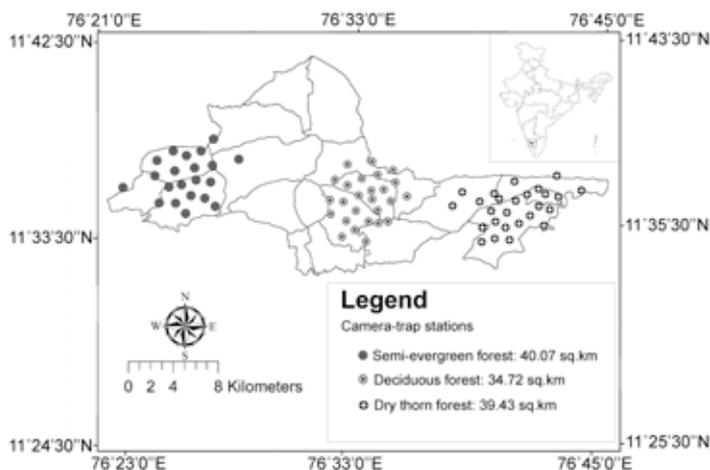


Fig. 1. Locations of camera-trap stations in Mudumalai Tiger Reserve, India (2010 and 2011). Outer perimeter shows the reserve's boundary.

dilleni are proliferating.

Methods

Field survey

An area of 114 km² within the altitudinal range of 920–1,003 m had three intensive camera-trapping zones, in deciduous (35 km²), semi-evergreen (40 km²) and dry thorn forest (39 km²), during 2010 and 2011 (Fig. 1). Deciduous and dry thorn forests were surveyed in both dry and wet seasons, while semi-evergreen forest was sampled only in the former (Table 1), reflecting inaccessibility and logistical constraints in the wet season. Thorough preliminary survey identified sites with evidence such as tracks, faeces and civetries. Paired camera-traps were set in a grid of 1 × 1 km. This design centred on identifying individual animals, where possible, in a mark-recapture framework and investigating seasonal habitat use by presence/absence modelling (results to be reported elsewhere). Each year there were 25 pairs of camera-traps in deciduous forest, 21 in semi-evergreen forest and 26 in dry thorn forest, for 30 days in each forest type (Table 1). The same stations were used in each survey. Each station had two independently operating passive-infrared cameras (Deercam DC300; Stealthcam; and Moultrie Game Spy D-40) mounted opposite each other on trails, dirt roads, stream beds, underpasses; near fruiting trees, termite mounds and fresh animal carcasses; and in other locations with evidence of small carnivore move-

ment. Camera-traps were active for 24 hours a day, without bait or lure. The latency after each photograph was set to 1 minute and sensitivity was set to high. Camera-traps were set approximately 25 cm above ground, except a pair on a *Mango *Mangifera indica** branch, over-hanging a stream (targeting civets). A pair of skilled Kurumba trackers (former hunters) suggested camera-trap locations for civets, based on vegetation, terrain and their recent sightings. All camera-traps were checked, on average, every three days. Camera ID, film roll ID or memory card ID, location names, GPS-derived co-ordinates, habitat descriptions, set-up and removal dates, and presence of animal signs were recorded for each camera-trap site. Additional information came from sign surveys, interviews with locals and forest officials, and opportunistic drives during day and night using a four-wheeler at a speed of 15 km/hr to look for small carnivores.

Data analysis

Each photograph recorded its date and time. A photographic event, whether by both camera-traps at a single camera station or at one, was considered notionally independent if it was at least 10 minutes after the species's preceding image at that station. Detections involving more than one individual part of the same social unit, e.g. mother and young, were counted as single events. Encounter rates were derived by dividing the number of notionally independent events by the camera-trap-nights × 100.

Results

Ten species of small carnivores, including small cats (Felidae), were found. Totally, 7,380 trap-nights yielded 439 notionally independent photographs of nine species: small cats (89, including Jungle Cat *Felis chaus*, Leopard Cat *Prionailurus bengalensis* and Rusty-spotted Cat *P. rubiginosus*), Small Indian Civet *Viverricula indica* (87 notionally independent photographs), Common Palm Civet (36), Brown Palm Civet (20), Stripe-necked Mongoose *Herpestes vitticollis* (61), Ruddy Mongoose *H. smithii* (95) and Indian Grey Mongoose *H. edwardsii* (51). Smooth-coated Otter *Lutrogale perspicillata* and Brown Mongoose *H. fuscus* were not camera-trapped, but the former was sighted opportunistically, while the latter was perhaps reported by locals outside the reserve. Mean encounter rates of small carnivores (excluding small cats) across both years ranged from 0.13 captures per 100 trap-nights to 2.56 captures per

Table 1. Camera-trapping effort in three major forest types in dry and wet seasons in Mudumalai Tiger Reserve, Western Ghats, India (2010 and 2011).

Year	Season	Habitat types	Number of camera-trap stations	Number of camera-trap-nights
2010	Dry	Deciduous forest	25	750
	Dry	Dry thorn forest	26	780
	Dry	Semi-evergreen forest	21	630
	Wet	Deciduous forest	25	750
	Wet	Dry thorn forest	26	780
2011	Dry	Deciduous forest	25	750
	Dry	Dry thorn forest	26	780
	Dry	Semi-evergreen forest	21	630
	Wet	Deciduous forest	25	750
	Wet	Dry thorn forest	26	780

Table 2. Number of camera-trap stations with records (CS), notionally independent photo-captures (NIPC) and encounter rates (ER) (NIPC/100 trap-nights) of small carnivores in Mudumalai Tiger Reserve, India (2010 and 2011).

Species	Year	Deciduous [#]			Wet			Dry thorn [*]			Wet			Semi-evergreen [^]		
		Dry	Dry	ER	CS	NIPC	ER	Dry	Dry	ER	CS	NIPC	ER	Dry	Dry	ER
Small Indian Civet	2010	4	7	0.93	4	5	0.67	5	9	1.15	3	6	0.77	4	4	0.63
	2011	9	16	2.13	4	7	0.93	2	3	0.38	9	15	1.92	6	15	2.38
	Mean			1.53			0.80			0.76			1.34			1.50
Common Palm Civet	2010	2	2	0.40	1	1	0.13	3	8	1.02	2	4	0.51	0	0	0
	2011	3	4	0.53	3	6	0.80	4	5	0.64	4	6	0.77	0	0	0
	Mean			0.93			0.46			0.83			0.64			
Brown Palm Civet	2010	0	0	0	0	0	0	0	0	0	0	0	0	5	8	1.27
	2011	0	0	0	0	0	0	0	0	0	0	0	0	6	12	1.90
	Mean															1.58
Stripe-necked Mongoose	2010	7	14	1.87	4	20	2.66	1	1	0.13	0	0	0	1	1	0.16
	2011	5	10	1.33	2	6	0.80	0	0	0	0	0	0	7	9	1.43
	Mean			1.53			1.73			0.065						0.79
Ruddy Mongoose	2010	5	14	1.87	4	5	0.67	6	23	2.95	5	9	1.15	0	0	0
	2011	3	4	0.53	3	12	1.60	10	17	2.18	6	11	1.41	0	0	0
	Mean			1.2			1.13			2.56			1.28	0	0	0
Indian Grey Mongoose	2010	1	1	0.13	1	1	0.13	5	17	2.18	3	8	1.03	0	0	0
	2011	1	2	0.26	1	1	0.13	7	15	1.92	6	6	0.77	0	0	0
	Mean			0.19			0.13			2.05			0.90			

= 3000 camera-trap-nights, * = 3120 camera-trap-nights, ^ = 1260 camera-trap-nights.

'Notionally independent photo-captures' and 'encounter rate' are calculated as given in the text. No camera-trapping was carried out in the semi-evergreen forest during the wet season.

100 trap-nights (Table 2).

Species accounts

Accounts are given for all species of Mustelidae, Viverridae and Herpestidae detected, but small cats are not considered further, being covered in Kalle *et al.* (2013).

Smooth-coated Otter *Lutrogale perspicillata*

Otters were recorded only by opportunistic sightings and ancillary evidence. Camera-traps were rarely set in localities (near streams and rivers) likely to record otters. In 2010, we sighted a group of seven otters at around 07h00, for 10 minutes, in the eastern part of the reserve along the Moyar river, within thorn forest (Fig. 2). In 2011, we sighted a duo at 09h00 along a shallow bamboo-lined stream (Video 1), towards the southern portion of the reserve, 2–3 km from highway NH-67. Tracks, specifically in moist mud, and spraints were often observed. The spraints consisted of crushed crabs, shells and fish remains, deposited over rocks along the banks of perennial water bodies (large and small), and sometimes along forest trails close to these water bodies. Images of footprints and faeces suggest the signs are at least mostly of the Smooth-coated Otters (S. A. Hussain verbally 2011). Otters are quite familiar to the local tribes and anti-poaching watchers. Based on their verbal descriptions of morphology, otters were called '*neer nai*' in Tamil, which means 'water dog'. Based on their own observations and after examining the photographs in Menon (2003), tribes claim to have seen two kinds/species of otters. There is no species-specific local name for either, yet

they are aware that one is larger than the other. Local tribes stated that they often noticed otters capturing fish in shallow waters, usually during 06h00–07h00. We found no evidence of otter hunting.

Small Indian Civet *Viverricula indica*

Small Indian Civet was camera-trapped more often than were palm civets, perhaps reflecting its more ground-dwelling nature. It was the most widely found species, recorded at 55.5% of all camera-trap locations in all three forest types. During night drives, it was sighted twice in deciduous forest and once in thorn forest. In semi-evergreen forest, it was also photographed near understorey-coffee shade, c. 300 m from a village. In 2010's peak dry season it was photographed repeatedly near a human-made water hole in dry deciduous forest. All images showed only one animal. The species seems not to be camera-trap-shy: some individuals (identified by spot patterns along the neck and flank) were camera-trapped repeatedly. It is strictly nocturnal, with all photographs obtained during darkness (18h00–06h00). On seeing camera-trap photos of Small Indian Civet, the locals referred to it as '*palm seeri*' where '*palm*' is the English word and '*seeri*' is in the language (other than Tamil) spoken by Kurumba tribes. Its etymology is unclear. Locals reported frequent observations of the species visiting settlements by night to prey on domestic fowl. These results fit with past views that it is a habitat generalist. Kumar & Umapathy (1999) reported low live-trapping success rates for it in the Nilgiri BR. In Karnataka, sightings came from habitats varying from crop fields in the drier plains to evergreen forests (Kumara & Singh 2007). It was more frequently record-



Fig. 2. A group of Smooth-coated Otters *Lutrogale perspicillata* near moist bamboo brakes in the Moyar range of Mudumalai Tiger Reserve, India, 21 March 2010 (Photo credit: R. Kalle).

ed in rainforest fragments than in the relatively undisturbed, large, contiguous rainforest tracts of Kalakad-Mundanthurai Tiger Reserve (Mudappa *et al.* 2007, Ramesh *et al.* 2012).

Common Palm Civet *Paradoxurus hermaphroditus*

Common Palm Civet was recorded at 23.3% of camera-trap locations, but may have been under-recorded because of its semi-arboreal habit (see Su Su & Sale 2007). Encounter rates were similar in thorn forest and deciduous forest in the dry season, but none was recorded in semi-evergreen forest (Table 2). Most records were close to water, near riparian vegetation and dried stream beds, possibly because frequent canopy breaks force animals to ground level to cross them. A kitten was photographed in dry deciduous forest on 31 March 2011. During a night drive, an animal was observed on the trunk of an *Anoigessus latifolia* tree 3 m above ground; local tribes reported them using this species and *Grewia tiliifolia*. All photographs showed only one animal. The species does not appear to be camera-trap-shy: some were photographed repeatedly. It was photographed only in the dark hours (18h00–05h00). On seeing camera-trap photographs, tribes referred to Common Palm Civet in Tamil as '*maranai*' ('tree dog' or 'wood dog'), stating that in lateral view it resembles a dog. The local tribes stated that they used to hunt them for meat, many years back; each animal was reportedly removed from its resting site (tree cavity) by pulling its tail. Earlier studies in southern India camera-trapped many Common Palm Civets in drier deciduous forests at lower elevations (< 800 m), with no observations in the rainforests (Mudappa *et al.* 2007), and in Kerala and Karnataka, it was recorded almost entirely in deciduous forests and plantations (Kumara & Singh 2007, Nixon *et al.* 2010).

Brown Palm Civet *Paradoxurus jerdoni*

Brown Palm Civet was photographed only in semi-evergreen forest, being recorded in 76.2% of camera-trap locations there (Table 2); thus within its preferred habitat it seems quite gen-

erally distributed. It was camera-trapped amid natural vegetation and near understorey-coffee shade. During a night drive in semi-evergreen forest, an animal was observed on the ground. All photographs showed only one animal. A few individuals had yellow markings near the tail tip (Fig. 3) but most did not. All photographs were obtained by night (23h00–03h45). In Tamil, the species is seemingly locally called '*maranai*', as is Common Palm Civet (see above). Sometimes it might be referred to as '*palam panni*' in Tamil, where '*palam*' means 'fruit' while '*panni*' means 'pig'. Both names were assigned based on verbal descriptions of animals by tribes; no photographic corroboration was made. To the locals, the frugivorous diet and frontal facial appearance resemble a pig. Locals stated that such animals are often sighted in tea and coffee estates during the peak coffee-berry season. A coffee estate owner near the Nellakotai Range found two kittens, about five weeks old, in coffee plantations on 25 February 2010 (Fig. 4). No evidence of hunting was found. Brown Palm Civet has been recorded only in evergreen biomes, occurring in both little-disturbed, large contiguous forests as well as fragments surrounded by tea plantations and/



Fig. 3. Brown Palm Civet *Paradoxurus jerdoni* camera-trapped in semi-evergreen forest of Mudumalai Tiger Reserve, India, 18 February 2011 (Photo credit: Wildlife Institute of India).



Fig. 4. Two young Brown Palm Civets *Paradoxurus jerdoni* found locally in a coffee plantation outside Mudumalai Tiger Reserve, India, 25 February 2010 (Photo credit: R. Kalle).

or human habitations (Mudappa 2001, Rajamani *et al.* 2002).

Stripe-necked Mongoose *Herpestes vitticollis*

Stripe-necked Mongoose was photographed most often in moist regions, especially along stream beds and close to water sources (Video 2), amounting to 36.1% of all camera-trap stations. Encounter rates were highest in deciduous forest followed by semi-evergreen forest, and very low in thorn forest (Table 2). It was photo-captured and sighted directly in duos and apparently singly. Tracks identified as this species were observed along stream beds especially in the dry season, when dead tadpoles, fish and molluscs (all potential food) are found in receded or stagnant water. Close to these tracks, frequent small holes in the soil perhaps indicated searches for sub-soil prey; once a duo was watched searching thus, walking along stream beds. A camera-trap placed near a dead male Gaur *Bos gaurus*, over a dried stream bed of the Kakanullah river, photographed a duo in the late evening. The next day at around 20h00 (when dark) a duo was observed feeding on the carcass. Most records come by day, but one was photographed at 21h06 in semi-evergreen forest (Fig. 5). Seeing camera-trap photographs, the Kurumba tribes referred to the species as 'berki' in a local language; the etymology was not explained. The animal has been reported in wet, semi-evergreen and dry deciduous forests especially near water bodies in the Nilgiri BR (Van Rompaey & Jayakumar 2003, Choudhury *et al.* 2008), suggesting that the present survey's lower encounter rates in the thorn forest than in other forest types reflect association with moist regions.

Brown Mongoose *Herpestes fuscus*

Brown Mongoose was neither camera-trapped nor sighted. On seeing photographs of the species in Menon (2003), some locals (tribes and tea/coffee estate employees) called this species 'karpu keeri' in Tamil, where 'karpu' means 'black' and 'keeri' is a name used for other mongoose species (see below). Perhaps Brown Mongoose exists around the reserve: locals report observing 'karpu keeri' (whether this name is used only



Fig. 5. Stripe-necked Mongoose *Herpestes vitticollis* camera-trapped in semi-evergreen forest, Mudumalai Tiger Reserve, India, 15 February 2011 (Photo credit: Wildlife Institute of India).

for this species is unclear) by night, amidst tea and coffee estates along roads next to the Nellakotai range of the reserve.

Ruddy Mongoose *Herpestes smithii*

Ruddy Mongoose was camera-trapped widely (41.7% of all camera locations), but not in semi-evergreen forest (Table 2). One was, however, seen in this habitat, about 2 km from the nearest moist deciduous forest. All photographs showed only one animal (e.g. Fig. 6), yet direct observations confirm that they may sometimes travel in duos. Four late-evening encounters of the species scavenging over large mammal carcasses involved Asian Elephant *Elephas maximus* (once a duo, once a singleton) and Chital *Axis axis* (two singletons, once in a *vayal* and the other in thorn forest). A duo was observed on a Teak branch, a meter above ground, in moist deciduous forest. Faeces of one sighted defecating held rings of millipede (some, pill millipedes) exoskeleton, and termite and beetle mouth-parts and wings. In the dry season, it was photographed repeatedly for three days at a human-made water hole, sometimes drinking. One evening (in low light) it was observed feeding along a tar road (Video 3A). It was sighted several times along forest roads by day (Video 3B & C). It seems to be largely diurnal, being photo-captured mostly by day but also occasionally in the early part of the night (18h00–20h30). Seeing camera-trap images, the tribes called this animal 'keeri' in Tamil, apparently lacking a unique local name for it. In Karnataka, Kumara & Singh (2007) often sighted the species in dry forests or rocky areas. By contrast, in Someshwara Wildlife Sanctuary Nixon *et al.* (2010) camera-trapped it frequently in evergreen/semi-evergreen forests; survey effort was too low in deciduous forest and plantations to assess status there but it was sighted in deciduous forests of Biligiri Rangan Temple Wildlife Sanctuary, as well as semi-evergreen forests in Someshwara Wildlife Sanctuary, Karnataka (A. M. A. Nixon verbally 2013).

Indian Grey Mongoose *Herpestes edwardsii*

Indian Grey Mongoose was camera-trapped most often near termite mounds and in open habitats of deciduous and thorn forests amounting to 30.6% of all camera sites. None was re-



Fig. 6. Ruddy Mongoose *Herpestes smithii* camera-trapped in dry deciduous forest, Mudumalai Tiger Reserve, India, 7 November 2010.

corded by any method in semi-evergreen forest. It was sighted easily in open vegetation (Video 4A & B) and along forest roads and narrow trails during day drives, including a grassy area in the reserve's tea estate. Although images were all of singletons, on 21 February 2010 a group of four was sighted around 17h00, and on 4 March 2010 a duo was sighted. It is a regular visitor at the Peacock dormitory in the Kargudi Range of the reserve, where it comes to feed on kitchen refuse (pers. obs.). Most were photo-captured by day, but some thorn forest records were between 18h00 and 03h24, and one in deciduous forest was at 18h40. According to verbal descriptions of morphology by tribes and on their seeing camera-trap images, the species is locally called 'keeri' in Tamil, like Ruddy Mongoose. Tribes reported observing *keeri* (Indian Grey and/or Ruddy Mongoose) frequently entering backyard pens to prey on domestic fowl, in the late afternoon and evening, and predated Grey Junglefowl *Gallus sonneratii*. Elsewhere, it has generally been recorded in disturbed areas, in dry secondary forests, in thorn forests, and near human settlements (Choudhury *et al.* 2011). By contrast, in Someshwara Wildlife Sanctuary, almost all camera-trap images came from evergreen/semi-evergreen forests, but survey effort was too low in deciduous forest and plantations to assess status there. A few Grey Mongooses were sighted in deciduous forests of Kerala (Nilambur region) but never camera-trapped (Nixon *et al.* 2010, A. M. A. Nixon verbally 2013).

General discussion

Mudumalai's three main forest types apparently hold somewhat different compositions of small carnivores (Table 2). However, photographic encounter rate is an index of the animal's prevalence on the images. Without exhaustive additional investigation to estimate detection probability, it cannot be used as a surrogate for abundance because many factors other than animal density affect how frequently any species is camera-trapped.

This survey recorded most small carnivore species known (Yoganand & Kumar 1995, Kumar & Umapathy 1999, Kumar & Yoganand 1999, Baskaran & Boominathan 2010) or likely (Ashraf *et al.* 1993, Nameer *et al.* 2001) to occur in Mudumalai TR. The records of Brown Palm civet may be the first for the reserve and contrast with earlier speculations that it might not occur there (Ashraf *et al.* 1993). Whether these are absent from Mudumalai TR or were present but overlooked is unclear. Future camera-trap placement should use knowledge of their ecology to target such species. Local tribes' knowledge may increase survey effectiveness through improved camera-trap placement, and allow larger area coverage, particularly in deeper, denser, less accessible regions.

Anthropogenic forest conversion and degradation threaten forest-dwelling species like Brown Palm Civet and Stripe-necked Mongoose (Kodandapani *et al.* 2004). Camera-traps also recorded locals with fishing gear, firewood, domestic dogs and cattle, particularly in the reserve's southeast. Local tribes and/or villagers hunting in Mudumalai TR usually bring domestic dogs and target large ungulates or carnivore kills, especially Chital, Sambar *Rusa unicolor* and sometimes even Black-naped Hare *Lepus nigricollis*. Small carnivores might feature as opportunistic catch. Baseline surveys to assess levels of offtake and trade and, the status of small carnivores in

the surrounding landscape matrix outside protected areas, are needed. Threats to otters might come from water pollution and overfishing (Meena 2002, Nawab & Hussain 2012); threats in Mudumalai TR warrant investigation.

The priority research topics for small carnivores in Mudumalai TR and surrounding landscape include those which inform protection of critical habitats like riparian areas. Field research on semi-aquatic mammals like otters (heavily threatened in tropical Asia; e.g. Shepherd & Tansom 2013) should include better search efforts in an occupancy framework such that camera-trap placement and sign surveys are inclined towards riparian habitats (see Prakash *et al.* 2012). Understanding the status of generally rarely recorded, so perhaps vulnerable, species like Brown Mongoose and Nilgiri Marten demands focussing survey efforts in habitats believed to support them: rainforests/rainforest fragments, tea/coffee estates, mid-elevation tropical forests and montane shola grasslands.

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Electronic supplementary material

Videos filmed during the study in Mudumalai Tiger Reserve, India (Videos by R. Kalle).

1. Smooth-coated Otter *Lutrogale perspicillata*
<<http://www.youtube.com/watch?v=InPmYXgxJFM>>
2. Stripe-necked Mongoose *Herpestes vitticollis*
<<http://www.youtube.com/watch?v=TSfAltgcNek>>
3. Ruddy Mongoose *Herpestes smithii*
A) <<http://www.youtube.com/watch?v=ydQFANxUpnw>>
B) <<http://www.youtube.com/watch?v=ujX-f7p-zBg>>
C) <<http://www.youtube.com/watch?v=ecBhkSSGEr8>>
4. Indian Grey Mongoose *Herpestes edwardsii*
A) <<http://www.youtube.com/watch?v=scvx7soy5Lc>>
B) <<http://www.youtube.com/watch?v=Wg3TkpWzz-8>>