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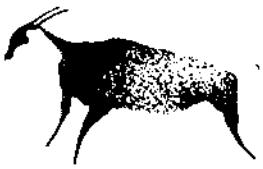

Malay Weasel Mustela nudipes *catching rat*
Photo: Neil Franklin / LIPI (Indonesian Institute of Sciences) / PHKA (Directorate of the Department of Forrestry)

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Small carnivores of the Udzungwa Mountains: presence, distributions and threats

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Summary

The mammalian carnivores of the Udzungwa Mountains National Park (UMNP) area were intensively investigated over a period of one year from November 2001 to November 2002. This was the first study in this area targeting this important group of animals. A combination of field methods was employed: ecological inventories (rapid assessment surveys; scat, spoor and sign surveys; camera trapping) and socio-economic investigations (structured village interviews). Some 678 km of transect were walked; 10,608 camera-trap hours were carried out, and 128 village interviews undertaken, across representative areas throughout the park and its buffer zones.

A total of 17 species of small carnivore (Mustelidae, Viverridae and Herpestidae) were confirmed for the UMNP and an additional species is 'probable'. This corresponds to at least 85% (or as many as 90%) of the Tanzanian total. These data show that UMNP is one of the richest protected areas (if not the richest) for small carnivores in Eastern Africa, as well as one of the most important. The presence of Jackson's Mongoose *Bdeogale jacksoni* was particularly significant. This little known and 'vulnerable' species was formerly recorded only from two areas; in and around Mt Kenya and south of Mt Elgon. This represents an important new record for Tanzania. Other high-risk species recorded included Lowe's Servaline Genet *Genetta servalina lowei* known only from the Udzungwas. Meller's Mongoose *Rhynchogale melleri* and the Bushy-tailed Mongoose *Bdeogale crassicauda* meanwhile, are significant and very rarely recorded. The former may be a new record for this animal in terms of altitude and habitat type. The Udzungwa carnivore community is rich and of considerable importance. Its status and complexity will depend much on the continued conservation of all Udzungwa habitats.

Introduction

As in most of Africa, small carnivores in Tanzania are little known, and the only recent information is often the documentation of Kingdon (1977; 1990; 1997) and the predictions of continental-scale databanks (Boitani *et al.*, 1999). Many species are deemed to be under threat because of habitat degradation, and persecution due to hunting and poisoning (Schreiber *et al.*, 1989). However, there are insufficient data to assess their distribution, population or degree of threat and thus to plan appropriate conservation intervention. In this paper we present data on the small carnivores from a wider investigation into all mammalian carnivores carried out in the Udzungwa Mountains in Southern Tanzania (De Luca & Mpunga, 2002, 2005).

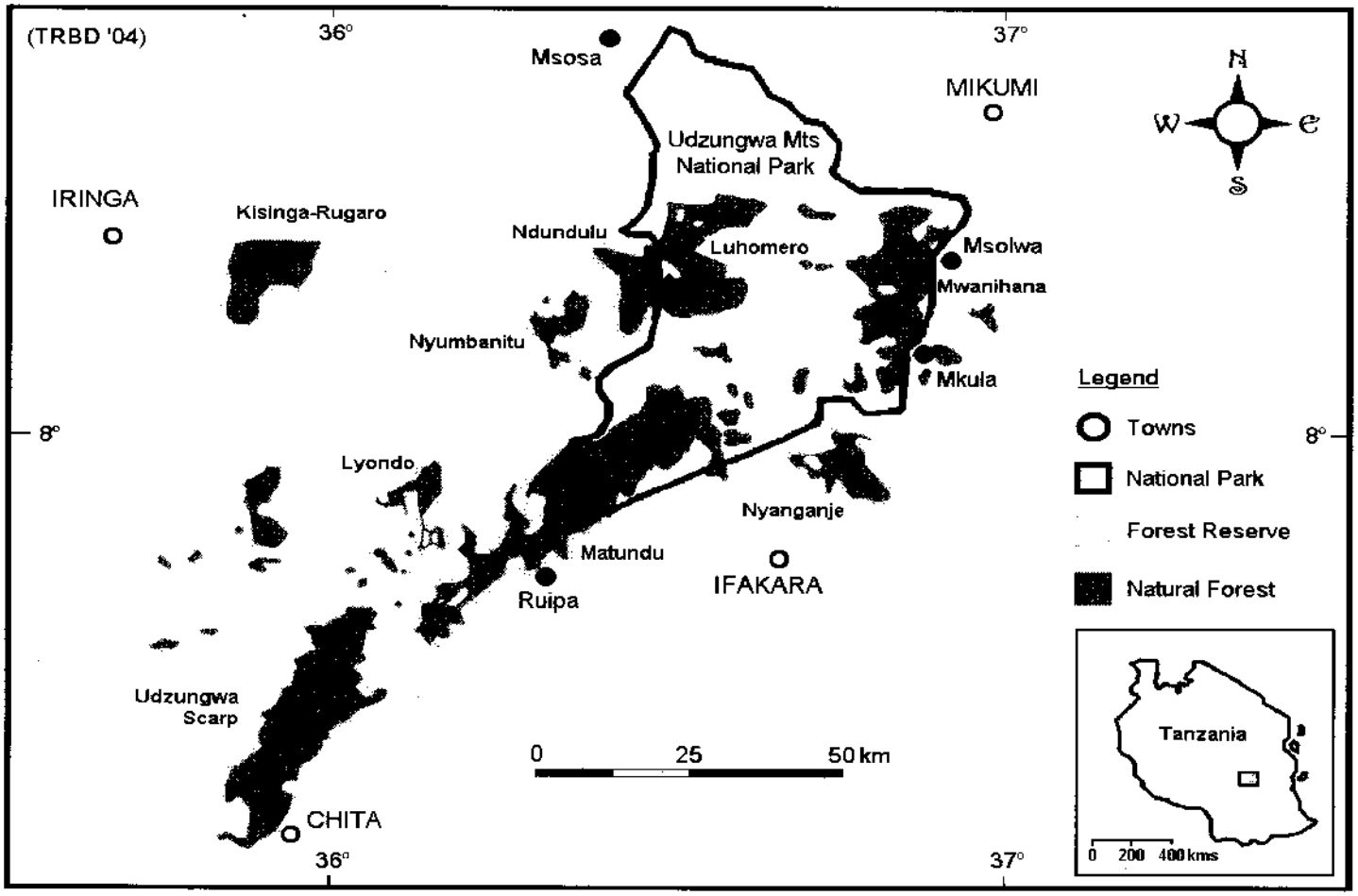


Fig. 1. Map of the Udzungwa Mountains area showing boundaries and the location of 'interview' villages.

Table 1. Locations and details of camera trap placements. Geographical positions of camera traps are given in WGS84 degrees-decimal minutes coordinates.

CT No.	Sensor Type	Location name	Habitat type	Loc. S	Loc. E	Altitude
TM6	P	Mbatwa	Open/closed woodland	S 07 34 772	E 036 35 903	1127
TM3	A	Mbatwa	Open/closed woodland	S 07 34 903	E 036 36 489	1127
TM5	P	Mbatwa	Open/closed woodland	S 07 35 051	E 036 36 797	1127
TM7	P	Mbatwa	Open/closed woodland	S 07 35 298	E 036 37 658	1132
TM8	P	Mbatwa	Open/closed woodland	S 07 35 512	E 036 37 369	1164
TM4	A	Mbatwa	Open/closed woodland	S 07 36 216	E 036 37 369	1373
TM1	A	Mbatwa	Open/closed woodland	S 07 36 344	E 036 37 218	1393
CT2	P	Mkula river/Sonjo	Lowland forest	S 07 47 591	E 036 52 615	719
CT4	P	Mkula river/Sonjo	Lowland forest	S 07 47 684	E 036 52 798	495
CT1	P	Mkula river/Sonjo	Lowland forest	S 07 47 693	E 036 52 712	526
CT3	P	Mkula river/Sonjo	Lowland forest	S 07 47 838	E 036 52 918	484
TM2	A	Mkula	Lowland forest	S 07 47 925	E 036 53 129	430
CT4	P	Mkula	Lowland forest	S 07 48 014	E 036 53 164	450
CT1	P	Mkula	Lowland forest	S 07 48 028	E 036 53 204	450
CT3	P	Mkula (ex-NP)	Lowland forest	S 07 48 117	E 036 55 799	285
CT2	P	Mwanihana	Open woodland	S 07 45 626	E 036 50 097	950
CT3	P	Mwanihana	Open woodland	S 07 47 596	E 036 49 865	980
CT4	P	Mwanihana	Open woodland	S 07 45 807	E 036 50 265	?
CT1	P	Mwanihana	Montane forest	S 07 49 0??	E 036 49 5??	1800
CT3	P	Mwanihana	Open woodland	S 07 48 081	E 036 51 675	650
CT2	P	Mwanihana	Montane forest	S 07 49 002	E 036 49 533	1830
CT3	P	Mwanihana	Wooded grassland	S 07 48 554	E 036 49 454	1470
CT4	P	Mwanihana	Open woodland	S 07 47 479	E 036 49 809	950
CT1	P	Mwanihana	Open woodland	S 07 47 713	E 036 50 265	915
CT2	P	Ruipa	Lowland forest	S 08 02 858	E 036 20 513	317
CT1	P	Ruipa	Lowland forest	S 08 03 303	E 036 20 668	415
TM2	A	Ruipa	Lowland forest	S 08 04 876	E 036 19 258	330
CT1	P	Ruipa	Lowland forest	S 08 02 986	E 036 20 761	415
CT3	P	Ruipa	Lowland forest	S 08 03 472	E 036 21 080	394
CT3	P	Ruipa	Lowland forest	S 08 03 474	E 036 21 078	343
CT3	P	Ruipa	Lowland forest	S 08 03 601	E 036 20 550	368
CT4	P	Ruipa	Lowland forest	S 08 03 643	E 036 20 148	327
CT2	P	Ruipa	Lowland forest	S 08 03 324	E 036 20 164	280

The Udzungwa Mountain National Park (UMNP) includes two of the richest forests of the region in terms of the number of species of primates, duikers and birds (Dinesen *et al.*, 2001); Mwanihana in the East and Luhomero in the West Kilombero Scarp. Consequently, they are cited as first conservation priority areas amongst all Udzungwa forests. However, despite their importance for global biodiversity, these forests are among the most threatened ecosystems in the world (Bakarr, 2000). Whilst the biodiversity of the Udzungwas has been well documented (see Rodgers & Homewood, 1982; Lovett & Wasser, 1993, Various authors, 1998; Ehardt *et al.*, 1999; Dinesen *et al.*, 2001; Frontier Tanzania, 2001a & b), there have previously been no surveys focusing on carnivores.

As part of a broader examination of carnivore status across southern Tanzania, we investigated the UMNP and buffer zones from November 2001 to November 2002. Combining ecological and socio-economic investigations we sought to record carnivore presence and relative abundance, habitat preference and the factors limiting their abundance. The work stems from a component of the Wildlife Conservation Society's *Southern Highlands Conservation Programme* and seeks to examine carnivore distributions, abundance and threats from unexplored sites, and provide conservation remedies and advice.

UMNP covers almost one fifth (1,999km^2) of the Udzungwa Mountains range and lies between 7°30'- 8°15'S and 36°20'-36°55'E (Fig. 1). It embraces a variety of habitats including natural forest (lowland, submontane and montane) ranging from 280 m to 2,600 m a.s.l. In addition, a corridor of wooded grassland and open and closed woodland lies between the two main forest blocks in the East and in the West. There is a longer variable dry season in the West (about 7 months) and shorter dry season in the East (about 5 months). The wet season between March and May has a short peak in December. Rainfall amounts to approximately 2,000 mm per year in the east decreasing to 800-1,000 mm in the west (Hall, 1986). The specific aims of the study were to produce a comprehensive and up-to-date carnivore list for the UMNP area and to investigate causes of threat for each species in order to provide information necessary for the implementation of conservation initiatives.

Methods

Fieldwork was carried out between November 2001 and November 2002. In order to determine small carnivore presence we used a combination of field methods: ecological inventories (sign surveys and camera trapping), and socio-economic investigations (village interviews). Initially however, we performed rapid

assessment surveys across different areas in order to select appropriate sampling sites representative of the park's diverse habitats, altitude, rainfall conditions and human influence. During such surveys all carnivore signs were also noted. Subsequently, four ecologically different areas were selected for camera trap placement (Table 1).

All carnivore signs and tracks were recorded at all times during fieldwork. Grid references, altitudes and habitat types were routinely noted. The distances and co-ordinates of transects walked were recorded by handheld Garmin GPS III+ and uploaded to a geographical information system using ArcView 3.2. Spoor was measured, identified and photographed, and data on footprints, signs and scats were noted on standard data sheets. A total of 678 km of transect was walked during the survey (adjusted to 822 km to include a factor of terrain roughness, De Luca & Mpunga, 2005).

Camera trapping was carried out in each area for a minimum of 210 trap-nights. A total of 10,608 camera-trap hours (884 trap-nights) were achieved in all areas. Between 5 and 13 camera traps were employed at any one time. Initially passive infrared units (Camtrakker™) were used (www.camtrakker.com). Subsequently, the number of camera traps employed was increased by using active infrared monitors (Trailmaster™1500) (www.trailmaster.com). Placement locations were chosen to maximize capture rate. Carnivores prefer to follow animal trails therefore most of the camera traps were placed in the vicinity of such trails. All traps were set to work from dusk to dawn between 7 pm and 7 am, and mounted on a pole at about 25-30 cm from the ground. They were baited and checked at regular intervals (De Luca & Mpunga, 2005).

To supplement information from the field 128 people were interviewed in four villages located within the buffer zones around the National Park: Mkula and Msolwa to the east of Mwanihana, Ruipa village just outside Matundu forest in the extreme south, and Msosa near Mbatwa in the north (Fig. 1). Mkula and Msolwa lie on the eastern boundary at 5 and 10 km respectively from park headquarters at Mang'ula. Interviews employed structured questionnaires, and interviewees were selected on their knowledge of the area. The interviews permitted the collection of data on carnivore sightings, location, date, frequency of sightings, and the vernacular names of the species in question. Human-carnivore conflict and hunting was also ascertained and data were taken on the frequency of problem animal occurrences and the ways employed to prevent or reduce them. Information on carnivore exploitation and consumptive uses was gathered in order to assess the degree of threat. Results about human carnivore conflict and carnivore exploitation are presented elsewhere (De Luca & Mpunga, 2005).

Table 2. Checklist of small carnivore species recorded in the UMNP area during this study.

	English name	Species	Kiswahili	Ph	Ob	Ac	Pr	% Mkula n=35	% Msolwa n=33	% Ruipa n=34	% Msosa n=30
		Mustelidae									
1	African Clawless Otter	*Aonyx capensis*	Fisi Maji Kubwa		**O**			82.0	84.9	60.6	23.3
2	Zorilla	*Ictonyx striatus*	Kicheche			**A**		36.4	57.6	63.6	33.3
3	Striped Weasel	*Poecilogale albinucha*	Chororo		**O**			18.2	63.6	63.6	46.0
4	Honey Badger (Ratel)	*Mellivora capensis*	Nyegere	**Ph**				39.4	63.6	63.6	90.0
		Viverridae									
5	Common Genet	*Genetta genetta*	Kanu	**Ph**				15.2	42.4	78.8	46.7
6	Servaline Genet	*Genetta servalina*	Kanu	**Ph**				12.1	33.3	21.2	40.0
7	Large-spotted Genet	*Genetta maculata*	Kanu	**Ph**				9.1	30.3	24.2	0.0
8	African Civet	*Civettictis civetta*	Fungo	**Ph**				88.0	87.9	67.7	72.7
9	African Palm Civet	*Nandinia binotata*	Fungo	**Ph**				12.0	27.3	15.2	10.0
		Herpestidae									
10	Egyptian Mongoose	*Herpestes ichneumon*	Nguchiro				**P**	21.2	27.3	18.2	30.0
11	Slender Mongoose	*Herpestes sanguineus*	Nguchiro		**O**			51.5	57.6	60.6	46.7
12	Dwarf Mongoose	*Helogale parvula*	Kitafe			**A**		48.5	42.4	54.6	80.0
13	Banded Mongoose	*Mungos mungo*	Nkuchiro		**O**			39.0	72.7	48.5	70.0
14	Marsh Mongoose	*Atilax paludinosus*	Nguchiro wa Maji	**Ph**				48.5	81.8	45.5	3.3
15	White-tailed Mongoose	*Ichneumia albicauda*	Karambago	**Ph**				0.0	6.1	0.0	80.0
16	Meller's Mongoose	*Rhynchogale melleri*	Nguchiro	**Ph**				0.0	0.0	0.0	6.7
17	Bushy-tailed Mongoose	*Bdeogale crassicauda*	Nguchiro	**Ph**				0.0	0.0	3.0	13.3
18	Jackson's Mongoose	*Bdeogale jacksoni*	Nguchiro	**Ph**				0.0	0.0	0.0	0.0
			TOTALS	**11**	**4**	**2**	**1**				

Key: Ph – Photo trapped; Ob – Observed (O)/ Spoor (S); Ac – Claimed by at least 60% of interviewees from at least one village area, and record accepted. Pr – Probable; claimed by 25 – 50% of interviewees from at least one village area. The Ph-Ob-Ac-Pr colums are additive. The columns with % indicate the percentage of people per village who claimed to have seen the animal in the Udzungwas area.

Results and discussion

A total of 17 small carnivore species was confirmed (and an additional species recorded as probable) in the UMNP area. An annotated checklist of these 18 species with their means of record is thus given in Table 2. Of the total, 11 were caught on film and a further four from direct observations and spoor. Two more species were claimed by at least 60% of interviewees from at least one village area, and the records accepted. The species cited as probable was claimed by 25-50% of interviewees from at least one village area. The list includes four mustelids, five viverrids and nine herpestids. One of the herpestids (see below) represents a new record for Tanzania and the national total of small carnivore species now stands at 20 species. As a consequence, UMNP contains at least 90% of the country's total and 42% of all small carnivore species in Africa (Boitani *et al.*, 1999; Mills *et al.*, 2001).

Furthermore, UMNP contains one more species than Serengeti National Park, an area more than six times the size, and known for having one of the largest predator and prey biomass(es) in the world (Caro & Durant, 1995; Sinclair, 1995). It is probable that UMNP is the richest protected area for carnivore diversity in Eastern Africa, if not beyond. The diversity can be explained by the biogeography, the range of habitat types and altitudes. The gazettement as a national park and consequent management over the last decade has also contributed to the conservation of both carnivores and prey.

In Matundu forest a mongoose that we have identified as Jackson's Mongoose *Bdeogale jacksoni* was caught on film. The shape of the ears, the intense yellow on the side of the neck and throat, and the white bushy tail are distinctive (back cover). This represents a new species record for Tanzania. The animal is little known, highly localised and formerly known only from montane and bamboo forest on Mt. Kenya and lowland forest near Mt. Elgon (Kingdon, 1997). Its status is classified as 'vulnerable' (VU B1 + 2c) by IUCN (2004) with a population that seems to be severely fragmented and with the subpopulations probably not containing more than 1,000 mature individuals. The animal has since also been photo trapped in the same area by F. Rovero (*pers. comm.*).

Table 3. Photo-trapping rates per species (number of independent photos / the number of trap-nights in areas where species was expected), ranked according to trap success.

Species	No. of independent pictures	No. of trap-nights	Photo trapping rate
Bushy-tailed Mongoose	79	674	8.53
Marsh Mongoose	32	674	21.1
Large-spotted Genet	15	637	42.5
White-tailed Mongoose	4	210	52.5
African Civet	15	884	58.9
Meller's Mongoose	8	688	86
Common Genet	3	460	153
Jackson's Mongoose	3	674	225
Honey Badger	3	884	295
African Palm Civet	2	674	337
Servaline Genet	2	674	337

Furthermore, during interviews a villager from Mkula mentioned having seen a mongoose corresponding to this description at the edge of the bamboo forest (1,700m) in the Kihulula area, Mwahihana. This area is higher than Matundu and if its presence is confirmed there, it would be habitat more similar to the central Kenya records of the Aberdare range and Mt. Kenya.

Jackson's Mongoose is similar to the White-tailed Mongoose *Ichneumia albicauda* but the latter has leaner legs, no yellow tints on the neck and throat and has five toes (Kingdon, 1997). The White-tailed Mongoose was caught on film only in Mbatwa in the drier north of UMNP. Meller's Mongoose *Rhynchogale melleri* was photographed in the Mwanihana montane bamboo forest at 1,850 m. The colour of the pelage, the dark legs and tail and the distinctive upturned shape of the muzzle are indicative of the species. Meller's Mongoose is normally associated with woodland up to approximately 1,500 m (Kingdon, 1997), and it is possible that this is the first record for this species in such a habitat and altitude. Its conservation status is regarded as being 'low risk' and 'least concern' (Lr+Lc). However, in the Tanzanian

Table 4. Camera trap locations with altitude ranges (Alt.), number of trapping hours (7pm-7am) and trap nights, number of cameras per location (CTs), frequency (F: number of times animals were photographed including unidentified mongooses), number of species per site (Spp), number of species per unit effort (Spp / Effort), species photographed at each site.

Location	Alt.(m)	Trap hours (1900-0700) Trap nights	CTs	F	Spp	Spp / Effort	Species photographed
Mwanihana	950-1850	2,964 247	9	87	5	0.0024	African Civet, Marsh Mongoose, Bushy-tailed Mongoose, Lowe's Servaline Genet, Meller's Mongoose
Mkula	300-750	2,772 231	8	78	4	0.0014	African Civet, Marsh mongoose, Large-spotted Genet, Bushy-tailed Mongoose
Ruipa / Matundu	300-450	2,352 196	9	96	8	0.0034	Jackson's Mongoose, Honey Badger, African Palm Civet, Marsh Mongoose, African Civet, Common Genet, Large-spotted Genet, Bushy-tailed Mongoose
Mbatwa	1150-1400	2,520 210	8	12	4	0.0015	African Civet, White-tailed Mongoose, Large-spotted Genet, Honey Badger

and Zambian part of the range, human populations have expanded considerably and dogs in particular could be an increasing local threat (Stuart & Stuart, *in prep.*).

The Bushy-tailed Mongoose *Bdeogale crassicauda* was the most photographed species in UMNP (back cover) with the highest photo-trapping rate (Table 3). The subspecies occurring in this region is *B. c. puisa* (Schreiber *et al.* 1989). Despite records that associate this species with wooded grassland rather than forest (Kingdon, 1977), our data show that it can be found (sometimes in pairs) in montane forest up to 1,850 m, and lowland forest between 300 and 750 m (Table 4). The only location where the species was not photographed was Mbatwa, a dry thicket woodland. It is nowhere considered common (Kingdon, 1997).

The Marsh Mongoose *Atilax paludinosus* was the second most photographed species (Table 3). The subspecies occurring in East Africa is *A. p. robustus* (Kingdon, 1997). With the exception of the dry woodland of Mbatwa, it was photographed in all habitats sampled from 300 m up to 1,850 m in the montane bamboo area of Mwanihana (where a pair was caught a few times). Its presence seemed to be linked to the vicinity of watercourses as it was not recorded more than 2 km away from rivers and streams.

Other more common mongooses recorded in the UMNP area were the Slender Mongoose *Herpestes sanguineus*, seen near park headquarters, Sonjo and Mbatwa, the Banded Mongoose *Mungos mungo* observed in the Mwanihana area near Mkula, and the Dwarf Mongoose *Helogale parvula*, a common species whose presence was claimed by 60% of all interviewees and 80% of those in Msosa. Finally the presence of the Egyptian Mongoose *Herpestes ichneumon*, a common and widespread carnivore, is considered very probable based on the interview data.

Lowe's Servaline Genet *Genetta servalina lowei* is an uncommon and little-known arboreal forest species, described from a skin found in the Dabaga area in 1932 by Willoughby Lowe (Kingdon, 1977; Brink *et al.*, 2002; De Luca & Mpunga, 2002). This species was photographed in the Mwanihana area (980 m) in habitat described by Rodgers & Homewood (1982) as intermediate rain forest, as well as in montane forest bordering bamboo at 1,830 m (Table 4). These data suggest that in Tanzania the species itself is a forest animal as in West Africa (Ray, 2001; Van Rompaey & Colyn, 1998).

Surprisingly, the Common Genet *Genetta genetta* was photographed only in lowland forest at Matundu, but not in the drier habitat of Mbatwa where it was more expected. The subspecies occurring in this region is G. g. *dongolana* (Kingdon, 1997). In Matundu however, the Common Genet (back cover) was sympatric with the Large-spotted Genet *Genetta maculata*, where ecological separation is probably achieved by different use of the forest habitat (Ray, 2001). The Large-spotted Genet (back cover) and the African Civet *Civettictis civetta* were present in various habitats (lowland forest, open and closed woodland) and across a broad altitudinal range (280-1,470 m). However, the Large-spotted Genet was not photographed in the montane forest or the woodland of Mwanihana (Table 4). It is possible that the Large-spotted Genet is in competition with the Servaline Genet, and/or that its distribution does not extend to higher elevations (Kingdon, 1997).

Together with the Servaline Genet, the African Palm Civet *Nandinia binotata* showed the lowest photo-trapping rate (Table 3; back cover). African Palm Civets are mainly arboreal but do come to ground to forage (Rosevear, 1974) or to seek water (Sanderson, 1940). With our camera traps set on the ground, this could explain the relatively low number of pictures. However, our current work in the Southern Highlands (in prep.) has shown that this species is also easily photo trapped on the forest floor. The individual photographed in Matundu does not show the narrower stripes on the neck typical of *N. b. gerrardi* (back cover), but has narrow poorly defined rings on the tail like *N. b. arborea* (Van Rompaey & Ray, *in prep*).

In East Africa palm civets are chiefly associated with fragmented forest up to 2,000 m (Kingdon, 1997). However, they are also found in lowland forest (such as Matundu), deciduous, gallery and riverine forests and savanna woodlands, as well as in cultivated mosaic forest and fields bordering forest edges (Charles-Dominique, 1978; Happold, 1987; Skinner & Smithers, 1990).

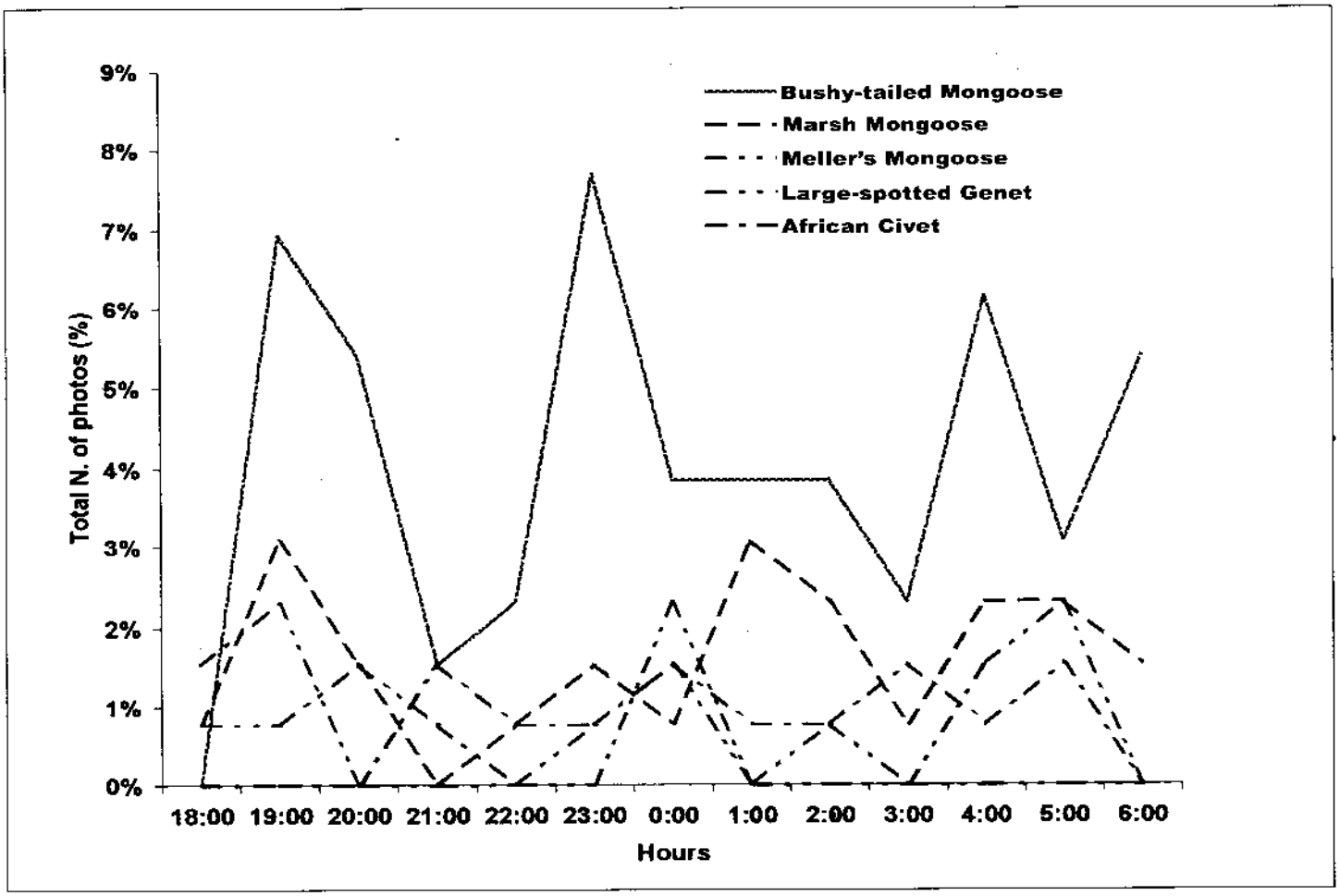
The Honey Badger *Mellivora capensis* was photographed in both Mbatwa and Matundu/Ruipa confirming its versatility in adapting to both wetter and drier conditions (Table 4). Spoor of the Striped Weasel *Poecilogale albinucha* was observed only in Mbatwa although the interview data suggests that it is widespread. The Zorilla *Ictonyx striatus* meanwhile, also a widespread animal, was acknowledged by 63% of interviewees in Ruipa.

Camera trapping is an effective tool for investigating the ecology of individuals and populations of animals. It is particularly valuable in remote areas, difficult terrain or dense forests that prevent direct observation. However, success rates for carnivores can be slow (see Carbone *et al.*, 2001). Indeed, with the exception of the two most commonly photo-trapped species, the Bushy-tailed and Marsh Mongooses, success rates in UMNP were relatively slow in terms of the photo-trapping rate or number of trap-nights per picture (Table 3). Table 4 illustrates camera trap success in the four locations studied, and indicates that the lowland forest of Matundu was the most diverse area for small carnivores. Matundu is already considered to be one of the richest areas in terms of birds and duikers (Dinesen *et al.*, 2001).

The frequency of independent photos for species with more than five pictures taken (and for which time data were recorded), was plotted in order to show their nocturnal activity patterns (Fig. 2). All pictures taken more than 5 minutes apart were considered 'independent'. The Bushy-tailed and Marsh Mongooses (occupying the same habitat) showed similar activity patterns during the night, with peaks at 19:00, 23:00 and 04:00 hrs, while Meller's Mongoose was most active at 01:00 hrs; a time of decreased activity for the other two species. The activity pattern of other species showed that whilst the African Civet was active throughout the night, the Large-spotted Genet avoided the times when Spotted Hyaenas *Crocuta crocuta* were particularly active (at around 23:00 hrs). It was active at 19:00, 00:00 and 05:00 hrs. The 19:00 hrs peak was the only one that corresponded to those of Bushy-tailed and Marsh Mongooses. Given that their diets are similar, it is possible that the Large-spotted Genet may be avoiding competition with the mongooses by descending less from the trees at this time. Interestingly also, the Bushy-tailed Mongoose activity peaked at around 23:00hrs. At this time we photographed a Spotted Hyaena with a Bushy-tailed Mongoose in its mouth.

According to Bakarr (2000), the major threats for wildlife within the UMNP area are illegal logging, excessive firewood collection, uncontrolled fire, medicinal plant collection, hunting and trapping of prey species. These are the result of increased

Figure 2. Activity pattern of small carnivore species (trapped > 4 times) in the UMNP area. The y-axis is the percentage of the picture taken per species over the total number of pictures of the species shown below.



population pressure within the last few decades. The demands for arable land and development have created barriers to wildlife dispersal by interrupting habitat patches (for example the road along the eastern side of the park separating it from Selous Game Reserve). Inadequate land use planning has exacerbated the problem.

During interviews, we investigated the terms of co-existence with people and identified the source of exploitation such as hunting and consumptive use (De Luca & Mpunga, 2005). Whilst we revealed hunting of carnivores, especially for retribution, medicinal and traditional purposes (De Luca & Mpunga, 2005), the impact on small carnivores was probably limited compared to the negative effects of habitat degradation. To quantify the impact of these threats on carnivore species however, long-term research and monitoring examining habitat use, edge effects, the size of habitat openings, responses to disturbance, hunting, and dispersal across heterogeneous landscapes is required (Sunquist & Sunquist, 2001). This study was an initial step towards this, by documenting the species composition and distribution of carnivore communities in UMNP.

The persistence of the carnivore community will depend on how the specialist and generalist species respond to landscape changes, such as habitat size and the persistence of connections between habitat patches (Terborgh *et al.*, 1997). In UMNP, forest conservation initiatives are likely to help the survival of forest dependent species. However, if habitats degrade changes in species composition would occur with an increase in generalist species that are more successful at adapting to human modified habitats.

Conclusion

This study recorded at least 17 species from 3 families of mammalian carnivores from the UMNP area. On the basis of these data, UMNP must be considered as amongst the richest protected areas for carnivore diversity in Eastern Africa and certainly one of the most important.

The presence of Jackson's Mongoose *Bdeogale jacksoni* is particularly significant being a new record for Tanzania. Amongst the species recorded, many are little known and information about their ecology is lacking, although many are believed to be under threat. The Udzungwa carnivore community is rich and important both in terms of its global significance and its ecological value. Its status and complexity will depend much on the preservation of lower levels of the ecological pyramid, and the tackling of the causes of threat.

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Recent records of Large-spotted Civet *Viverra megaspila* from Thailand and Myanmar

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The Large-spotted Civet *Viverra megaspila* is known by relatively few recent records from anywhere in its range. There are published historical and/or recent records from Myanmar, Thailand, Laos and Vietnam (Wilson & Reeder, 1993; Duckworth, 1994). It was also mapped for Cambodia in the generalised distribution maps of Lekagul & McNeely (1977) and Corbet & Hill (1992), although the first specific records appear to be in Walston (2001). Singapore is frequently stated to hold the animal (e.g. Chasen, 1925), although a recent re-examination of a specimen from there at the Muséum National d'Histoire Naturelle found that it was in fact a Malay Civet *Viverra tangalunga* (G. Veron *in litt.* 2004). The identity of the Singapore specimen(s) referred to in Chasen (1925), possibly not seen by him, remains unclear, and some authors are explicit the species does not occur there (e.g. Harrison, 1966).

There are many literature statements of occurrence in peninsular (= West) Malaysia (e.g. Robinson & Kloss, 1920; Chasen, 1940; Harrison, 1966; Medway, 1969), and at least one historical specimen (BMNH 1879.11.21.624, from Penang; G. Veron *in litt.* 2004). However, the only recent claim from the country seems to be of a road-kill from Sungai Petani in July 1985 (Asakawa *et al.* 1986). There are also several recent assertions of occurrence in southern China (southern Yunnan and western Guangxi; Wang Ying-xiang, 1987, 2003; Zhang Yong-zu, 1997; Wang Sung, 1998; Sheng Helin *et al.* 1999). Occasional reference to occurrence in India is based solely on the alternative viewpoint that the Malabar Civet *V. civettina* of the western Ghats is conspecific; *V. megaspila* itself has apparently never been suspected in the country.

Lekagul & McNeely (1977), in a comprehensive review of the mammals of Thailand, described the species as "found all over the country and ... rather common". Little over a decade later, a global review of all species of Viverridae (Schreiber *et al.* 1989) considered it very little known, traced no records from any protected areas, and urged the need for surveys to assess its current status.

In the 15 years since this alert for status information of Large-spotted Civet, few records have come to light. During extensive surveys of the Lao national protected area system in the 1990s, it was found at only two sites, Xe Pian and Phou Xang He National Protected Areas, with one animal found in a zoo in this general area. This contrasted with the widespread and often frequent occurrence of Large Indian Civet *V. zibetha* in the areas surveyed (Duckworth, 1994, 1997; Duckworth *et al.* 1999). Large-spotted Civet was recorded again in Xe Pian by Austin (1999). The only other subsequent record from Laos appears to be of remains seen in a hunter's possession on the Nakai Plateau, central Laos, in 2002 (K. Khounboline verbally, 2003). There appear to be few recent records from Vietnam (R. J. Timmins *in litt.* 2004). The species has been found at several sites in Cambodia (J. L. Walston *in litt.* 2004). However, we have traced no recent specific information on status in Thailand or Myanmar. Here we report recent records through camera-trapping on extensive surveys of both countries, and the lack of records from a similar survey programme in West Malaysia. These records were incidental to the primary survey aim, to document the status of Tiger *Panthera tigris*.

Large-spotted Civet Viverra megaspila *from Myanmar. Photo: WCS Myanmar Programme.*

Materials and methods

Surveys using heat-and-motion-sensitive CamTrakker™ (Camtrak South Inc., Georgia, USA) camera-traps were mounted at numerous sites across Thailand, Myanmar and West Malaysia during 1997-2002. Camera-traps are good at amassing the very many hours of observational effort which may be needed to detect low-density, shy and/or nocturnal mammals, provided they are ground-dwelling (e.g. Griffiths & van Schaik, 1993; Cutler & Swann, 1999). Moreover, the photographs provide objective and verifiable evidence of species' presence, a consideration particularly pertinent to Large-spotted Civet given its general morphological similarity to the Large Indian Civet with which it is widely sympatric, and to Malay Civet which overlaps in distribution in the Sundaic subregion. Field protocol was shaped by the primary aim of the surveys, to document Tiger presence and abundance. Cameras were thus deployed in grids and along traplines across areas predicted on various grounds (e.g. habitat type, condition and extent, human use patterns) potentially to hold Tigers (see Myanmar Forest Department 2003 for further details). Points of relevance to the recording of Large-spotted Civet are that:

- a wide geographical range was covered in each country;
- a wide range of altitudes and habitats were covered in each country;

- most trapping was in relatively remote areas;
- camera-traps were set at a height suitable for being triggered by passing small carnivores, as shown by the overall numbers of viverrid photographs;
- in total, surveys covered all seasons of the year although individual sites were not trapped throughout the year;
- the need for semi-quantitative information on Tiger status meant that massive survey effort was undertaken at all sites, typically several hundred to several thousand trap nights at each;
- in total, there were eight survey areas in Thailand and 17 in Myanmar; and nine in Malaysia surveyed in a comparable manner by a collaborative programme of the Department of Wildlife and National Parks and the Wildlife Conservation Society.

Records

Few photographs of Large-spotted Civet were obtained: one each from two survey areas in Myanmar, and two from one survey area in Thailand. The details are as follows:

- **Htaung Pru Reserve Forest, Southern Taninthayi Division, Myanmar**
  Location, extent and description of survey area: the survey area, of 120 sq. miles (310 km²), lies in the Htaung Pru Reserve Forest over 11°38'-11°38'N, 99°03'-99°07'E, in Taninthayi and Bokpyin Townships, Myeik District. The eastern portion is drained by the Naukpyan, La Mu, Tabalat, and Ngawun streams, which flow into the Little Taninthayi River. To the west the Monoron Stream flows into the Lenyar River to the south. The area is partially low-lying with swamps and grassland that are annually flooded, interspersed with mixed evergreen - bamboo forest groves on higher ridges. The area lies on both sides of the new Taninthayi-Bokpyin highway, and is partially under cultivation for rice and areca palm, with some shifting cultivation. The area has two monsoons with a prolonged wet season from June – November, and annual rainfall of around 160" (4,100 mm). Base camp was situated 3 miles (5 km) south of Htaung Pru Village containing 15 households, with a further 38 households in adjacent Manoron Village.
  - Number of trap-nights in survey area: 837
  - Location of camera-trap: 11°37.27'N, 99°04.49'E
  - Date and time: 7 February 2002, 01h49
  - Elevation: 110'-2,264' (33-690 m); exact altitude of camera trap 80' (25 m)

- **Hukaung Valley Wildlife Sanctuary, Kachin State, northern Myanmar**
  Location, extent and description of survey area: 525 sq. mi. (1,360 km²) at 26°36' - 26°42'N, 96°34' - 96°53'E in the newly declared Hukaung Valley Wildlife Sanctuary (size 2,493 sq. miles; 6,459 km²), which has even more recently been expanded to the Hukaung Valley Tiger Reserve at 21,890 sq. km. To the north an upland area rising to 6,758' (2,060m) divides the Tarung Tawan watershed and Gedu River catchment, with the Kumon Mountains to the east, the Nambyu and Nampyek River catchments in the south and the Tarung River and old Ledo Road to the west. Vegetation is predominantly dense lowland evergreen forest interspersed with meadows. Rainfall is about 2,340 mm annually. Apart from a 5 acre shifting cultivation area near Tawang River, there were no permanent human settlements in the survey area.
  - Number of trap-nights in survey area: 1,563
  - Location of camera-trap: 26°38.75'N, 96°51.10'E
  - Date and time: 2 December 2002, 18h19
  - Elevation: 193 - 1,307' (59 - 398 m); exact altitude of camera trap 900' (277 m)

- **Taphyra National Park, eastern Thailand**
  Location, extent and description of survey area: roughly 100 km² within 20 km from the Thai-Cambodia border, one of three plots used to assess large mammal occurrence in this part of the Dong Phayayen-Khao Yai Forest Complex. Much of the area was dominated by scrubby, low stature secondary evergreen forest, and scrub roughly 10-20 m high with a few scattered larger trees remaining, but with no continuous canopy anywhere. There were very few rattans in the understory and no bamboo. Some *Licuala* palms were present along the banks of streams. Annual rainfall is approximately 1,200 - 2,000 mm. A well-used trail passed through the area and was littered with instant noodle packets, articles of clothing and other items, suggesting use by people other than forest product collectors and hunters. These were thought to be possibly immigrant workers from Cambodia. There were many large stumps of *Afzelia* which were now coppicing. These post-dated the era of legal logging concessions and were indicative of more recent poaching. Newer (1-2 year old) signs of logging were also found. During part of the survey, wheelbarrow tracks appeared overnight on one trail, indicating the possible extraction of illegal timber or possibly a hunted large mammal.
  - Number of trap-nights in survey area: 1,384.
  - Locations of camera-traps: (a) 14°07.02'N, 102°37.00'E; and (b) 14°10.52'N, 102°44.63'E
  - Dates and times: (a) 17 November 1998, 05h35; and (b) 11 October 1998, 01h03
  - Elevation: c. 300m; exact altitude of camera traps (a) 120m and (b) 270m

Discussion

These records come from, in total, a wide geographical range and (together with recent Lao, Vietnamese and Cambodian records) effectively confirm that Large-spotted Civet persists across its non-Sundaic, non-Chinese, historical range. All three records are from evergreen forest: this is the predominant habitat of other recent records, although some have been from deciduous dipterocarp forest (Duckworth, 1994; Austin, 1999). There is no evidence of the species in areas remote from forest, but the Thailand records, from an extensive logged-over area, strengthen the suggestion by Duckworth (1994) that the species is not particularly sensitive to forest degradation.

Almost all field records with known altitudes have been from the extreme lowlands (below 300 m). There are two, as yet unpublished, apparently from higher altitudes: from the Nakai Plateau, Laos, at c. 520 m, and from Konkhakhin, Vietnam, assumed to be about 700-900 m (Le Trong Trai verbally, 2000, photograph examined by JWD). However, both are of hunted animals for which the precise capture site is not known. These two areas are plateaux possessing habitat more typical of lower areas, and, especially in the case of the Nakai Plateau, a suite of lowland indicator bird species (Evans & Timmins, 1998). These records from Myanmar and Thailand, from such widely disparate sites, yet all from below 300 m, consolidate the impression that Large-spotted Civet is a lowland species. This contrasts with Large

Indian Civet, which ranges widely in South-east Asia up to well over 1,000 m (e.g. Duckworth, 1997), and was recorded in these surveys over ranges of 50-1,280 m in Thailand and of 15-1,628 m in Myanmar. Notably, in the highest altitude site for Large-spotted Civet with nocturnal survey data, the Nakai Plateau at about 520 m, Large Indian Civet is considerably more numerous (Duckworth, 1997), whereas in the extreme lowlands of Xe Pian, the balance is reversed, with Large-spotted Civet being much the commoner (Austin, 1999). Indeed, we are not aware of any site in non-Sundaic South-East Asia lying predominantly under 300 m, supporting 500+ sq. km of (semi-) evergreen forest, and having received heavy camera trapping or spotlighting effort, that has not recorded the species.

A restriction to lowland forest probably explains the apparent contradiction in status assessment between Lekagul & McNeely (1977) and observers in and after the 1990s. During the interim, massive areas of lowland forest were logged across the species' range and, particularly in Thailand and Vietnam, converted to non-forest land-uses. There was doubtless a major decline in the species' population during this period, accompanied by a change in distribution pattern from being widespread to restriction to isolated sites. In its distributional range, only Cambodia and parts of Myanmar retain truly extensive, albeit mostly degraded, level lowland forests. All records come from large forest blocks (500 km^2 or bigger), with no evidence for persistence in fragmented forests. It is difficult to tell if this is a meaningful result, because much fieldwork for mammals, especially Tigers, necessarily focuses on the largest remaining forests. In increasingly smaller fragments, persistence by forest species becomes ever more unlikely, reflecting increased risks of chance extinction, possible loss of seasonal movement areas and, especially in Indochina, heightened vulnerability to the effects of hunting. Information on the lower size class of fragments able to support viable populations of Large-spotted Civet is lacking. The conservation needs of a host of lowland species with large area needs argue for the retention of very large lowland forest blocks at representative sites across South-east Asia (e.g. Seidensticker *et al.* 1999; Lambert & Collar, 2002) and this would certainly be beneficial for this civet.

These trapping rates (one per 837 trap nights, one per 1,563 trap-nights and one per 692 trap-nights at the respective sites) are well below those of Austin (1999) who found in two habitat-types of Xe Pian, one per 69 and one per 49 trap-nights respectively. However, this disparity in encounter rate probably reflects, at least partly, methodological differences. Austin (1999) baited some camera sites and all Large-spotted Civet photographs were at baited sites, whereas no baits or lures were used for these surveys in Thailand, Myanmar and Malaysia. Moreover, it is highly likely that all Austin's (1999) trap sites were below 300 m altitude, whereas the present Thai and Myanmar surveys set cameras across a wide altitudinal range. Hence, it should not be concluded that these sites are holding much lower density populations than Xe Pian.

Mammal hunting is very heavy across most of the Large-spotted Civet's range. Ground-dwelling civets can be caught by various methods, notably snares and other traps, direct shooting, cornering with dogs, and digging out of dens. Recent advances in the reduction of guns in civilian usage across much of the range (especially Cambodia, Laos, and Vietnam) may, ironically, have heightened pressure on species such as Large-spotted Civet, whereby former shooters increase snaring levels to compensate. Reduction of snaring levels is likely to be a lot more challenging than reduction of gun usage, for several reasons. Gun campaigns have been primarily driven by civil order needs rather than wildlife conservation, whereas snaring does not have this priority. Snaring needs less complex materials than shooting, so there is no possibility of controlling the equivalent of 'ammunition'. And, snaring is now a major means of trapping the vast number of mammals to supply the rocketing Chinese and, increasingly, Vietnamese markets for wildlife meat. Active hunting is still rife in the Hukaung Valley, Myanmar, with people using both black powder guns and bows-and-arrows to hunt. There is only limited information on hunting pressures in the Htaung Pru Reserve Forest. In Taphyra National Park, Thailand, snares, pipebombs and black powder guns are all used to kill large mammals.

The conservation needs for Large-spotted Civet can now be revised from those in Schreiber *et al.* (1989). There remains a need for further status information, notably camera-trap or spot-lighting surveys in areas within the species' range with no recent confirmation of its presence. This is particularly so for peninsular Thailand and Malaysia, which are ecologically very different from the non-Sundaic (more northern) areas whence come all the recent records. The lack of any Large-spotted Civet photographs from the nine survey areas in Malaysia is particularly of concern. The sites ranged from the Thai border in Perak State to Johore State in the far south, and were surveyed between December 1997 and December 1999, and involved 174 camera-trap set-ups and 6,259 trap-nights of sampling. Other small carnivores were detected: Yellow-throated Marten *Martes flavigula*, Large Indian Civet, Malay Civet, Banded Linsang *Prionodon linsang*, Common Palm Civet *Paradoxurus hermaphroditus*, Masked Palm Civet *Paguma larvata*, Binturong *Arctictis binturong* and Banded Civet *Hemigalus derbyanus*. This indicates that Large-spotted Civets were probably not simply overlooked through inappropriate methodology. Recent records not so far written up, notably from Cambodia, need to be presented. But now that several protected areas are known to hold the species, more important is on-ground effort to ensure that forest extent at key sites is not decreased or fragmented. Coupled with this is the need to reduce, and preferably eradicate, snaring from declared protected areas; usually this will be in accord with the area regulations, at least in total protection (core) zones. Key sites are likely to include several areas in Cambodia (J. L. Walston *in litt.* 2004), Xe Pian National Protected Area in Laos, and all the three Thai and Myanmar sites discussed here: these all include hundreds of sq. km of forest at below 300 m.

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