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Small carnivores of Silent Valley National Park, Kerala, India

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Abstract: A study on the small carnivores in Silent Valley National Park (SVNP), southern Western Ghats, Kerala, India was conducted from September 2015 to April 2016, using the camera trap technique. Seven species of small carnivores were recorded during the study. The most common species of small carnivore of SVNP was *Viverricula indica* (44%) followed by *Paradoxurus jerdoni* (20%) and *Herpestes vitticollis* (17%). The other small carnivores found at SVNP were *Herpestes fuscus* (7%), *Prionailurus bengalensis* (6%), *Aonyx cinereus* (5%) and *Martes gwatkinsii* (1%). *P. jerdoni* and *M. gwatkinsii* are endemic to the Western Ghats. We discuss the niche partitioning among small carnivores in SVNP.

Keywords: Camera traps, civets, martens, mongoose, otters, small cats, Western Ghats.

The need to undertake biodiversity studies is accelerated by the rapid destruction of forests, particularly in the tropics including the Western Ghats. The number of small carnivore species reported from different protected areas of Kerala vary, e.g., 11 species from Parmbikulam Tiger Reserve (Sreehari & Nameer 2016), nine species from Eravikulam National Park (Nikhil & Nameer 2017), and Wayanad Wildlife Sanctuary (Sreekumar & Nameer 2018). The first record of *Martes gwatkinsii* from Parambikulam Tiger Reserve was reported by Sreehari & Nameer (2013), and the social behavior, feeding habits and activity pattern of *Martes gwatkinsii* were reported from Pampadum Shola National Park (PSNP) (Anil et al. 2018). Sreehari et al. (2013) reported the presence of *Herpestes smithii* in Parambikulam Tiger Reserve and Chinnar Wildlife Sanctuary, and *Herpestes fuscus* in Parambikulam Tiger Reserve and Eravikulam National Park. The lack of details on small carnivores from the Silent Valley National Park (SVNP), except on the sighting records of *M. gwatkinsii* (Christopher & Jayson 1996) and habitat characterization of *M. gwatkinsii* (Balakrishnan 2005), prompted the present study. We report the status and distribution of small carnivores in SVNP.

Materials and Methods

Study Area

Silent Valley National Park is part of the Nilgiri Biosphere Reserve and has an extent of 237.52km². The

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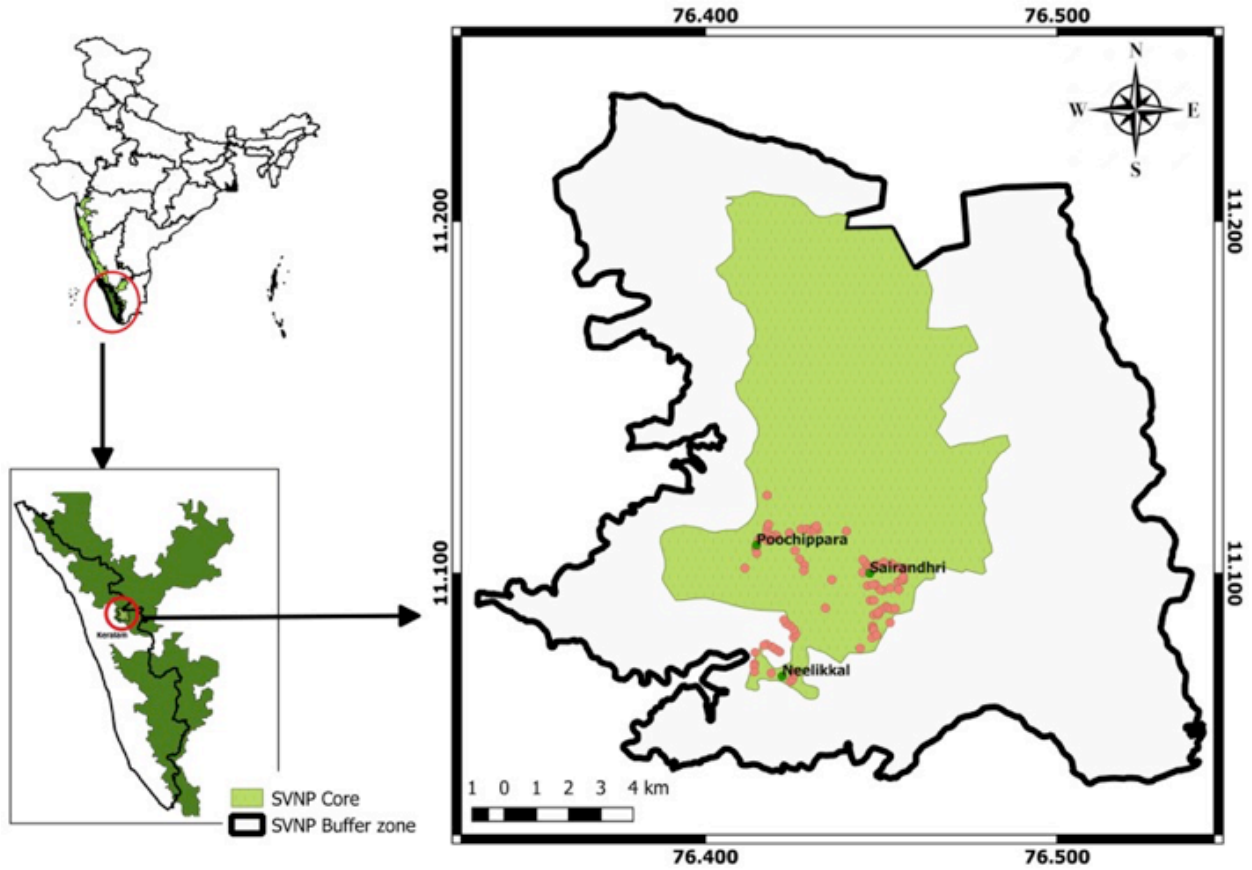

Figure 1. Camera trap locations at Silent Valley National Park

original extent of the Silent Valley National Park was 89.52sq.km. Subsequently in 2007 an area of 148sq. km. was added to the National Park as buffer zone. The SVNP is located within 76.25–76.58 ^{0}E & 11–11.25 ^{0}N. The elevation ranges from 900–2,300 m with Anginda being the highest peak (2,383m) (Fig. 1) (Anonymous 2012). The study was conducted in the core area of SVNP from September 2015 to April 2016.

Camera Trap Survey

Digital scout cameras having passive infra red sensors for heat and motion detection (Cuddeback Attack model C1) were used for the current study. Camera trap stations were placed in the west coast tropical evergreen forest (1A/C4) and southern montane wet grasslands (11A/C1/DS2). Overall a 100 trapping stations (Fig. 1) were identified based on the presence of the indirect evidence of the small carnivores (Mudappa 1998). The camera traps were set at a height of 30cm above the ground and at least 250m apart from each other (Sreehari & Nameer 2016; Nikhil & Nameer 2017; Sreekumar & Nameer 2018). The cameras were set up in default mode with the time-delay between pictures as fast as possible in daytime and the time-delay of five seconds between pictures during night time. The camera trap locations were marked using Garmin GPS eTrex 30. The cameras were kept open for 24 hours a day. The date and time of exposure were automatically recorded by the camera on the images, as and when the images were taken. At each trapping stations, each camera was opened for 15 days. Thus, a total of 1,500 camera-trap days, monitoring 36,000 hours were carried out in the Silent Valley National Park. The data analysis was done using the statistical packages such as the XL STAT (Version 2016.03.30846), and PAST (Hammer et al. 2001).

Microhabitat parameters were documented at each of the camera trapping sites. Microhabitat parameters that are crucial for the survival of the small carnivores, such as, canopy height (clinometer), canopy cover (visual estimation), height of shrubs (stems <10cm girth at breast height) and ground vegetation (herbaceous plants <50cm in height, measured with tape), litter depth (average of four measurements taken around the

trap using a calibrated probe), and basal area of trees >30cm girth, densities of shrubs (within 2m radius), trees, climbers, buttresses and canes, and distance to the nearest large tree (measured with a tape to a tree >60cm girth), frequency of natural hollow in the trees etc., were taken in the camera trapping sites. At each camera trap site, a circular plot having a dimension of 5m radius was taken and 100 such plots were enumerated for the microhabitat parameters listed above. Thus, a total of 7,850m^2 area was sampled. The relationship between these microhabitat variables on the distribution of small carnivores in the study area was analysed using discriminant analysis.

Results and Discussion

We recorded seven species of small carnivores in SVNP representing four families such as Viverridae, Herpestidae, Mustelidae and Felidae. This comprises two herpestid, mustelid, and viverrid species each, and one felid species (Fig. 2; Table 1).

Of the total 607 photographs of all the mammals (20 species) obtained, 165 images (seven species) were of small carnivores. The most common species recorded was *Viverricula indica* (72, 44%) followed by *Paradoxurus jerdoni* (33, 20%) (Table 1). The camera trap success rate of small carnivore was 10.90%.

Table 1. Small carnivores recorded from Silent Valley National Park

Family	Species	Number of captures	Relative abundance (%)
Viverridae	*Viverricula indica* Small Indian Civet	72	43.64
	Paradoxurus jerdoni Brown Palm Civet	33	20.00
Herpestidae	*Herpestes fuscus* Brown Mongoose	11	6.67
	Herpestes vitticollis Stripe-necked Mongoose	29	17.58
Mustelidae	*Aonyx cinereus* Asian Small-clawed Otter	8	4.88
	Martes gwatkinsii Nilgiri Marten	2	1.21
Felidae	*Prionailurus bengalensis* Leopard Cat	10	6.06

Family Viverridae

Out of the three species of viverrids (Nameer 2015) of Kerala, *V. indica* (Image 1) and *P. jerdoni* (Image 2) are found in SVNP. *V. indica* was the most common species of small carnivores, photo-captured 72 times (Fig. 3), between an altitudinal range of 900–1,200 m, and from the rainforests as well as from the grasslands. In the previous studies done in the Kerala part of the Western Ghats in Parambikulam Tiger Reserve (Sreehari & Nameer 2016) and in Wayanad WS (Sreekumar & Nameer 2018), *V. indica* was the most abundant species of small carnivore. Mudappa (2002), however, had reported that the *V. indica* is the most common small carnivore in the drier forests of the southern Western Ghats and rare in the tropical wet evergreen forests.

Paradoxurus jerdoni (Image 2) is an endemic small carnivore restricted to the rainforests of the Western Ghats (Rajamani et al. 2002). *P. jerdoni* was the most common small carnivore in Kalakkad-Mundanthurai Tiger reserve followed by *V. indica* (Kumar et al. 2002). A total of 33 captures of *P. jerdoni* were obtained during the study period from SVNP, and there was a single direct sighting in the night (06 October 2015) from Sairandri (Fig. 3). All the captures of the *P. jerdoni* were from the tropical evergreen forest and between the altitudes of 900–1,200 m.

Family Herpestidae

Four species of mongoose are known from the Western Ghats (Mudappa 2013) of which two species, *Herpestes vitticollis* and *H. fuscus* are seen at SVNP. The *H. vitticollis* (Image 3) is a wide-spread species of small carnivore that occurs in well-wooded habitats of

Image 1. Small Indian Civet *Viverricula indica*

Image 2. Brown Plam Civet *Paradoxurus jerdoni*

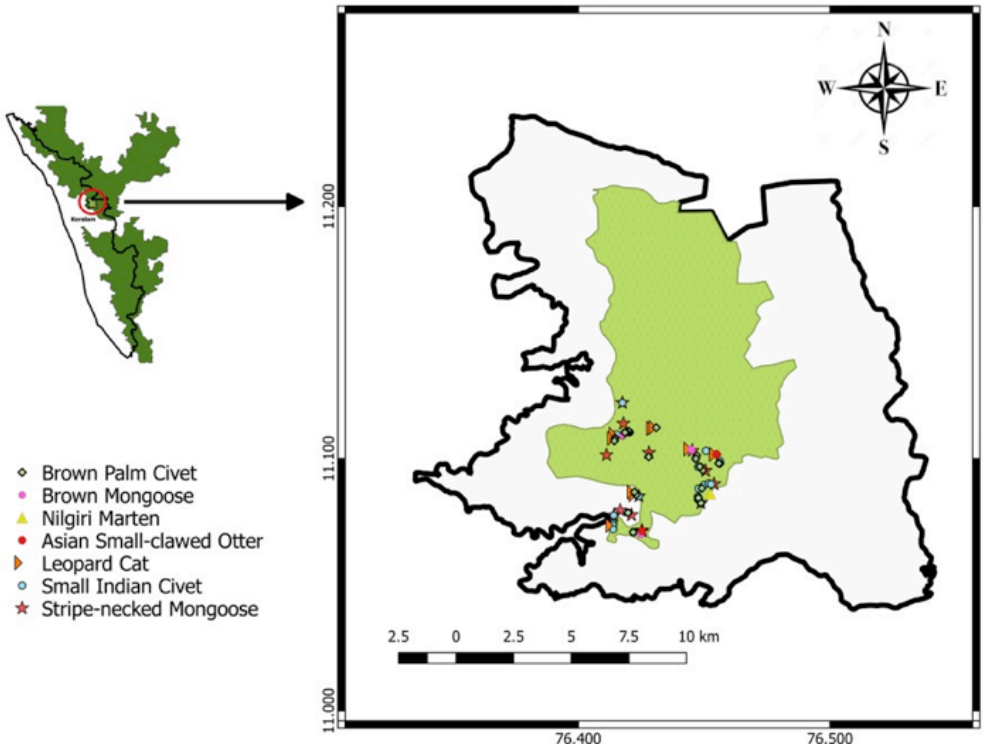

Figure 2. Camera trapped locations of the seven species of small carnivores in SVNP

the Western Ghats (Ramachandran 1985; Madhusudan 1995; Mudappa 2013; Rompaey & Jayakumar 2003; Pillay 2009; Kumara et al. 2014; Sreehari & Nameer 2016; Nikhil & Nameer 2017; Sreekumar & Nameer 2018), and the northernmost distribution range is Kolhapur and Sindhudurg districts of Maharashtra (Punjabi et al. 2014). During the present study, 27 captures were obtained, and there were also two independent sightings of the species from Sairandri (07 October 2015) and another from Panthanthode (24 February 2016) (Fig. 4).

H. fuscus (Image 4) is found in the forests of the southern Indian hill ranges at 900–1,850 m (Mudappa 1998) and is also seen in Sri Lanka (Phillips 1984). The previous records of this species from the Western Ghats are from Parambikulam Tiger Reserve (Sreehari et al. 2013; Sreehari & Nameer 2016), and Eravikulam National Park (Sreehari et al. 2013; Nikhil & Nameer 2017). During the present study, 10 captures were obtained between an altitude range of 900 and 1,200 m (Fig. 4). In southern India, *H. fuscus* is found from an altitude range of 492 and 2,032 m and is reported from different hill ranges of the Western Ghats such as Coorg, Nilgiri Hills, Palni Hills, Anamalai Hills, High Wavy Mountains and Agasthyamalai Hills (Sreehari et al. 2013; Mudappa & Jathanna 2015).

Family Mustelidae

Martes gwatkinsii (Image 5) is endemic to the Western Ghats and is currently listed in the IUCN Red List as *Vulnerable* (Choudhury et al. 2012). During the present study, two captures were obtained in the camera trap near a fig tree (*Ficus* sp.) in the evergreen forest (Fig. 5). *M. gwatkinsii* is also reported from various parts of the Western Ghats including Kalakkad-Mundanthurai Tiger reserve (Kumar et al. 2002), and Karnataka State (Kumara & Singh 2007; Krishna & Karnad 2010).

Of the two species of the otters seen in the Western Ghats, only the *Aonyx cinereus* could be found in SVNP that was captured five times during the current study (Fig. 5, Image 6), and all the captures were above 1,000m. The only previous records of the *Aonyx cinereus* from the Western Ghats were from Eravikulam National Park (Perinchery et al. 2011; Nikhil & Nameer 2017), Anamalai Tiger Reserve (Prakash et al. 2012) and Wayanad WS (Sreekumar & Nameer 2018). There is, however, a record of this species from the northern Western Ghats in Maharashtra (Punjabi et al. 2014).

Family Felidae

Prionailurus bengalensis (Image 7) is the only small cat recorded during the present study and 10 camera trap images were obtained from the SVNP between an altitude range of 900 and 1,200 m in evergreen forest

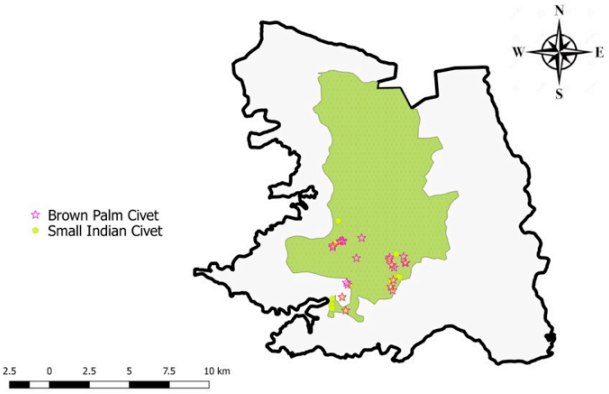

Figure 3. Camera trapped locations of Small Indian Civet and Brown Palm Civet in SVNP

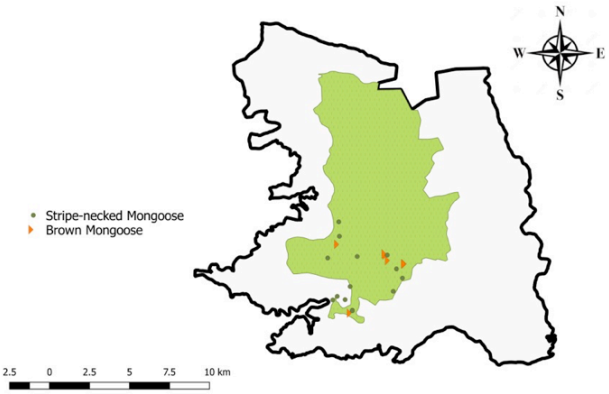

Figure 4. Camera trapped locations of Stripe-necked Mongoose and Brown Mongoose in SVNP

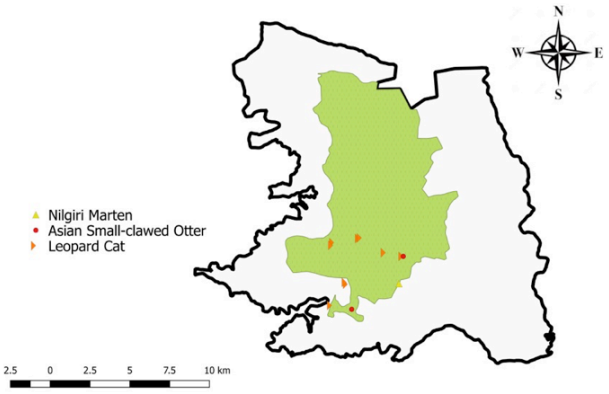

Figure 5. Camera trapped locations of Leopard Cat and Mustelids in SVNP

(Fig. 5). The other records of this species from the Western Ghats are from Peppara Wildlife Sanctuary (Jayson & Christopher 1996), Kalakkad-Mundanthurai Tiger Reserve (Mudappa 2002), Bilgiri Rangaswamy Tiger Reserve (Kumara et al. 2014), Parambikulam Tiger

Image 3. A pair of Stripe-necked Mongoose *Herpestes vitticollis*

Image 4. A pair of Brown Mongoose *Herpestes fuscus*

Image 5. Nilgiri Marten *Martes gwatkinsii*

Reserve (Sreehari & Nameer 2016), Eravikulam National Park (Nikhil & Nameer 2017), and Wayanad Wildlife Sanctuary (Sreekumar & Nameer 2018).

The microhabitat preference of the selected small carnivores in Silent Valley NP

The differential preferences for microhabitat variables in the study area by small carnivores were examined using discriminant analysis (Table 2). This helps to understand whether there is any niche partitioning between and among the species concerning the habitat

Image 6. Asian Small-clawed Otter *Aonyx cinereus*

Image 7. Leopard Cat *Prionailurus bengalensis*

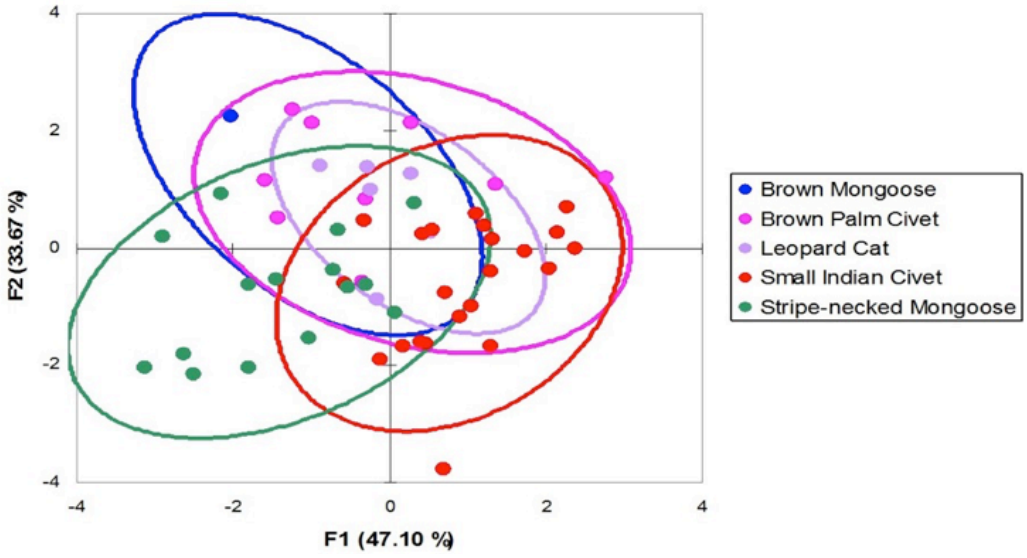

Figure 6. Niche partitioning of small carnivores in Silent Valley National Park

Table 2. Summary statistics on the microhabitat variables recorded at the camera trap stations at Silent Valley National Park

Parameters	Mean (n=100)	SD
Canopy Height (m)	21.2	8.50
Canopy cover (%)	61.52	27.45
Litter depth (cm)	1.75	1.26
Shrub density	35.28	35.88
Tree density	7.58	5.06
Climber density	2.46	3.31
Buttress density	0.63	0.98
Canes density	0.29	1.22
distance to largest tree (m)	5.26	6.37
Width of the waterbody	1.42	3.52
GBH (cm)	139.09	99.21
Slope (degrees)	21.4	15.02

variables studied. The pair-wise Fisher's distances (blue cells) and associated P values (red cells) clearly show that there is no significant difference in the clusters, thus indicating that the selected small carnivores show no significant niche partitioning (Table 3, Fig. 6).

Conclusion

The Silent Valley National Park which constitutes one of the few pristine rainforests of the Western Ghats is a home for many endemic and threatened species including small carnivore fauna. Even though some of the high-altitude areas of the SVNP could not be surveyed due to logistical reasons, it supports seven species of small carnivores. The disturbed habitats are vulnerable to incursions by more widespread species at the cost of restricted range species. The absence of widespread species of small carnivores in the national park indicates the intact habitats of SVNP.

Table 3. Fisher's distance matrix

	Brown Mongoose	Brown Palm Civet	Leopard Cat	Small Indian Civet	Stripe-necked Mongoose
Brown Mongoose		0.721	0.777	1.457	0.956
Brown Palm Civet	0.787		0.389	0.908	1.616
Leopard Cat	0.728	0.989		0.767	1.116
Small Indian Civet	0.136	0.579	0.739		1.757
Stripe-necked Mongoose	0.525	0.082	0.361	0.051	

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