Research Article - 1

Distribution and Abundance of Small Carnivores in Nilgiri Biosphere Reserve, India

AJITH KUMAR and K. YOGANAND

ABSTRACT

The distribution and abundance of small carnivores in eleven Protected Areas of Nilgiri Biosphere Reserve representing various altitude, vegetation and human disturbance regimes were examined during 1994-96 using frequency of scats as an indicator. Nearly 800 km were surveyed, mostly on foot, during which around 500 scats were collected. These could, however, be identified only up to the family level. The overall encounter rate of scats was 0.83/km, that of civets being the most abundant (0.47 scats/km), followed by mongoose (0.17 scats/km), cats (0.14 scats/km) and marten (0.05scats/km). The wet and semi-evergreen forests had the highest abundance of scats (2.78 scats/km), primarily because of the abundance of civet scats (2.46 scats/km). The montane shola-grasslands had the next highest abundance (1.29 scats/km) owing to the abundance of marten scats (0.79 scats/km) which were found only in this vegetation type. The dry thorn and scrub forests (0.36 scats/km), dry and mixed deciduous forests (0.38 scats/km) and moist deciduous forests (0.58 scats/km) had considerably lower abundance of scats, those of mongoose being the most abundant. Cat scats occurred in all these vegetation types, being low in abundance as well as in variation. Plantations, mostly of teak, had the lowest scat abundance (0.15 scats/km). The small carnivores also varied in their response to habitat degradation. Civet scats were least abundant in areas with low canopy cover and high weed cover, whereas that of mongoose and cats were more abundant in moderately open canopy. Scats of these taxa were also highest in areas with lowest weed cover, however, the difference was not as large as in the case of civets.

INTRODUCTION

Species in a small carnivore community share a wide variety of food resources which include fruits, invertebrates, lower vertebrates, birds, and small mammals. This community in a locality is therefore a good indicator of diversity at habitat and species levels. It also has important ecosystem functions since species in this community are major dispersers of seeds as well as predators of other animals. The conservation and ecological studies of small carnivores have therefore attracted considerable attention in recent years. The advent of new technologies such as radio-telemetry has, in the recent years, made ecological studies of this community feasible. India has a rich assemblage of small carnivores belonging to the families of Felidae (cats), Mustelidae (weasels, badgers, rate and martens), Viverridae (civets and linsangs) and Herpestidae (mongoose). Eastern Himalaya and the Western Ghats, the two biodiversity hotspots in India, are also major centres of species richness among the small carnivores. However, the rich assemblage of small carnivores in India has received very little conservation and research attention. It was in this context that the Salim Ali Centre for Ornithology and Natural History undertook a project during 1994-97 with the following objectives:

Ajith Kumar
Salim Ali Centre for Ornithology and Natural History
Coimbatore. 641 108, Tamil Nadu

K. Yoganand
Wildlife Institute of India
Post Box # 18, Dehra Dun. 248 001

1. assess the distribution and abundance of small carnivores (four species each of civets, mongoose, and lesser cats, and one species of marten) with reference to different habitat types and human disturbance levels;
2. assess the diet and habitat use pattern of some species; and
3. assess the conservation implications of the findings.

Nilgiri Biosphere Reserve was chosen as the study area since it has a full complement of the habitat types as well as the small carnivore community of the Western Ghats (Fig. 1). This paper deals with the objective 1 - distribution and abundance of small carnivores of Nilgiri Biosphere Reserve with reference to different habitat types and human disturbance.

Sites for surveying the small carnivores in the Nilgiri Biosphere Reserve were selected representing the various vegetation types, altitudinal ranges and human impact levels.

METHODS

Selection of sites for survey

Sites for surveying the small carnivores were selected representing the various vegetation types, altitudinal ranges and human impact levels in the Reserve (Table 1). The following sources were used to classify the habitat types and to select the survey sites; Survey of India topo sheets, ISRO/NRSA satellite imageries, Champion & Seth (1968), Gadgil & Sukumar (1986) and the various forest working plans. On the basis of these sources, we selected survey areas. Of these, 10 areas were surveyed (Table 1). These 10 areas covered all the eight major vegetation types and the grades of human disturbance within the vegetation types. An area was selected to either represent one or more of the vegetation types or to represent the human impact patterns. For example, the Silent Valley NP area was selected to represent the nearly undisturbed wet evergreen forest, whereas the New Amarambalam RF represented moderately disturbed wet evergreen and the Nilambur Kovilakam RF represented the highly disturbed wet evergreen forests.

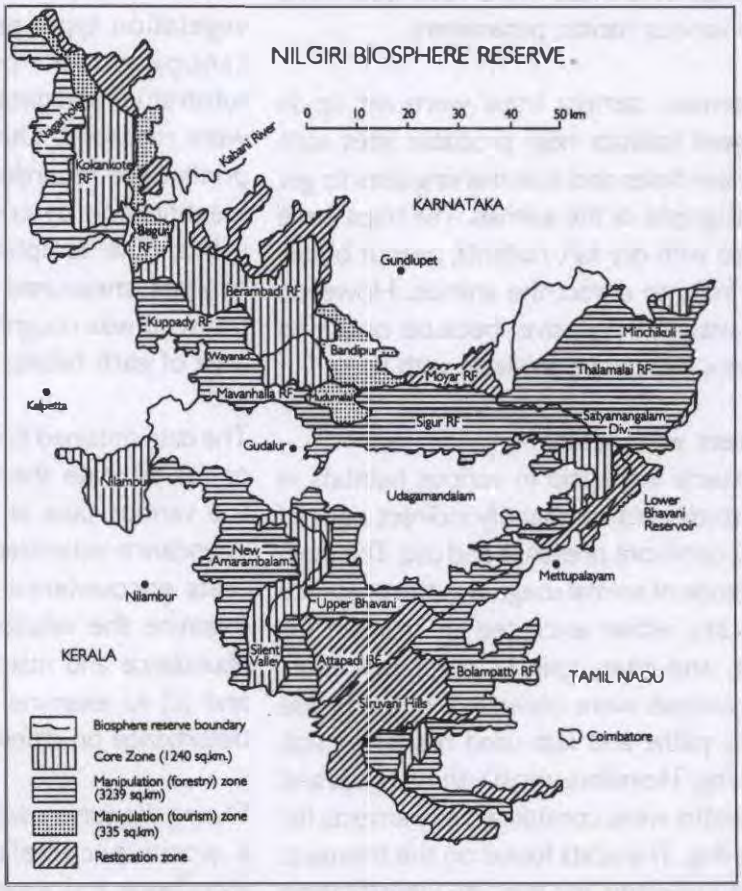


Fig. 1. Map of Nilgiri Biosphere Reserve showing different habitat types

Direct sightings

Most small carnivores occur in low densities, and are nocturnal and solitary. Therefore, direct sightings can not be relied upon to make an assessment of their distribution and abundance. However, during the survey, the various habitats in the selected areas were extensively walked to get direct sightings of the study species. Vehicular

Table 1. Major localities and forest types of the Nilgiri Biosphere Reserve.

S.No	Locality	Major vegetation types
1*	Nagarhole National Park	Moist, dry deciduous.
2*	Bandipur Tiger Reserve	Dry deciduous.
3	Wynad Wildlife Sanctuary	Moist, dry deciduous.
4	Mudumalai Wildlife Sanctuary	Moist, dry deciduous, scrub.
5	Sigur Reserve Forest (RF)	Scrub forest.
6	Talamalai Reserve Forest	Dry, moist deciduous.
7	Moyar valley Reserve Forest	Dry thorn forest.
8	Nilgiris southeastern slopes RF	Mixed deciduous.
9	Siruvani hills Reserve Forest	Wet, semi-evergreen, moist deciduous.
10	Upper Nilgiris, Mukkurthi NP	Montane evergreen (shola-grassland).
11*	Attapadi Reserve Forest	Evergreen, moist deciduous, scrub.
12	Silent valley National Park	Wet evergreen.
13	New Amarambalam RF	Wet evergreen, semi-evergreen.
14*	Nilambur Kovilakam RF	Wet evergreen, semi-evergreen.

(* sites not surveyed)

Various habitats in the selected areas were extensively walked to get direct sightings of small carnivores. Automatic camera traps were set up in different habitats near water holes and scat-marking sites to get photographs of the animals. Transects were monitored in various habitats in the study area to quantify indirect signs of small carnivore presence.

transects were done, mostly at night, wherever possible. Stationary observations for long periods of time were made at probable haunts of the various species, such as water holes and fruiting trees. The sightings of animals were recorded along with various habitat parameters.

Automatic camera traps were set up in different habitats near probable sites such as water holes and scat-marking sites to get photographs of the animals. The traps were baited with dry fish, rodents, peanut butter and fruits to attract the animals. However, this was not intensive, because only two camera traps were available with us.

Indirect evidences

Transects were laid in various habitats in the study area to quantify indirect signs of small carnivore presence and use. The main evidence of animal usage was the presence of scats, either excreted or marked for intra- and inter- specific communication. The animals were observed to mainly use bridle paths and less-used roads for scat marking. Therefore, mostly these roads and footpaths were considered as transects for sampling. The scats found on the transects were collected for species identification using biochemical technique. In the field, scats were assigned to various family groups - cats (Felidae), civets (Viverridae), mongoose (Herpestidae) and the marten (Mustelidae) - depending on the various characteristics such as size, shape and scent marking sites. A number of macro and micro habitat parameters such as altitude, vegetation type, proximity to streams, canopy cover, prominence of the substratum, and distance along the transect were recorded. Other signs such as foot prints were recorded and traced for later identification by comparing with known prints. The sampling effort in different habitats, measured as the length of the transect, was roughly proportional to the area of each habitat type.

The data obtained from the survey was used to (a) estimate the relative abundance of the various taxa at the family level. The abundance estimated was the number of scats encountered per km walked, (b) examine the relationships between scat abundance and macro habitat parameters; and (c) to examine the impact of human disturbance on different taxa.

During the survey we assumed that there is a positive correlation between scat abundance and abundance of a particular taxon irrespective of other parameters which influence defecation rate.

Picture Gallery


Fritz Vollmar/WWF

Beech marten


Sean A. Austin

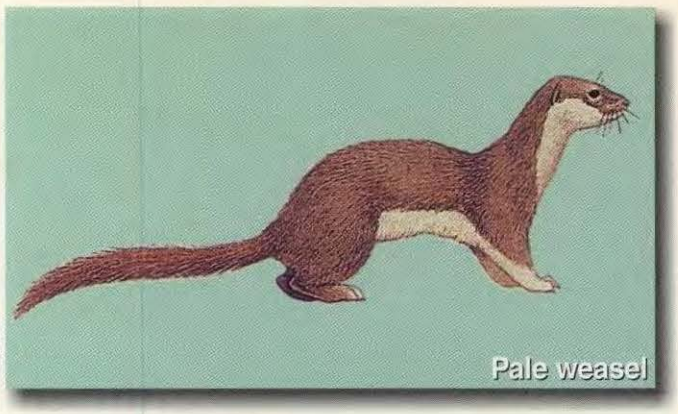
Yellow-throated marten


M.D. Madhusudan

Nilgiri marten


E. Dragesco/WWF

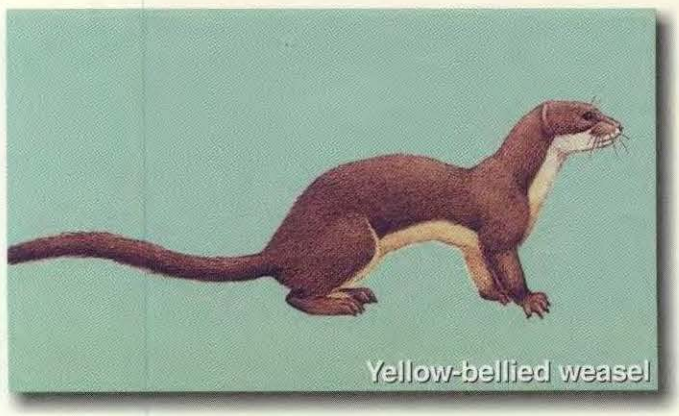
Ermine or stoat


BNHS

Pale weasel


BNHS

Siberian weasel


BNHS

Yellow-bellied weasel


BNHS

Back-striped weasel


Spotted linsang

BNHS


Spotted linsang (skin)

Suresh Kumar


Small Indian mongoose

Peter Jackson


Grey mongoose

Shomita Mukherjee


Ruddy mongoose

Yogesh Dubey


Brown mongoose

Divya Mudappa


Striped-necked mongoose

BNHS


Crab-eating mongoose

BNHS

RESULTS

Direct sightings

A total distance of about 800 km was walked covering all the survey sites. We had 18 sightings of eight species of small carnivores (Table 2). The animals sighted included the common mongoose, ruddy mongoose, stripe-necked mongoose, brown mongoose, common palm civet, small Indian civet, jungle cat and leopard cat. Of the 18 sightings, 12 were of mongoose.

Scat abundance

Overall scat abundance

About 800 km of transects were done in order to estimate the abundance of small carnivore scats in different sites and vegetation types. A total of about 500 scats were collected, and categorised as belonging to cats, civets, mongoose and Nilgiri marten. Of the total scats, those of civets formed 56.7%, followed by mongoose (20.5%), cats (16.6%) and marten (6.1%). Overall, civet scats were encountered at a rate of 0.47/km, compared to 0.17/km for mongoose, 0.14/km for cats, and 0.05/km for marten. It should be noted that marten is represented in the study area by only one species, compared to four species each in the other three families. The overall encounter rate of scats was 0.83/km, that of civets being the most abundant (0.47 scats/km), followed by mongoose (0.17 scats/km), cats (0.14 scats/km) and marten (0.05 scats/km) (Fig. 2).

A total of 800 km was walked during which 18 sightings were made of which 12 were of mongoose. Of the 500 scats collected during the survey those of civets formed 56.7%, mongoose 20.5%, cats 16.6% and marten 6.1%.

Scat abundance in various sites

a) Siruvani hills

Forests in Siruvani were surveyed during November and December 1994. Siruvani forest is very diverse, its vegetation types range from degraded scrub to disturbed wet evergreen forests. A total of 64.5 km of transect was done to estimate scat abundance in the various vegetation types. Out of 99 scats collected, 41 were of mongoose, 33 of civets and 25 of cats. Siruvani had an overall scat abundance of 1.54/km. Mongoose were the most abundant (0.64 scats/km), followed by civets (0.51 scats/km) and cats (0.39 scats/km). A total of 159 km was walked to get two sightings of common palm civet. The overall scat abundance was highest in the dry deciduous forest (2.78 scats/km), with high abundance of mongoose and cats. Wet evergreen forest stands next (1.63 scats/km), with most being contributed by civets. No scats were found in the teak plantations.

b) New Amarambalam Reserved Forests

Survey of New Amarambalam forests was done in January 1995. This area holds a large patch of wet evergreen forest. In the lower altitudes considerable amount of past human disturbance has transformed the vegetation to semi-evergreen. Small patches of natural moist deciduous forest remain in certain areas whereas the rest have been converted into teak and multi-species plantations. A total of

Table 2. Sightings of small carnivores during the survey of the Nilgiri Biosphere Reserve in 1994-95

Vegetation	Species (number)
Dry thorn forest & scrub	ruddy mongoose (3); jungle cat (1)
Dry & mixed deciduous	common mongoose (2); ruddy mongoose (1); stripe-necked mongoose (1); small Indian civet (2)
Moist deciduous	ruddy mongoose (1); common palm civet (2); stripe-necked mongoose (1)
Wet & semi-evergreen	brown mongoose (1); leopard cat (1)
Montane evergreen	stripe-necked mongoose (1)
Plantation	brown mongoose (1)

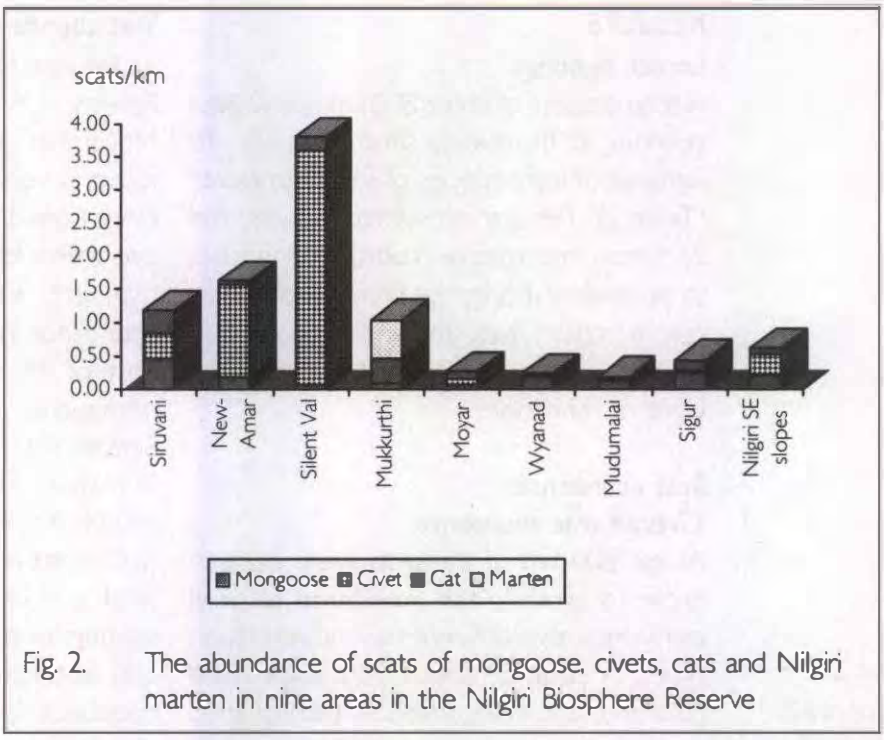


Fig. 2. The abundance of scats of mongoose, civets, cats and Nilgiri marten in nine areas in the Nilgiri Biosphere Reserve

Seven scats, probably of Nilgiri marten were found along the transects in the Mukkurthi NP, giving an abundance of 0.16 scats/km.

38.5 km of transect was done to estimate scat abundance, during which 67 scats were collected, with an overall abundance of 1.74 scats/km. Four scats were of mongoose, 61 of civets and two of cats. Civets were the most abundant (1.58 scats/km). A total of 66 km was walked to record direct sightings. Nothing was sighted while sampling, but one leopard cat was sighted near the campsite at Maancheri. The wet evergreen forests had the highest overall abundance (5.07 scats/km), contributed largely by civets (4.77 scats/km). The semi-evergreen also had a high abundance of civets (2.08 scats/km). Like Siruvani hills, no scats were found in the teak plantations.

c) Silent Valley National Park

Silent Valley National Park was surveyed in March 1995. It is known for its vast stretch of relatively undisturbed wet evergreen forest. Along with this, sampling was also done in the grasslands of the hill tops. A total of 35.75 km of transect was done to estimate scat abundance and 136 scats were collected, with an overall abundance of 3.80 scats/km. A total of 84 km were walked to record direct sightings with one sighting of a brown mongoose. Civets were by far most abundant in this area (3.55 scats/km), while cats (0.20 scats/km) and mongoose (0.06 scats/km) were rare. The grasslands have very similar species composition as the dominant wet evergreen forests, with civets being the most abundant. But, the interesting finding here is the frequent presence of cat scats (0.67 scats/km), in contrast to wet evergreen forest (0.07 scats/km).

d) Mukkurthi National Park

Mukkurthi National Park was surveyed in March 1995. This is situated in the upper Nilgiri plateau at an altitude of above 2000 m. It has the unique montane evergreen forest and grass land community - the shola-grasslands. The evergreen forest is found in the valleys and the folds of rolling hills, and the grasslands in the hilltops. Generally this is considered as a single community of forests and grassland, due to a high interspersion of both, and having remained as a climax community since long. In the fringes of the National Park and in the surrounding reserve forests, there are plantations of wattle.

A total of 43 km of transect was done to estimate scat abundance. Scat abundance

was generally low with an overall abundance of 1.28 scats/km. This can be explained by the absence of signs of civets in the sampled area, which generally accounts for the major part of scats in other survey sites. In total 55 scats were collected, with three scats of mongoose and 45 of cats with an abundance of 0.07 and 1.05 scats/km respectively. Cats were thus the most abundant species in this area. The interesting finding here is the presence of Nilgiri marten (not seen, but reported by others). Seven scats, probably of this species, were found along the transects, giving an abundance of 0.16 scats/km. The unusual greater abundance of cat scats may be due to the difficulties in distinguishing these with those of the jackals, which is common in this area. A total of 92.5 km was walked to record direct sightings with one sighting each of brown and stripe-necked mongoose. The shola-grasslands had an overall abundance of 1.41/km, and the wattle plantation 0.96. Cats were the most abundant. All the animals had a higher abundance in shola-grasslands than in plantations. The high abundance of scats in plantations may be due to two reasons: either interspersion of plantations with natural habitats, or misidentification with jackal scats, which were common in plantations.

The high abundance of scats in plantations may be due to interspersion of plantations with natural habitats.

e) Moyar Valley Reserved Forest

The reserved forests in Moyar valley were surveyed, covering 50 km for estimating scat abundance and 69 km for direct sightings. Only one vegetation type, the dry thorn forest, was surveyed here. The abundance of scats was relatively low (0.26 scats/km), with those of cats being the most abundant (0.12 scats/km). There was only one sighting of a ruddy mongoose.

f) Wayanad Wildlife Sanctuary

A total of 63 km were surveyed in this Sanctuary for estimating scat abundance, and 81 km for direct sightings. Three vegetation types were surveyed. Overall abundance was low (0.22 scats/km), those of mongoose being the most abundant (0.16 scats/km). Among the three vegetation types, the dry deciduous forest had the highest abundance (0.4 scats/km), especially for mongoose (0.32 scats/km). The abundance of scats in the moist deciduous forest and teak plantations was very low (0.08 and 0.11 scats/km respectively). Even though 81 km was covered for direct sighting, no small carnivore was seen.

g) Mudumalai Wildlife Sanctuary

This Sanctuary has several vegetation types of which scrub forest, dry deciduous forest, moist deciduous forest and plantations were included in the survey, which covered 105 km for estimation of scat abundance and 111 km for direct sightings. The abundance of scats, for all vegetation types together was low (0.18 scats/km), mongoose scats being the most abundant (0.1 scats/km). The scrub forest had the highest abundance (0.42 scats/km), both mongoose and cats being equally abundant (0.18 scats/km each). No scats were seen in 4 km of transects in the teak plantations. There were four sightings of small carnivores, one each of ruddy mongoose, jungle cat, stripe-necked mongoose, and small Indian civet.

h) Sigur Reserved Forest

The reserved forests in Sigur plateau were surveyed for a total of 52 km for estimating scat abundance, and 73 km for direct sightings. Scrub forests covered the entire area. The overall scat abundance was 0.42 scats/km, that of mongoose being the most abundant (0.25 scats/km) followed by cats (0.15 scats/km) and civets (0.02 scats/km). There was only one sighting, that of a ruddy mongoose.

i) Nilgiri southeast Reserved Forest

The mixed deciduous forests in Pillur were surveyed for a total distance of 45 km for estimating scat abundance, and 67 km for direct sightings. The overall abundance was 0.65 scats/km, civets being the most abundant (0.33 scats/km) followed by

mongoose (0.2 scats/km) and cats (0.07 scats/km). Two common mongoose were sighted.

Comparison among sites

There were considerable differences in the abundance of scats among the sites surveyed. It was highest in Silent Valley National Park (3.81 scats/km) followed by New Amarambalam (1.61 scats/km), and least in Mudumalai Wildlife Sanctuary (0.18 scats/km) and Wayanad Wildlife Sanctuary (0.22 scats/km). There were also considerable differences among the sites in the abundance of scats of the four taxa. Thus, in the more moist forests in Silent Valley National Park and New Amarambalam Reserved Forests civet scats were the most abundant (3.55 and 1.4 scats/km respectively), whereas in the drier Wayanad Wildlife Sanctuary, Mudumalai Wildlife Sanctuary and Sigur Reserved Forests mongoose scats were most abundant (0.16, 0.10 and 0.25 scats/km respectively). In the high altitude Mukkurthi National Park the abundance of Nilgiri marten scat was 0.16 scats/km. It was the only site from where scats of Nilgiri marten were recorded. In contrast to civets, mongoose and marten showed considerable differences among the sites. The lesser cat scats were more or less equally abundant in all sites. In some sites (Siruvani Hills, Moyar Valley and Pillur Reserved Forests) the scats of mongoose, lesser cats, and civets were more or less equally abundant, while that of Nilgiri marten were absent. The above differences among the nine sites were by and large due to differences in the major vegetation or habitat types among them to which the small carnivores seemed to be sensitive. In Silent Valley and New Amarambalam the vegetation is mostly wet evergreen forest, in Mukkurthi it is shola-grassland, in Siruvani Hills dry and moist deciduous forests, and in other areas mostly dry deciduous (Wayanad, Mudumalai and Pillur) or thorn and scrub forests (Sigur and Moyar Valley).

The abundance of scats was highest in Silent valley NP, followed by New Amarambalam RF and least in Mudumalai and Wayanad Wildlife Sanctuaries. According to vegetation types, wet and semi-evergreen forest had the highest abundance of scats, with about 53.8% of the total number of scats.

Factors affecting scat abundance

Vegetation type

Nine different vegetation or habitat types (including plantations), which were surveyed for scat abundance, were grouped into six vegetation types by pooling the similar ones, e.g. thorn and scrub forests. Data from

Table 3. The abundance of scats (no./km) of mongoose, civets, cats and marten in six vegetation categories that were surveyed in the Nilgiri Biosphere Reserve. Number of scats is given in parenthesis.

Vegetation type	Transects (Km.)	Mongoose	Civets	Cats	Marten	Total
Dry thorn forest & scrub	118	0.16	0.06	0.14	0	0.36 (43)
Dry & mixed deciduous	129	0.19	0.14	0.05	0	0.38 (48)
Moist deciduous	90	0.28	0.12	0.18	0	0.58 (52)
Wet & semi-evergreen	79	0.15	2.46	0.17	0	2.78 (220)
Montane evergreen (shola-grassland)	31	0.07	0	1.20	0.20	1.48 (46)
Plantation	47	0.02	0.04	0.06	0.02	0.15 (7)
Mean		0.17 (84)	0.47 (232)	0.30 (92)	0.04 (7)	

various survey sites were pooled to estimate scat abundance in different vegetation types (Table 3).

Wet and semi-evergreen forest had the highest abundance of scats, with about 53.8% of the total number of scats. Moist deciduous forests had 12.7% of the scats, followed by dry and mixed deciduous forests (11.7%), dry thorn and scrub forests (10.5%), montane shola-grasslands (9.5%) and plantations (1.7%). Mongoose were the most abundant in the drier forests, civets in the wet evergreen and marten in montane forests and wattle plantations. Cats were almost equally abundant in all forest types. Plantations had very low abundance of all the taxa.

There was a significant difference in the distribution of scats of the various taxa with reference to the distance from water. Civet scats were found closer to water than those of cats or mongoose.

Wet and semi-evergreen forests had the greatest abundance of scats (2.78 scats/km) among the different vegetation types, followed by montane shola-grassland (1.48 scats/km), moist and dry deciduous forests (0.38 scats/km), dry thorn and scrub forests (0.36 scats/km) and plantations (0.15 scats/km). There were differences among the vegetation types in the abundance of various species groups. In the wet and semi-evergreen forests, civets were the most abundant (2.46 scats/km). In the shola-grassland, cats were the most abundant (1.20 scats/km) followed by marten (0.20 scats/km). In the moist, dry and mixed deciduous forests, mongoose were the most abundant (0.19 scats/km), followed by civets and cats. In the dry thorn and scrub forests mongoose were the most abundant followed by cats.

Altitude

Sampling effort was highest in 400-1200 msl, and most of the scats were collected from this altitude class (Fig. 3). All Nilgiri marten scats were collected from above 2000 m. Where as mongoose and cat scats were found above 2000 m, those of civets were not. Mongoose scats were found from all altitude classes, unlike the other taxa. Overall, there was a significant difference in the distribution of scats of the four taxa with reference to altitude (X^2=263.4, df=9, $p<0.001$), but this was because the marten was found only in the higher altitudes.

Proximity to water

Apart from being sources of water, streams and other water bodies are also the sources of food (fishes, amphibians, invertebrates) to small carnivores. Fruit abundance is also greater along riparian forests, especially in dry forests. There was a significant difference in the distribution of scats of the various taxa with reference to the distance from water (X^2=101.1, df=9, $p<0.001$). While civet scats were found closer to water (nearly 80% within 200 m), those of cats were found farther (nearly 75% more than 200 m away, (Fig. 4). Mongoose scats were mostly at medium distance from water (nearly 75% at 100-500 m), while those of marten were found equally at all distance classes. This difference among species persisted even when the analysis was done for each vegetation type separately.

Disturbance

The extent of habitat disturbance at each scat location was grouped into three classes (low, moderate and high) for analysis. Disturbance was estimated in the field taking into consideration disturbance to the vegetation around the site from which scat was collected, distance to the nearest village, presence of cattle dung *etc.* The effect of disturbance was also evaluated with reference to canopy cover and weed cover. Overall, there was a significant difference in the distribution of scats of various taxa with reference to the three disturbance categories (X^2=68.0, df=6, $p<0.001$). Most of the civet (72.4%) and marten (79.2%) scats were found in the low disturbance areas, whereas those of the cats (54.4%) and mongoose (54.1%) were found in moderately disturbed areas (Fig. 5). In the highly disturbed areas scats of mongoose were more abundant than that of the other species.

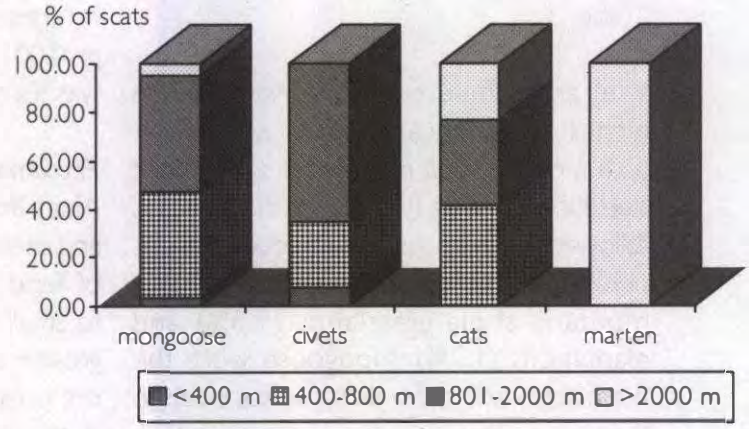


Fig. 3. The percentage of scats of mongoose, civets, cats and martens found in four different altitude classes.

The civets and martens scats were found in the low disturbance areas, whereas those of the cats and mongoose were found in moderately disturbed areas. In the highly disturbed areas scats of mongoose were more abundant than other species.

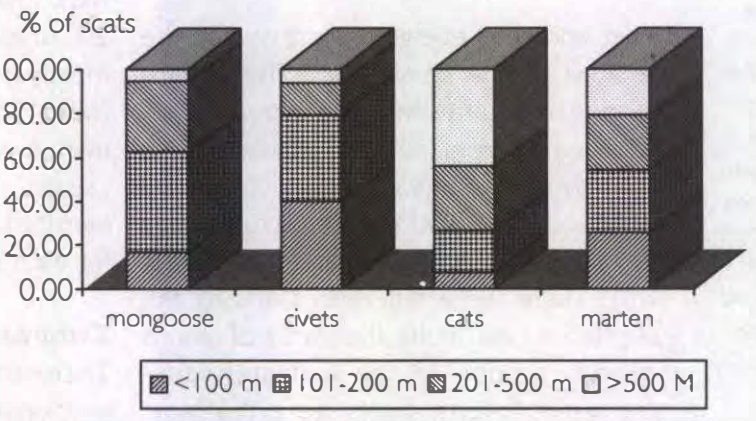


Fig. 4. The percentage of scats of mongoose, civets, cats and martens found in four distance classes of water.

Canopy cover

Canopy cover varies among vegetation types (e.g. between wet evergreen and dry deciduous), but within each it is a good indicator of human disturbance (Fig. 6a). When all the vegetation types were combined, there was a significant difference in the distribution of scats with reference to canopy cover (X^2=63.7, df=12, p<0.001). Cat scats and, to a lesser extent, mongoose scats were more in the low canopy cover areas compared to civet scats which were more common in the high canopy cover areas. Scats of the Nilgiri marten, found only in the shola-grasslands, were also more common in the low canopy cover areas. An analysis of the effect of canopy cover in each vegetation type separately, however, gave mixed results. In the wet evergreen forests and associated forests, civets scats were most abundant and in moist deciduous and scrub forests the above results were repeated; civet scats were more abundant in sites with high canopy cover, while cat and mongoose scats were more common in the low canopy cover sites. However, in the dry and mixed deciduous forests civet scats were equally distributed while cat and mongoose scats were more in the high canopy cover areas.

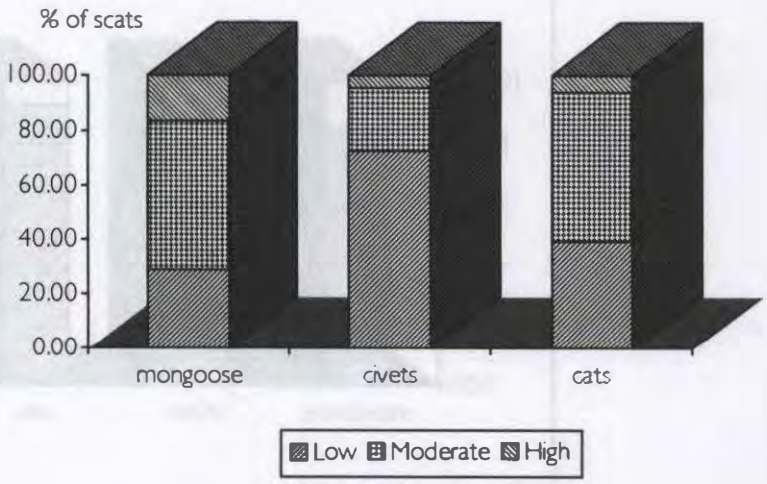


Fig. 5. The percentage of scats of mongoose, civets, cats and martens found in three disturbance classes.

The scats of all taxa were more common in the low weed cover areas. However, scats of civets were relatively less in high weed cover areas compared to cats and mongoose.

Weed cover

The distribution of scats differed significantly with reference to weed cover (Fig. 6b). The scats of all taxa were more common in the low weed cover areas. However, scats of civets were relatively less in high weed cover areas compared to cats and mongoose.

DISCUSSION

The survey results based on scats are constrained by the tentative identification of the scats. Personal observation shows that there is a large scope for misidentification of scats of cats and mongoose. Another constraint was that the relative abundance of scats in an area is assumed to be indicative of the abundance of animals. The defecation behaviour of the various groups of animals is largely unknown and the rates of defecation, sites of scat-marking, communication system and other characters may vary among the different groups. The results of this survey should be viewed bearing these constraints in mind.

The distribution of scats shows considerable variation among sites and altitude, primarily because of the variation in vegetation types. There are few reports of other similar community studies. Using track plots, Mukherjee (1998) found that jungle cats in Sariska Tiger Reserve used dense scrub forests more than hill forests, open scrub forests and grasslands. In Huai Kha Wildlife Sanctuary in Thailand, civets used the dry evergreen and mixed deciduous forests over dry deciduous forests (Rabinowitz 1991). Greater abundance of civet scats in the wet evergreen forests and in areas with greater canopy cover in all vegetation types is not surprising since civets, especially palm civets, are to a large extent frugivorous and also adapted for arboreal life. It is also true that southeast Asia, where closed forest is the primary habitat, was a major centre of speciation in the case of civets. In contrast, the arid areas in Africa have been the major centre of radiation in the case of mongoose. Mongoose in India are also primarily adapted to drier forests and hence the greater abundance of their scats in such forests. However, the sub-specific endemics of the Western Ghats (the stripe-necked mongoose and brown mongoose)

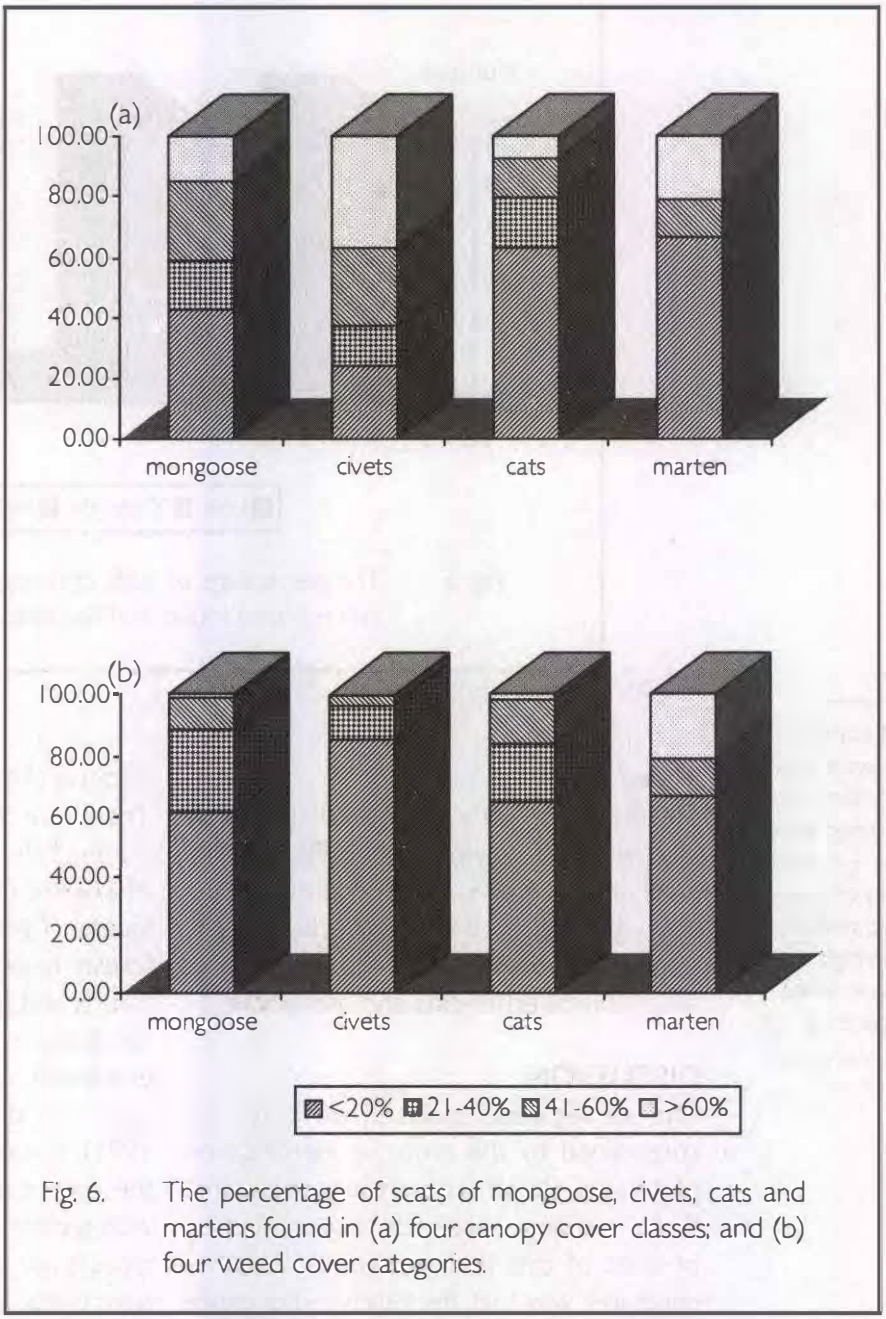


Fig. 6. The percentage of scats of mongoose, civets, cats and martens found in (a) four canopy cover classes; and (b) four weed cover categories.

The sub-specific endemics of the Western Ghats (e.g. stripe-necked mongoose and brown mongoose) are both absent from the drier parts of the Western Ghats.

are both absent from the drier parts of the Western Ghats. The brown mongoose has not been, in fact, reported from vegetation types other than wet and semi-evergreen forests, even though the sub-species in Sri Lanka is frequently seen in tea estates (Prater 1971). Stripe-necked mongoose has been reported from wet and semi-evergreen and dry deciduous forests especially near water bodies. Lesser cats are known to occur in low densities compared to other small carnivores, but more ubiquitous.

The very low abundance of small carnivores in plantations should be a matter of concern. High abundance of large herbivores such as gaur and sambar has been reported from teak plantations (Karanth 1993). Thus, small carnivores are far more adversely affected by habitat conversion than the larger mammals. The primary reason would be low

diversity of the fruiting trees, invertebrates and rodents in the plantations.

The survey shows considerable variation among the taxa in their tolerance to habitat degradation and other forms of human disturbance. Civets seem to be most adversely affected, primarily because of their dependence on tree cover. This might be particularly true for palm civets which are primarily frugivorous. In contrast, mongoose and cats can not only tolerate but might even increase in abundance following moderate disturbance. Scats of both taxa are more abundant than that of civets in areas with low canopy cover and weed cover. Both these taxa are more carnivorous than civets, and might benefit from increased abundance of invertebrates and rodents owing to moderate habitat disturbance. Increased abundance of rodents following habitat fragmentation and disturbance has been reported from the Western Ghats (Kumar *et al.* 1998).

The small carnivores are far more adversely affected by habitat conversion than the large mammals. The primary reason would be the low diversity of fruiting trees, invertebrates and rodents in the plantations.

The above analysis and conclusions are based on scats identified only up to the family level. There might be considerable differences among the species within the family which we are unable to examine at present owing to the problems of identification of scats up to species level. Such differences might include habitat preferences as well as response to disturbance. For example, among civet there are clear differences between species at the subfamily level. Of the two species of palm civets (Subfamily: Paradoxurinae), the common palm civet is most like to be confined to the drier forests whereas the brown palm civet seems to be mostly confined to the wet-evergreen and semi-evergreen forests (Ashraf *et al.* 1993). These two species are therefore parapatric rather than sympatric.

Similarly, of the two true civets (Subfamily: Viverrinae) the highly endangered Malabar civet is most likely restricted to the forests of the foothills, while the small Indian civet also occurs in the Western Ghats proper. Sympatry between these two is most likely restricted to the foothills. Between common palm and small Indian civets there could be differences in their uses of areas with varying canopy cover. Mongoose also showed a similar difference in habitat preference. The common Indian mongoose and ruddy mongoose are sympatric throughout Western Ghats, and even central India, but restricted to the drier and more open forest. In contrast, the brown and stripe-necked mongoose were restricted to the more moist and closed forests. The pattern of habitat selection among the small cats is less known. However, all the four species reported to occur in the Western Ghats are widely distributed in the Indian subcontinent. The jungle cat is known to be tolerant of disturbance and human presence, and might even benefit from it due to increased abundance of rodents which are their major diet (Mukherjee 1998). The fishing cat is highly dependent on water bodies and thus, even though widely distributed, might be a microhabitat specialist. Nothing much is known about habitat preferences of the leopard cat and rusty spotted cat, except that both are widely distributed and have been reported to occur in dry as well as moist forests.

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