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INDIRECT EVIDENCES OF WILDLIFE ACTIVITIES IN SHOLAS OF WESTERN GHATS, A BIODIVERSITY HOTSPOT

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Indirect Evidences of Wildlife Activities in Shoals of Western Ghats, a Biodiversity Hotspots. Jain Manjari, Singha Roy Utpal, Mukhopadhyay S. K. — The presence of wildlife fauna and its activities were ascertained with the density of the scat, dung and other markings or droppings of the wildlife abode therein. Attempt was made to find out spatial differences in the activities of the wildlife populations and to comment on the abundance of different preys and predators within shola forests of Western Ghat hill forests, a Biodiversity hotspot in India. An indirect sampling method, Transect Count Method, was employed to count dung/pellet group/scat and other markings in that area. Pachyderms were found to be mostly dominant in Varagaliar and Punnumala shola patches while scats of all the three important predators, viz., tiger (*Panthera tigris tigris*), Indian wild dog (*Cuon alpinus*) and leopard (*Panthera pardus*) were encountered only in Varagaliar shola. Greater abundance was recorded from Indira Gandhi Wildlife Sanctuary than Silent Valley National Park may be because of the restriction of animal movements in the former due to topographical barriers and its existence as isolated shola patches that led to a greater concentration of wild fauna in a relatively segregated forest cover.

Key words: scat, shola, hotspot, topographical barriers, tribal settlements, Western Ghats.

Косвенные доказательства жизнедеятельности диких животных в лесах шола* Западных Гат, точке наибольшего биоразнообразия. Джайн Манджари, Сингха Рой Утпал, Мукхопадхиаи С. К.** — Присутствие организмов в природной среде и их жизнедеятельность были установлены по плотности распределения экскрементов и других меток животных в исследованных местах. Были сделаны попытки найти отличия в жизнедеятельности популяций диких животных, и прокомментировать многообразие хищников и их жертв в лесах шола, местах наибольшего биоразнообразия в Индии. Метод косвенных образцов и метод трансектного подсчета были использованы для подсчета экскрементов/погадок и других меток в исследуемом регионе. Установлено, что на небольших участках земли в шола Варагалиар и Пуннумала доминируют толстокожие, тогда как экскременты хищников — тигра (*Panthera tigris tigris*), красного волка (*Cuon alpinus*) и леопарда (*Panthera pardus*) — были случайно обнаружены только в шола Варагалиар. Значительно большее количество было зарегистрировано в Заповеднике дикой природы им. Индиры Ганди по сравнению с Национальным парком «Тихая Долина», возможно, из-за ограничения миграций животных топографическими барьерами в прошлом, что привело к большей концентрации дикой фауны в относительно обособленном лесу.

Ключевые слова: экскременты, шола, горячая точка, топографические барьеры, племенные поселения, Западные Гаты.

Introduction

Since British Raj, thousands of hectares of rich virgin forestlands of Western Ghat region have been cleared off for timber harvesting, coffee or spices plantation, or to accommodate tea gardens in the pristine

* Шола — дождевые леса Западных Гат.
** Западные Гаты — горная цепь на западе Индостана.

rain-forested and undulating grassland areas. Later, the pressure of growing population and the demand of civilization have further decimated the jungle of these regions. Unspoiled shola patches of the Western Ghats attract numerous national and international tourists throughout the year that put a lot of pressure on the ecosystem. Numbers of tribal settlements that circumscribe some of the shola patches also exert anthropogenic pressures. However, this region harbours varied forest types and such variation in the vegetation provides a home for a number of endemic species of flora and fauna. Precipitation (about 600–6000 mm; Venkatesh et al., 2009), topography, and temperature combine to influence the unique flora and fauna across this ecoregion. Hilly terrains covered by wet evergreen biotope, in most cases are very difficult to approach and even if such areas are approached, it is extremely difficult to locate animals to work on population densities and prey-predator interactions. But many of these declare their presence by way of indirect evidences like tracks, footprints, droppings, gnaw-marks on the barks of trees, scratches on trees and burrows (Seber, 1982; Stokes and Stokes, 1986; Boyce, 1988). In principle, it is possible to distinguish scat/dung/pellets of the major herbivores and carnivores of the area studied by the size and shape of it and thus species specific scat/dung/pellet count can be made (Jayson and Esa, 1997; Davison et al., 2002). Use of indirect evidences in population density estimation and in determining prey-predator relations have been emphasized globally (Collins, 1981; Putman, 1984; Marques et al., 2001). Recently such indirect evidences from Indian forests have been used to study the population density, prey-predator relations and diet habits (Karanth and Sunquist, 1995; Jathanna et al., 2003; Kushwaha et al., 2004; Bargali et al., 2004 and Reddy et al., 2004). The present work uses indirect evidences as an important field tool to ascertain the relative abundance of prey and predator and their activity in the selected shola forest areas under varied human interferences so that the conservation priorities could be ascertained for these isolated shola patches.

Study areas

The studies were made in shola and semi-evergreen forest patches of three different Wildlife Sanctuaries and National Parks of Tamil Nadu and Kerala between January 11 and February 02, 2002. The location codes, along with latitudes, longitudes, forest types and human activities are given below:

Indira Gandhi Wildlife Sanctuary (IGWLS), Tamil Nadu: Lat. 10°12.5'—11°7' N, Long. 76°—77° 56.5' E, covers an area of 958 km^2; Observations were made at the edges of Karian Shola and Varagaliar Shola; anthropogenic interferences mainly at Karian Shola through tourists, vegetation alterations, and Varagaliar Shola through tribal settlements and activities in relation to elephant training camp.

Silent Valley National Park (SVNP), Kerala: Lat. 11°4'–11°13' N, Long. 76°24'–76°29' E, covers an area of 90 km^2; Observations were made at the edge of Punnumala Shola; barring a light tourist activities, relatively little anthropogenic interferences.

Materials and methods

Direct count methods for estimating population size (Coughley, 1977; Roth, 1982), such as aerial counts or vantage point counts, can provide accurate estimates of abundance, but such methods are only applicable in more open ground areas where the animals can be easily seen. However in thick woodland areas, indirect count methods based on faecal pellet counts are preferred. Currently two indirect count methods are popular to woodland wildlife populations, namely the "clearance plot method" which is based on the number of pellet groups deposited within an area that was initially cleared of all pellets and the "standing crop method" in which all pellet groups within some previously defined area are counted (Putman, 1984; Kohn, 1997).

An alternative approach, which is likely to reduce any bias and improve the precision of abundance estimates, is the use of belt transects method for quantification of pellets. Such method was employed in the present study with a slight modification in counting the pellets which has been alternatively named as Transect Count Method. This method involves following a transect track of a particular length (5 — 10 km for each trek) and width (1–5 m on either side, depending on visibility). Along the track the first dropping/pellet is identified and the distance of the scat encountered from the starting point is recorded with the help of the pedometer. Similarly as the second scat is encountered its distance is recorded again. This process is followed throughout the transect length. On reaching the stipulated distance, we start walking back along the same path, again taking in account the droppings (new ones) encountered. But the question remains, how do we know that the droppings encountered on our trip back are fresh ones and not those previously recorded? This is where the transect count method comes handy (Anderson et al., 1979). As we move back along the same path we neglect all the droppings noticed at previously recorded distances and take into accounts those that were not recorded earlier. This method is followed till the starting point is reached. At each study location three pairs of survey treks were made through randomly chosen path to cover a distance of 8–10 km for each trek with a sighting detection limit of 1m on either side. The camp was taken as the base point. Trek routes were chosen for the survey involving all possible habitat types that included rocky beds of hill streams, grassland patches, forest edges, forest areas with thin canopy cover and dense forest areas with closed canopy cover. These treks were made between 10.30 a. m. to 5.30 p. m. A Casio (Japan) pedometer was used to measure the trekking distance. The pedometer was used to record the specific distance of each scat encountered in up and down journey through the transect line to avoid double counting of the same scat, and later the total scat/dung counted within a belt width of 2 m for the total transect length was calculated and represented per square km basis.

Statistical analyses were made using *Statistica* for Windows, Version 5.1A, Statsoft Inc., USA, 1996, and SPSS 13.0, SPSS Inc.

Results

Site-wise animal dropping and/or marking abundance are depicted in table 1. Leopard droppings were observed in high numbers in Varagaliar while least seen in Punnumala shola. Tiger (*P. tigris tigris*) and leopard (*P. pardus*) scats were encountered only in Varagaliar shola. Scats of another major predator species of that area, Indian wild dog (dhole) (*C. alpinus*), were observed in higher number in Varagaliar; however, their presence was also noticed in Punnumala shola. Though the scats of dholes were not encountered in Karian shola, their pugmarks were observed around different water bodies inside Karian shola. Likewise, leopard pugmarks were observed in Karian shola while leopard cat pugmarks were observed in Punnumala shola. As the scats of tiger were abundant in Varagaliar, the pugmark as well as their scratch marks was also noted there in a number of occasions.

The prey population was dominated by wild boar (*Sus scrofa*) in Karian shola, while both in Varagaliar and Punnumala sholas, gaur (*Bos gaurus*), porcupine (*Hystrix indica*) and sambar (*Rusa unicolor*) formed the major diversity of prey species. Both in Varagaliar and Punnumala shola, dominant presence of pachyderms were attested by the frequent encounter of their dung piles. Deer groups were mainly represented by chital (*Axis axis*) and sambar. Sighting of both chital and sambar and their pellet-groups were observed in Karian shola. However, both these deer were neither seen and their pellet groups were encountered in Varagaliar and Punnumala shola. Though bear droppings were spotted in all three shola forests, the maximum number of droppings was seen in Varagaliar. Black-naped hare (*Lepus nigricollis*) alone represented lagomorphs and its pellets were found in Karian shola and Varagaliar shola. Civet cat (*Viverricula indica*) droppings were observed both in Karian and Varagaliar sholas. Nilgiri langur (*Trachypithecus johnii*) droppings were observed in all the three sites. The exact species could be ascertained, as the major primate species in these forests are nilgiri langur and lion tailed macaque (*Macaca silenus*), and both have very contrasting faecal characteristics (Jayson, Esa, 1997). Eurasian eagle owl (*Bubo bubo*) droppings and their feath-

Table 1. Site-wise animal dropping and/or marking abundance (nos. per 0.02 km^2)

Таблица 1. Плотность распределения экскрементов и/или других меток по их местонахождению (на 0,02 км^2)

Animal Droppings	Karian shola	Varagaliar shola	Punnumala shola
Leopard (*Panthera pardus*)	5.00	6.00	3.00
Tiger (*Panthera tigris tigris*)	0.00	12.00	0.00
Sloth Bear (*Melurses ursinus*)	7.00	12.00	4.00
Dhole (*Cuon alpinus*)	0.00	8.00	2.00
Leopard Cat (*Felis bengalensis*)	0.00	3.00	0.00
Eurasian Eagle Owl (*Bubo bubo*)	2.00	0.00	0.00
Elephant (*Elephas maximus*)	5.00	40.00	34.00
Chital (*Axis axis*)	2.00	0.00	0.00
Sambar (*Rusa unicolor*)	2.00	0.00	2.00
Black Naped Hare (*Lepus nigricollis*)	2.00	2.00	0.00
Nilgiri langur (*Trachypithecus johnii*)	4.00	5.00	6.00
Lesser oriental Civet (*Viverricula indica*)	4.00	3.00	0.00
Gaur (*Bos gaurus*)	4.00	11.00	0.00
Porcupine (*Hystrix indica*)	2.00	14.00	0.00
Wild Boar (*Sus scrofa*)	18.00	0.00	0.00

Table 2. Different diversity indices to comment on the community structure on the basis of availability of animal droppings and markings found in the study sites

Таблица 2. Различные индексы разнообразия структуры сообществ на основе доступности экскрементов и отметок животных, обнаруженных в исследуемых местах

	Karian shola	Varagaliar shola	Punnumala shola
Shannon-Wiener Species Diversity Index	1.982	2.047	1.142
Pielou's Evenness Index	0.798	0.431	0.637
Margalef's Richness Index	2.721	2.104	1.272
Simpson's Dominance Index	1.151	0.264	0.471
	Between KS and Vs	Between KS and Ps	Between VS and Ps
Sorensen Similarity Index	0.410	0.357	0.370

ers were observed in Karian shola. In many places (especially along the hill-streams) half eaten crab-shells were observed in Varagaliar.

Site-wise variations in dominance, diversity, evenness, richness and other indices of community structure are given in table 2. Shannon-Wiener species diversity index (H') was almost similar in Karian shola (1.982) and Varagaliar shola (2.047). Much lower value of 1.142 was calculated from Punnumala shola. Pielou's index of evenness (J') was the highest in Karian shola (0.798) and lowest in Varagaliar shola (0.431). Simpson-Yule's dominance index (D_{SIMP}), which is also based on proportional abundance like H', showed quite contrasting values to those for H'. Maximum D_{SIMP} value was found in Punnumala shola (0.471) indicating maximum dominance as the spot was having minimum diversity as reflected by the H' value. Opposite was the situation for Karian shola where dominance was minimum (0.151) while diversity was nearly highest. Although both Shannon measures and Simpson-Yule's index consider the proportional abundance of all the species, but H' is more sensitive to rare species, whereas D_{SIMP} puts emphasis on the common species. Therefore, these indices point out the occurrence of many rare species in Karian shola reflecting lower dominance while the reverse situation is evident in Punnumala shola. Margalef's richness index (D_{MARG}), which considers both abundance and species numbers, also attests the situation, as the values were 2.721 in Karian shola and 1.272 in Punnumala shola. When comparison between sites was made by using quantitative presence-absence type *Sorensen similarity index* (S_i), Karian shola and Varagaliar shola showed maximum similarity ($S_i = 0.410$) followed by Varagaliar shola and Punnumala shola ($S_i = 0.370$) and lastly between Karian shola and Punnumala shola ($S_i = 0.357$). The interrelationship between the different indices is also calculated basing on Pearson Correlation Coefficient values. Significant negative correlation ($p < 0.01$) was observed between dominance and diversity indices ($r =\ 0.91$) and dominance versus richness indices ($r =\ 0.99$), while significant positive correlation between richness and general diversity ($r = 0.88$; $p < 0.01$). Dendrogram showing the distance between the study sites depicts the similar picture (fig. 1). Simpson-Yule dominance index also support the evenness components of the study site. Hierarchical cluster analyses of the site characteristics when plotted in

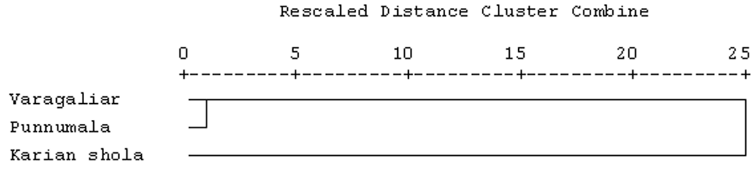

Fig. 1. Cluster Analysis plotted in Dendrogram to show the similarities in respect to animal activities

Рис. 1 Кластерный анализ, выраженный в дендрограмме, показывающий сходство в отношении деятельности животных

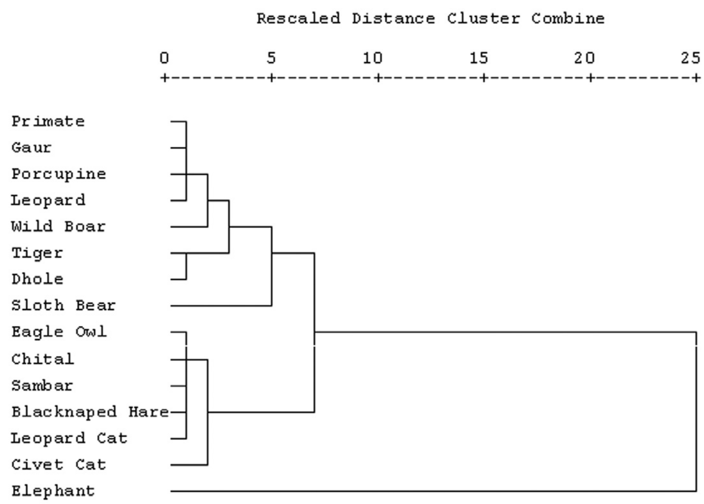

Fig. 2. Cluster analysis plotted in dendrogram to show the animal groupings in respect to the indirect evidences observed at the study locations.

Рис. 2. Кластерный анализ, выраженный в дендрограмме, показывающий группирование животных в отношении косвенных доказательств, наблюдаемых в исследованных точках.

dendrogram, based on the species-wise abundance of indirect evidences, three distinct clusters were identified. Maximum cluster distance of elephant with the other two clusters was evident reflecting the frequency of the elephant dung encountered in the study areas (fig. 2). Likewise, when the predator scat abundance of the study sites was clustered together, three different clusters were evident showing the preference of the tiger, leopard and dhole for open forest trail and rocky patches as their defecation sites.

In the present study Sorensen index values have pointed out that the maximum similarity was between the community structures of the areas surveyed inside Karian shola and Varagaliar shola and least between Karian shola and Punnumala shola. It may be pointed out that Karian shola samples contained the droppings of 12 species and Varagaliar shola of 11 species while the Punnumala shola had only 6 species. Both Karian shola and Vargaliar shola had comparable diversity while much less was recorded from Punnumala shola. Likewise, Peilou's evenness index values reflected that the component species was much more even at Karian shola followed by Punnumala shola and then Varagaliar shola. At Karian shola total importance value of 57 was distributed within 12 species while 116 within 11 species at Varagaliar shola and 51 within 6 species at Punnumala shola. Whatever may be the sampling error as regard to reflect the real picture of community structure of the study sites, evenness index values clearly indicate that single species dominance (by elephant) and 2-species dominance (by elephant and tiger) at Punnumala shola and Varagaliar shola respectively lowered the index values compared to Karian shola where almost all (except the wild boar) the 12 species were evenly represented.

Discussion

The trekking paths were selected as unbiased as possible, albeit certain crucial questions could be raised from the findings made during the present investigation. How come the droppings of the arboreal animals were so less in number in the samples? Or why the prey animals were much less represented by their droppings than the predators did? Incidentally, a large section of the trek was along the rocky bed of hill-stream. The rocky topography of the path, limited the spoor mark record, which could otherwise be encountered in large numbers if the trek paths selected were muddy or sandy. Again, along the hill stream areas the vegetation cover was of course thinner. Due to the lesser canopy cover along the strip transects, the droppings of primates were lesser in number, although abundant primate species were spotted in the canopy areas away from the strip.

During the trek the scat count was surprisingly higher than the dung/pellets. This can be attributed to the absence of grassland patches in the trekking path, which are usually frequented by herbivores. Also the path selected seems to be along the predator frequented areas resulting in higher recording of scats than that of dung/pellets. A matrix of several different vegetation associations, under different levels of habitat modification, was observed to proximately influence the co-existence of prey and predator (Mukherjee, 1998). The dendrogram plotted on the basis of abundance of indirect evidences (fig. 2) also suggested a sort of prey-predator dependence. Tiger, leopard, dhole, primates, gaur, wild boar and porcupine in one cluster could suggest the prey preference of the predators. Tiger scat analysis made by Reddy et al. (2004), revealed that wild boar (*Sus scrofa*) was the most common prey followed by chital (*Axis axis*) and sambar (*Rusa unicolor*). In a detailed study Bargali et al. (2004) reported that the plant matter was greater than animal matter in bear scats in all seasons and moreover, the presence of crop remains in the scat during the monsoon suggested their crop dependence, thereby increasing chances of human–bear conflict. Interestingly, very high bear scat and markings were noted from Varagaliar shola, which was bordered by the tribal settlements. However, from Varagaliar shola no such conflict was reported, as cultivation was not allowed in the concerned area.

Although the trekking distance in the three-shola patches were standardised before the calculation and analyses of the results, higher numbers of animal droppings and markings were observed in Karian shola and Varagaliar shola as compared to Punnumala shola. There could be many attributes to induce such result among which animal movement could be the primary one. The topography of the study sites could very much affect the animal movements thus contributing to the stark disparity in the relative abundance of animal signs. Greater abundance was recorded from IGWLS than SVNP may be because of the restriction of animal movements in the former due to topographical barriers and its existence as isolated shola patches that led to a greater concentration of wild fauna in a relatively segregated forest cover. Karian shola is guarded by Pandaravarai range towards north that falls steeply in the eastern boundary to the habitations of Pollachi plains while southern and western sides are bordered by the Pollachi — Perambikulum road way and thus restricting free animal movements. In Varagaliar shola too the whole of the northern side is guarded by the high mountain ranges and continues eastward up to lofty Perunkundrumalai peak at eastern end. South and west sides are bordered here by Varagaliar River and restrict the animal movement. Aggregates of tribal settlements and the elephant training camp at the southern and western sides of the shola area also pose as an anthropological barrier for free movement. It is felt that regular human interference and anthropogenic modifications in the areas of higher wildlife densities should be stopped and special care should be taken to prevent forest-fire and spread of diseases.

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