

Feeding ecology of sloth bears in a disturbed area in central India

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Abstract: In Central India, the North Bilaspur Forest Division (Nbfd) harbors a large number of sloth bears (*Melursus ursinus*). The managed forests of the division are mostly patchy, fragmented, degraded, and interspersed with crop fields and villages with high human and cattle population. The feeding ecology of sloth bears was studied by analyzing 568 scats; 21 species of plants, termites, ants, and bees, as well as unidentified animal matter (bone, hairs and tissue) were found in bear scats. Year-round frequencies of occurrence of animal and plant matter were similar. Animal matter constituted 87% of scats during monsoon and 82% during winter seasons, but dropped to 65% during summer. On percent dry-weight basis, plant matter was greater than animal matter in scats in all seasons. Frequency of occurrence of insects was high during monsoon (87%) and winter (82%), whereas *Ficus* species were more common (68%) during summer season. *Ficus* species were high in percent weight in all seasons. *Ficus* species appear to be important to bears, especially when fields lack crops, few other species are fruiting, and soil is hard, making it difficult to dig for ants and termites. The presence of groundnut and corn (maize) in diets during the monsoon suggests crop damage by bears, thereby increasing chances of human–bear conflict.

Key words: animal matter, crop damage, degraded habitat, feeding, *Ficus*, food items, *Melursus ursinus*, plant matter, scat analysis, sloth bear

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The sloth bear is endemic to Indian Subcontinent. In India, sloth bears are found from the foothills of Himalayas to the southern end of Western Ghats. Although widely distributed, many populations are declining due to habitat loss and deterioration (Johnsingh 1986), diminished food resources (Murthy and Sanakar 1995), timber and firewood harvesting, and use of their body parts in medicines (Cowan 1972, Servheen 1990). Sloth bear is included in Schedule I of Indian Wildlife Protection Act 1972 and Appendix I of CITES (Committee on International Trade in Endangered Species of Wild Fauna and Flora).

Most bears are opportunistic omnivores. As such, their activities are governed by the availability of food items and dietary components within their habitat. Nutrition plays an important role in the reproductive rate of female bears (Jonkel and Cowan 1971). Most species of bears have been documented, at least on occasion, to feed on insects, especially ants (Joshi et al. 1997). However, the sloth bear is the only ursid having myrmecophagous

adaptations to feed on insects, especially termites and ants (Laurie and Seidensticker 1977, Joshi et al. 1997). Like other bears but unlike other myrmecophagous mammals, sloth bear diets vary seasonally and geographically across their range from Nepal south through India and Sri Lanka, depending on the availability of food and hardness of termite mounds (Laurie and Seidensticker 1977, Baskaran 1990, Gopal 1991, Gokula et al. 1995, Baskaran et al. 1997, Joshi et al. 1997).

The objective of this study was to document food habits of sloth bears in a highly disturbed and fragmented habitat. Information on composition and seasonal variation in bear diet can be collected either through foraging observations or indirectly through scat analysis (Desai et al. 1997). Because sloth bears in this area forage primarily at night, we found it difficult to collect data based on direct observations, and thus depended on scats to provide information on food habits.

Study area

The study area included the Pendra and Marwahi administrative ranges (regions) of Nbfd in the state of Chhattisgarh, central India, between 81°45'–82°13'E

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Table 1. Frequency of occurrence of food items in scats of sloth bears by season during 1998–2000 in North Bilaspur Forest Division, India.

Food items	Amount in scat (%)			
	Summer (n = 192)	Monsoon (n = 184)	Winter (n = 192)	Annual (n = 568)
Black ant egg shells	2.6	35.3	7.3	14.8
Black ant	20.8	60.9	60.4	47.2
Red ant egg shells	0.0	0.5	1.0	0.5
Red ant	10.9	11.4	27.1	16.5
Termite egg shells	0.5	11.4	5.7	5.8
Termites	64.1	79.9	74.5	72.7
Bones	0.5	0.0	0.5	0.4
Hair	0.5	0.0	0.0	0.2
Bees	2.1	0.5	0.0	0.9
Animal tissue	0.0	0.5	0.0	0.2
<i>Ficus benghalensis</i>	33.3	13.0	14.1	20.2
<i>Ficus virens</i>	21.4	6.5	29.2	19.2
<i>Ficus religiosa</i>	16.1	3.3	21.9	13.9
<i>Ficus racemosa</i>	4.7	0.0	2.6	2.5
<i>Ziziphus mauritiana</i>	15.1	0.5	14.6	10.2
<i>Ziziphus oenoplia</i>	0.5	0.0	4.7	1.8
<i>Ziziphus nummularia</i>	0.0	0.0	2.1	0.7
<i>Aegle marmelos</i>	12.5	0.5	6.3	6.5
<i>Briedelia squamosa</i>	0.0	0.0	1.0	0.4
<i>Diospyros melanoxylon</i>	6.3	0.0	0.0	2.1
<i>Buchanania lanzan</i>	2.6	0.0	0.0	0.9
<i>Schleichera oleosa</i>	0.0	0.5	0.0	0.2
<i>Syzygium cumini</i>	7.3	6.0	0.0	4.4
<i>Cassia fistula</i>	2.1	2.7	0.0	1.6
<i>Madhuca indica</i> (fruit)	1.6	0.5	0.0	0.7
<i>Madhuca indica</i> (flower)	1.0	0.0	0.0	0.4
Groundnut	0.0	32.1	8.9	13.4
Corn	0.0	6.0	2.1	2.6
<i>Psidium guajava</i>	0.5	0.0	5.7	2.1
<i>Mangifera indica</i>	3.6	0.5	0.0	1.4
Unknown fruit 1	0.0	1.1	0.0	0.4
Unknown fruit 2	0.0	1.1	0.0	0.4

longitude and 22°40'–23°7'N latitude. Forests covered about 337 km² of the total study area of about 1,396 km² (125 km² in Pendra and 212 km² in Marwahi). This region includes the Chhattisgarh plains and hilly regions of Maikal range. According to Champion and Seth (1968), the vegetation of the study area is northern tropical dry deciduous peninsular sal forest, northern tropical dry mixed deciduous forest, and northern tropical moist mixed deciduous forest. Most of the forest fragments consist of small hillocks with boulders that offer suitable denning areas for sloth bears.

Habitat available for sloth bears within Nbfd is highly degraded and interspersed with villages and agricultural fields. Survival of sloth bears depends on the availability of suitable habitat along boulders and rocky outcrops in forest areas. Because of a lack of irrigation facilities during summer season, local inhabitants grow crops only during the monsoon season (Jul–Oct). Local

people also collect non-timber forest products and fuel wood and graze cattle in forest fragments.

Important flora of the study area include sal (*Shorea robusta*), char (*Buchanania lanzan*), tendu (*Diospyros melanoxylon*), dhawa (*Anogeissus latifolia*), bel (*Aegle marmelos*), palas (*Butea monosperma*), and bargad (*Ficus benghalensis*). Mammals include common leopard (*Panthera pardus*), golden jackal (*Canis aureus*), striped hyena (*Hyaena hyaena*), Indian fox (*Vulpes bengalensis*), toddy cat (*Paradoxurus hermaphroditus*), wild boar (*Sus scrofa*), and Indian porcupine (*Hystrix indica*).

During April–June, mean temperature exceeds 40°C. The months of December and January are the coldest; mean annual rainfall is 1,381 mm. For study purposes, we defined 3 seasons: summer (Mar–Jun), monsoon (Jul–Oct), and winter (Nov–Feb). The study area has a human population of about 180,000 and about 150,000

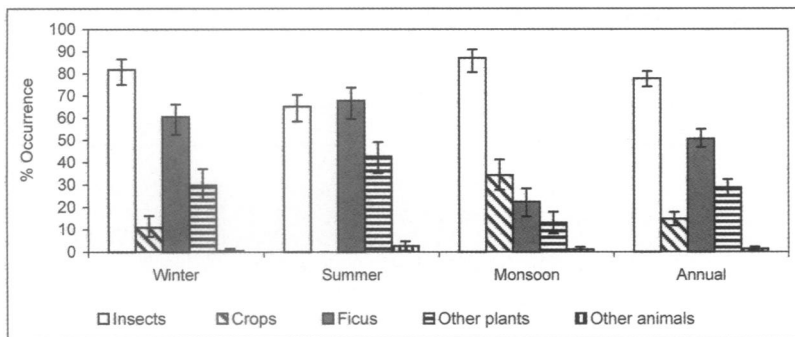


Fig. 1. Frequency occurrence of food items in scats of sloth bears by season during 1998–2000 in North Bilaspur Forest Division. Error bars display 95% bootstrap confidence intervals.

cattle. All the villages in the study area are connected through a network of roads that are drivable during winter and summer, but not during the monsoon season.

Methods

Collection of scats

Scat collection, May 1998–December 2000, was incidental to other studies on sloth bear ecology (Gokula et al. 1995, Baskaran et al. 1997, Joshi et al. 1997). Scats were collected whenever encountered during transect work, tracking of radiocollared bears, and surveys of bear dens. Scats were also collected opportunistically from trapping, feeding, and resting sites as well as along trails. Scat collection was difficult during the monsoon season because of increased vegetation cover and frequent rains; most scats collected during the monsoon were from den sites. Scats were stored in polythene bags and dried in the sun.

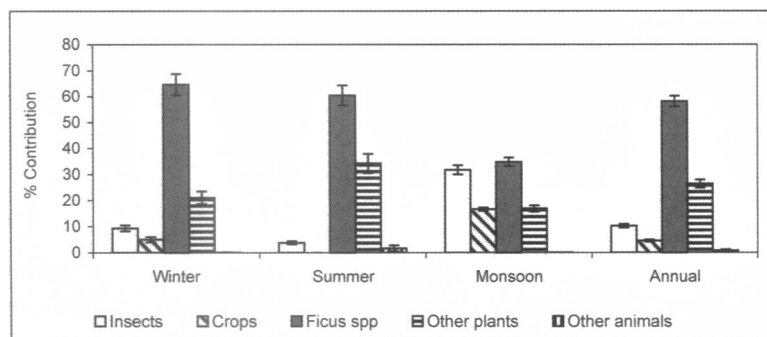


Fig. 2. Percent dry weight of major food items in scats of sloth bears by seasons during 1998–2000 in NBFD. Error bars display 95% confidence levels.

Analysis

From the total collected, we randomly selected 16 scats from each month of collection for analysis (except during monsoons, when all scats were used). Scats were weighed separately, and only 10% of each scat was used in further analysis. Samples were soaked in water for 10–15 hrs, then washed in running water to remove mud and other matter using 0.7 and 0.4 mm sieves. Remaining portions of each scat were oven dried at 60°C for 15–24 hrs. Scat samples were analyzed manually by separating components (such as ants, termites, and fruit) in the

scats. A dissecting microscope was used to identify food items when needed. If the scats contained only ants and termites, 20% of the remaining oven-dried scat material was examined. All inseparable, unidentifiable crushed matter, including parts of insects and fruits, was considered waste and discarded.

Scat composition was quantified by both frequency of occurrence and percent dry weight of each food item. In addition to quantifying each item by species, we grouped animal matter into “insects” and “other animal matter”, and plant matter into 3 categories: “crops” (corn and groundnut), “*Ficus*” spp. and “other fruits.”

Results

Year-round diets

We analyzed a total of 568 scats, consisting of 192 from summer months, 184 from the monsoon, and 192 from winter months. We identified 21 plant species as well as termites, ants, bees, and unknown animal matter (bone, hairs, and tissues) in bear scats (Table 1). Other than flowers from *Madhuca indica* and nuts from groundnut, all plant material consisted of fruits.

Among the 32 food items identified, termites (72.7%) occurred in scats most often (Table 1). Of the plant species found in scats, *Ficus benghalensis* (20.2%) was found most frequently. On a dry weight basis, plant matter constituted 89%; the rest (11%) was animal matter (Table 2). *F. benghalensis* also ranked highest in percent composition (20.5%) on a dry-weight basis, followed closely

Table 2. Percent dry weight composition of food items in the scats of sloth bears by season during 1998–2000 in North Bilaspur Forest Division. Total weight of the mud in scats was 15,488.6 g (average = 27.3 g), total weight of all scats was 33,581.7 g (average = 59.1 g)

Food items	Dry weight in scat (%)			
	Summer (n = 192)	Monsoon (n = 184)	Winter (n = 192)	Annual (n = 568)
Black ant egg shells	0.1	10.9	2.1	2.5
Black ant	0.3	8.3	1.0	1.8
Red ant egg shells	0.0	0.3	0.1	0.1
Red ant	0.1	0.4	1.2	0.5
Termite egg shells	0.0	0.9	0.8	0.5
Termites	3.3	11.0	4.1	4.8
Bones	0.0	0.0	0.1	0.1
Hair	1.6	0.0	0.0	0.7
Bees	0.1	0.0	0.0	0.0
<i>Ficus benghalensis</i>	27.6	18.8	13.0	20.5
<i>Ficus virens</i>	15.5	12.8	28.4	20.2
<i>Ficus religiosa</i>	14.6	3.2	21.9	15.8
<i>Ficus racemosa</i>	2.8	0.0	1.3	1.8
<i>Ziziphus mauritiana</i>	10.4	1.9	14.7	10.8
<i>Ziziphus oenoplia</i>	1.9	0.0	0.7	1.2
<i>Ziziphus nummularia</i>	0.0	0.0	1.4	0.6
<i>Aegle marmelos</i>	5.6	0.0	1.7	3.2
<i>Briedelia squamosa</i>	0.0	0.0	0.1	0.0
<i>Diospyros melanoxylon</i>	9.7	0.0	0.0	4.4
<i>Buchanania lanzan</i>	0.4	0.0	0.0	0.2
<i>Schleichera oleosa</i>	0.0	0.3	0.0	0.0
<i>Syzygium cumini</i>	3.3	11.3	0.0	3.2
<i>Cassia fistula</i>	0.3	1.4	0.0	0.4
<i>Madhuca indica</i> (fruit)	0.1	1.4	0.0	0.3
<i>Madhuca indica</i> (flower)	0.9	0.0	0.0	0.4
Groundnut	0.0	15.2	4.1	3.9
Corn	0.0	1.4	0.9	0.6
<i>Psidium guajava</i>	0.3	0.0	2.4	1.1
<i>Mangifera indica</i>	1.1	0.1	0.0	0.5
Unknown fruit 1	0.0	0.2	0.0	0.0
Unknown fruit 2	0.0	0.3	0.0	0.0

by *F. virens* (20.2%). Termites were the highest ranking animal item on a dry-weight basis.

Frequency of occurrence of insects was highest (occurring in 77.8% of all scats) followed by *Ficus* species (50.5%), other fruits (28.7%), crops (14.8%), and other animal matter (1.4%; Fig. 1). Expressed by dry weight, *Ficus* was highest (58.2%), followed by other fruits (26.4%), insects (10.2%), crops (4.5%), and other animal matter (0.8%; Fig. 2).

Seasonal diets

During summer, plant matter (90.6%) was identified in more scats than animal matter (65.1%). *F. benghalensis* had the highest dietary contribution expressed both as frequency of occurrence (33.3%) and dry weight (27.6%).

During monsoon, animal matter was found in scats more frequently (87%) than in summer. Only groundnut and *F. benghalensis* appeared to be important plant

items during monsoon; termites and ants dominated diets during this season.

In winter, animal matter occurred in 81.8% of scats. *F. virens* was the major food item assessed by dry-weight, and the most frequently encountered plant species. However, termites and ants were by far the most frequently encountered food item.

Discussion

Scat analysis has been used on a wide variety of bear species to infer dietary composition (Schaller 1967, Laurie and Seidensticker 1977, Landers et al. 1979, Maehr and Brady 1984, Hamer and Herrero 1987). In some studies, both scats and stomach contents have been used. Dietary composition of the sloth bear has been studied based on frequency occurrence and percent weight of different food items in scats (Gokula et al. 1995, Baskaran et al. 1997, Desai et al. 1997) as well as through direct observations of

feeding behavior (Joshi et al. 1997). All these methods have shortcomings. Percent occurrence of a particular food in scats may differ from actual consumption (Desai et al. 1997, Joshi et al. 1997). Different plant species also vary in the seed size and pulp–seed size ratio, which affects percent weight.

Sloth bears have morphological adaptations to feed on insects but, like other bear species, they are opportunistic omnivores and their diets may vary seasonally and geographically (Joshi et al. 1997). As in other studies, we found that sloth bears consumed both animal and plant matter, with variation probably related to food availability in different seasons (Laurie and Seidensticker 1977, Baskaran 1990, Gokula et al. 1995, Baskaran et al. 1997, Joshi et al. 1997).

In Nbfd, we found that insects were the most frequently encountered food item in scats during the winter and monsoon seasons, whereas *Ficus* species were most frequent during the summer season. By weight, *Ficus* species dominated in all seasons. Plants (mainly *Ficus* spp.) dominated in scats during summer. Expressed as percent dry-weight, plant matter dominated in all seasons. Similarly, a study on sloth bears in central India, (Gopal 1991) found that fruits were eaten year round and were the mainstay of the diet from February to June, whereas termites, ants, and honey were the predominant foods in other months.

We believe that the relative importance of plant matter in bear scats during summer is due to seasonal flowering and fruiting. In contrast, hard soil during summer probably deterred bears from digging for termites and ants (Davidar 1983, Gopal 1991, Joshi et al. 1997). *Ficus* species occur throughout the year in different stages of fruiting. We interpret the high frequency groundnuts in scats during monsoon as evidence of crop raiding. We also noted extensive digging for termites and ants in crop fields close to the den sites during monsoon. With the onset of monsoon, rain water softens the soil, and bears have been documented digging extensively for termites and ants at this time (Schaller 1967, Davidar 1983, Gopal 1991, Joshi et al. 1997). With the onset of winter, *Ficus* spp. and other plant matter became important, but crops were also present in low frequency because bears consumed crops left in fields after the harvesting was over.

Residents of Nbfd collect a number of non-timber forest products (NTFP) that are also used by sloth bears. NTFP materials collected include flowers and fruits of mahuwa (*Madhuca indica*) and fruits of bel (*Aegle marmelos*), char (*Buchanania lanzan*), jamun (*Syzygium cumini*), and tendu (*Diospyros melanoxylon*). Such

collection may limit their availability for bears. *Ficus* spp. are not used by local people, so are readily available for the bears.

In the degraded habitats of Nbfd, both animal and plant matter contribute to the diets of sloth bear. However, *Ficus* spp. play important roles by providing a constant supply of food throughout the year. This is particularly important during summer when there are no crops in fields to raid and fewer fruiting species, and bears find it difficult to dig for termite and ants.

We recommend that cutting and lopping of *Ficus* trees around sloth bear den sites should be prohibited. To lessen conflicts, villagers should avoid growing corn and groundnut crops near den sites and should be encouraged to grow crops of less interest to bears.

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