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Feeding Ecology of Sloth Bears in Chitwan National Park, Nepal

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ABSTRACT

Food habits of a species influences habitat use, ranging pattern and behavior. Seasonal diet composition of Sloth bear (*Melursus ursinus*) in the Chitwan National Park, Nepal was determined from 143 scats. Through macroscopic and microscopic analysis of scats; six types of plants, termites, ants, honey bees, wax, as well as mammalian hairs were identified. Although variation was observed, there was no significant difference in the diet composition in two different seasons. Overall, insects dominated the composition, occurring in 100% of the scats followed by the plants (39.16%) and mammalian hair (3.49%). Termites and ants were the major and stable dietary components. Termites (90%), Red ants (65%) and *Aegle marmelos* (35%) were important food for Sloth bear in summer season but the utilization of plants was very low. During winter, insects were heavily utilized by the bear. The utilization of termites (93.97%) and *Ziziphus* sp. (14.45%) was higher in comparison with summer season. Utilization of fruits in summer was negligible. By and large, on percent dry weight basis, insects (78.98%) dominated Sloth bear diet, followed by plants (20.99%) and mammalian hairs (0.04%).

Key words: Sloth bear, feeding, scat, insects, termites, diet composition

INTRODUCTION

Understanding food habits and diet composition is important to assess distribution and habitat use of the bears (MacHutchon & Wellwood, 2003). Most of the bears are opportunistic omnivores. All the bears, except Polar bear (*Ursus maritimus*) have been documented to feed on insects, especially ants (Joshi *et al.* 1997). However, Sloth bear is only the ursid having mymercophagus adaptation to feed on insects, especially termites and ants (Laurie & Seidensticker, 1977; Joshi *et al.* 1997). The diets of Sloth bear vary seasonally and geographically across their range (Laurie & Seidensticker, 1977; Gokula *et al.* 1995; Baskaran *et al.* 1997; Joshi *et al.* 1997; Bargali *et al.* 2004). Sloth bear is only the species that entirely depend on social insects for its protein requirements (Yoganand *et al.* 2005). Various factors such as abundances, dispersion and bite size, availability and taste of fruits of plants and colony size and colony biomass of insect determine diet selection pattern of the Sloth bears (Yoganand *et al.* 2005).

Previous research revealed that insects are the main food components of bear all year round (Laurie & Seidensticker, 1977; Shrestha, 1993; Joshi *et al.* 1997), but fruits are major portion of diet during fruiting season (April- May) in Chitwan, Southern India (Gokula *et al.* 1995) and central India (Bargali *et al.* 2004). However, fruits comprised a major portion of diet in South India (Baskaran *et al.* 1997), in Panna National Park (Yoganand *et al.* 2005), in Vijaynagar North Gujarat (Mewada & Dharaiya, 2010). They occasionally feed on animal carcasses when food sources are limited (Shrestha, 1993; Baskaran *et al.* 1997; Bargali *et al.* 2004; Mewada & Dharaiya, 2010; Ramakrishnan & Deepalakshmi, 2012). The objective of this study was to determine seasonal diet composition of Sloth bear in Chitwan National Park (CNP) using macroscopic and microscopic examination of scats remain.

MATERIALS AND METHODS

Study area

The study was carried out in Chitwan National Park (CNP) situated between $27^0$34' to $27^0$68' North and $83^0$87' to $83^0$74' East, covering an area of 932 km^2 (Fig. 1). The Park has two Siwalik ranges, namely Churia and the Someswore, which rises about 150m to over 800m. Rapti and Reu flow through the park and ultimately join the Narayani, in between there are several depressions forming lakes and marshes with perennial water resources. In Chitwan, mean annual temperature is 17.6^0c, winter temperature falls almost to freezing point, whereas, from March to June temperature can reach as high as 43^0c. About 90% of rainfall occurs from May to September with annual rainfall of 1520 mm. In addition to the Sloth bear, other large mammals in this area includes *Rhinoceros unicornis*, *Elephus maximus*, *Bos Gaurus*, *Panthera tigris*, *Tetracerus quadricornis* etc. Important floras in the park are *Shorea robusta*, *Pinus roxburghii, Bombax Ceiba, Delbergia sisso, Ficus cunia* etc.

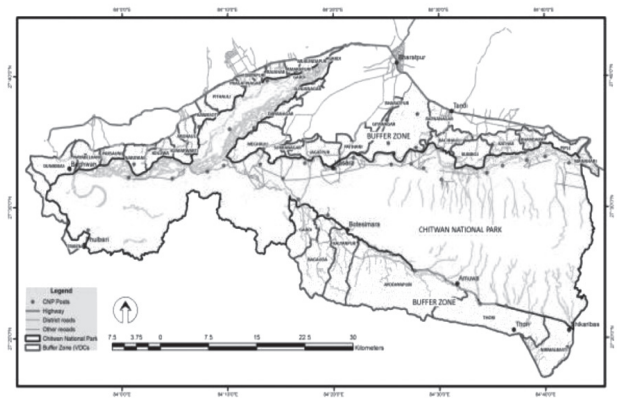

Fig. 1. Map of Chitwan National Park and Buffer Zone.

Scat collection

For the scat collection entire study area was divided into 70 grids with 4×4 Km^2 (Fig. 2) and scats were collected during April-May 2012 and February 2013 in 32 (45%) of the selected grids as well as along the trail and dirt roads in the CNP and BZ. Scats whenever encountered were dried in the sun if necessary and stored in polythene bags with proper labeling. These scats were then taken to the laboratory of Central Department of Zoology (CDZ), Tribhuvan University for analysis.

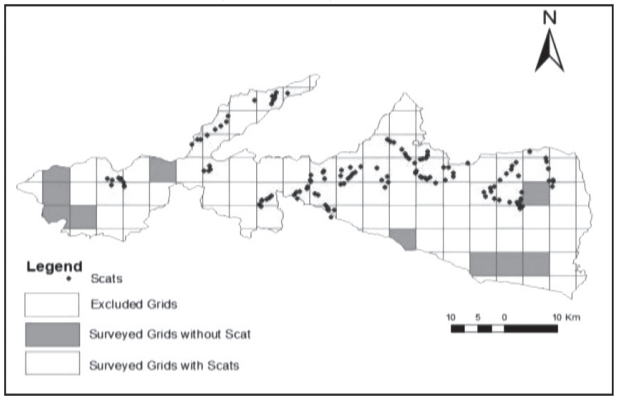

Fig. 2. Map showing surveyed, scat collected and excluded grids in CNP.

Scat analysis

Scat analysis were done following the method used by Gokula *et al.* (1995), Baskaran *et al*. (1997), Joshi *et al*. (1997), Bargali *et al*. (2004). The scat samples were soaked in water for about 15 hours and washed in running water to remove mud and other debris through the sieves of 0.7 and 0.4mm mesh size. Remaining portion of each scat was oven dried at 60º C for about 24 hours, weighed separately and only 4 gm from each sample was used for further analysis. Sample of dried material was sprinkled in a thin layer of non overlapping particles on a paper marked with 16 square boxes of 4cm length and materials of 2 boxes were selected randomly. Scat samples were analyzed manually by separating components. A dissecting microscope (40X) was used to identify food items when needed. All inseparable, unidentified crushed matters including parts of insects and fruits were discarded. Fruits were identified by comparing the seeds of fruits collected during field visit. Head parts of the insects were used for their identification. Seeds and insect part thus collected were weighted separately for analyzing the dry weight composition of food items. Remains of hairs and wax were considered as sources of indication of feeding carrion and honey. Food items were broadly grouped into "Insects", "Plants" and "Mammalian Hair".

Scat composition was quantified by both frequency of occurrence and percent dry weight (Gokula *et al*. 1995, Baskaran *et al*. 1997, Bargali *et al*. 2004). Kruskal-Wallis Rank Sum test was used to test the significant difference in diet composition of bear between seasons using program R (R Console version 2.15.2).

RESULTS

Overall diet composition

Altogether, 143 scats including 60 from summer (April-May) and 83 from winter season (February) were collected, and analyzed. Thirteen different types of food items occurred in total scats; six taxa of plants, five taxa of insects as well as wax and mammalian hair (Table 1).

Table 1. Over all frequency of occurrence of food items in scats of Sloth bears in Chitwan National Park

Food Categories	Food items	Summer (n=60)	Winter (n= 83)	Overall
		% occurrence	% occurrence	% occurrence
Insects	Termites	90	93.97	92.3
	Black ants	61.66	57.83	59.44
	Red ants	65	34.93	47.55
	Beetle	21.66	4.81	10.48
	Honey bee	21.66	7.22	13.28
	Wax	3.33	0	1.39
Mammalian Hair	Hair	5	2.4	3.49
Plants	*Aegle marmelos*	35	0	14.68
	Ziziphus spp.	3.33	14.45	9.79
	Bridelia retusa	10	0	4.19
	Ficus semicaudatum	21.66	1.2	9.79
	Cassia fistula	0	7.22	4.19
	Ficus benghalensis	0	2.4	1.39

Insects dominated the composition, occurring in 100% of the scats followed by the plants (39.16%) and mammalian hair (3.49%). Among the food items, termites (92.30%) occurred in scats most often. Of the plant species found in the scats, *Aegle marmelos* (14.68%) was found most frequently. On the dry weight basis also, insect (78.98%) contributed highest and the rest by plants and mammalian hair (Table 2). Termite was highest ranking insect item on dry weight basis and *Ziziphus* sp. ranged highest among the plants, followed by *Aegle marmelos* (4.13%). Mammalian hair contributed least, having only 0.04% dry weight composition.

Table 2. Percent dry weight composition of food items in the scats of Sloth Bears by season in Chitwan National Park.

Food Categories	Food Items	Summer	Winter	Total
		% dry weight	% dry weight	Total dry weight %
Insects	Termites	55.52	66.48	62.7
	Black ants	6.07	10.47	8.95
	Red ants	7.47	2.99	4.53
	Beetle	2.66	0.56	1.27
	Honey Bee	2.05	0.56	1.07
	Wax	1.14	0	0.39
Mammalian Hair	Hair	0.02	0.04	0.04
Plants	*Aegle marmelos*	12	0	4.13
	Ziziphus spp.	3.35	13.65	10.1
	Bridelia retusa	6.54	0	2.25
	Ficus semicaudatum	3.12	0.84	1.62
	Cassia fistula	0	0.58	0.38
	Ficus benghalensis	0	3.77	2.47

Seasonal diets

In the summer season, insects were most heavily utilized food items, dominating in term of both; frequency of occurrence and percent dry weight. Termites occurred more frequently (90%) in the scat samples than Red ants (65%) and Black ants (61.66%). Plant species occurred in 63.33% of scats in the summer season. *Aegle marmelos* (35%) occurred more frequently among the plants, followed by *Ficus semicaudatum* (21.67%). Expressed in term of dry weight, termite (62.70%) was highest among insects and *Aegle marmelos* (12%) among the plants (Table 2).

In the winter season also, insects were heavily utilized, occurring in 100% of the scats. Here, also termites (93.97%) occurred more frequently followed by Black ants (57.83%) and Red ants (34.93%). Plants occurred in only 21.68% of the scats. *Ziziphus* sp. (14.45%) was more frequent among the plants followed by the *Cassia fistula* (7.22%). In term of percent dry weight, insect contributed 81.03% and remaining by plants, least by mammalian hair. *Ziziphus* sp. (13.65%) contributed highest among the plants.

Seasonal variation of diet composition

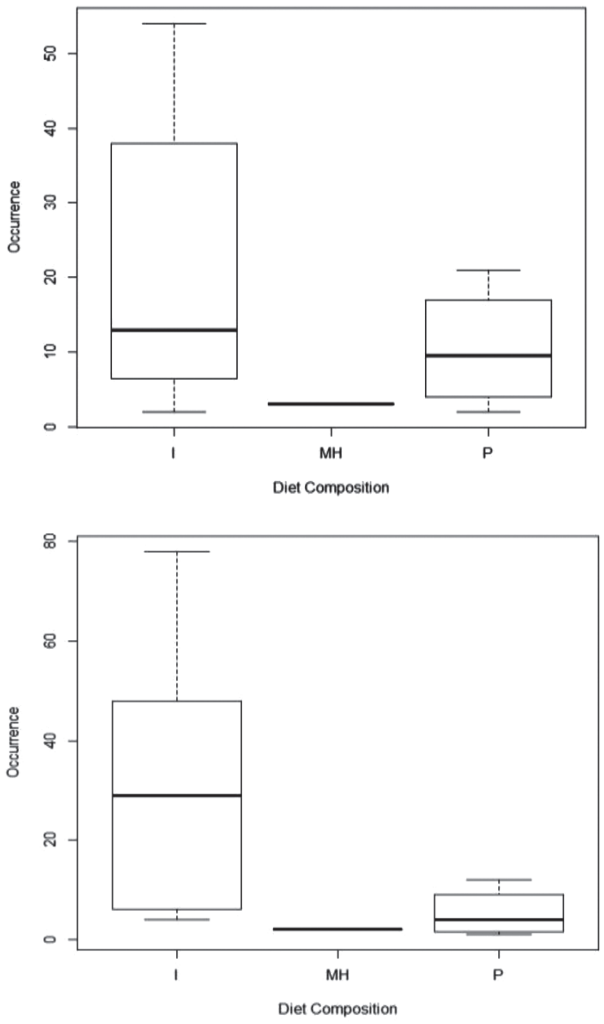

Fig. 3. Boxplots showing diet composition of Sloth bear in summer (1a) and winter season (1b) (I= insects, MH= Mammalian hair, P= plants). The dark line in the box plot represents the median or mid value and its arm represents the quartile value of number of diet composition.

Kruskal Wallis test revealed that there was no significant difference ($p>0.05$) in the composition of diet of Sloth bear between two seasons ($X^2=0.8586$, df= 1, $p=0.3541$,

α=0.05). Both seasons had more or less same composition of diet. Insects were the major diet followed by plants and the least as mammalian hair (Figs. 3a & 3b).

Adequacy of sample size

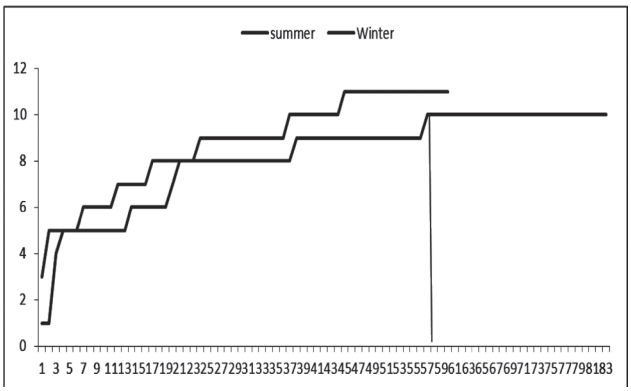

Fig. 4. Relationship between number of taxa occurred and number of scats analyzed in summer and winter season.

All the food items in the Sloth Bears diet were identified after analysis of 45 scat samples in summer season and 57 samples in winter season (Fig. 4).

DISCUSSION

Diets of Sloth bear have been analyzed in Chitwan by identifying remains of undigested food remains in the scat samples. Scat analysis is widely used method for diet analysis of Sloth bear (Laurie & Seidensticker, 1977; Gokula *et al.* 1995; Joshi *et al.* 1997) as it is a non invasive technique.

Sloth bears are opportunistic omnivores and their diet vary seasonally and geographically (Joshi *et al.* 1997). As in other studies, Sloth bear in CNP consumed insects, plants and mammalian carcasses, with variation probably related to food availability in different season (Laurie & Seidensticker, 1977; Gokula *et al.* 1995, Baskaran *et al.* 1997; Joshi *et al.* 1997; Bargali *et al.* 2004). In CNP, Sloth bear overall consumed 13 different taxa including six plants, five insects as well as wax and mammalian hair (Table 1). The diet diversity of Sloth bear identified in this study was less than that detected by previous researcher in CNP (Laurie & Seidensticker 1977, Shrestha 1993; Joshi *et al*. 1997). Low diet diversity of this study is probably related to the shorter duration of scat sampling in this study. Insects were the most common diets occurring in 100% scats. Similar results were reported by Sultan *et al*. (2012) from dry deciduous forests of Darrah Wildlife Sanctuary, India. However, Laurie and Seidensticker (1977) reported insects only in 52% of scats. This large difference is probably related with change in the habitat conditions of CNP between these studies as alluvial grasslands of the park was previously inhabited by the people, alluvial grassland are preferred by Sloth bears because of high density of termites (Joshi *et al.* 1995). Termites were the most important stable food items followed by ants. Proportion of insects (i.e. almost entirely termites and ants) in Sloth bear's diets was relatively higher in this study than previous studies, probably insects population in Chitwan are higher than others. The soft soils in Chitwan may be favourable for those insect taxas. The higher representation of insects matter in Sloth bear diet is probably related to easier digestibility and higher nutritional value of insects. The Sloth bears entirely depend on social insects (termites, ants) for its protein requirements (Yoganand *et al.* 2005).

The proportion of plant material (39.16%) occurred in the diets of the Sloth bear is higher than that reported by Gokula *et al.* (1995) in Mundanthurai Plateau, Tamil Nadu, India. Gokula *et al*. (1995), collected scats during December – March, which is non-fruiting. Monsoon is the main fruiting season for most of the plants but scats were not collected during his season due to heavy rain, water logging in much of the lowland areas and flooding of many rivers. This limitation probably related to the less number of plant taxa than previous studies (Laurie & Seidensticker 1977, Shrestha 1993; Joshi *et al*. 1997). .

Percentage frequency of mammalian hairs was lowest (3.49%) in the diets. Presence of mammalian hairs probably indicates the carrion feeding behaviour of Sloth bear. The hairs and bones in scat were also reported by other researchers (Shrestha, 1993; Bargali *et al.* 2004), Sreekumar & Balakrishnan (2012) and in addition hairs and bones bird feathers were also reported by Baskaran *et al*. (1997) and Mewada & Dharaiya (2010). All these indicate Sloth bear feeding diverse food items.

During the summer season, Sloth bear preferred insect diet. Beetle and Honey bee were the insects which unlike others occurred more in summer season. Relative importance of Honey bee found in the bears scats during summer season may be due to seasonal flowering of some plants. During winter season, utilization of insect matter was higher, hard soil during the summer season probably deterred bears from digging for termites and ants (Joshi *et al.* 1997; Bargali *et al.* 2004; Sukhadiya *et al.* 2012; Ramakrishnan & Deepalakshmi, 2012). Among the plants, *Ziziphus* sp. (14.45%) in winter and *Aegle marmelos* (35%) in summer was recorded higher probably as it was the fruiting season for both the species. They also contributed higher in dry weight basis it may be due to their larger seed size. Plants showed lesser contribution in diet during winter season than in summer season. The relative importance of the plant matter in bear diets during summer season may be due to seasonal flowering and fruiting.

In CNP all viz; insects, plants and mammalian hair contributed to the diets of the Sloth bear. Although, variation occurred in dietary composition between two seasons (summer and winter), there was no significant difference (X^2=0.8586, df= 1, p=0.3541, α=0.05) in the diet composition of Sloth Bears. Termites play important roles by providing a constant supply of food throughout the year. This is particularly important during winter when bear finds it easy to dig for termites and ants and there is less number of fruiting plants. Extraction of important food items of Sloth such as *Aegle marmelos, Ficus* sp., *Ziziphus* sp., and honey could threaten the bear, therefore such practice should control.

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