

JOURNAL OF THE BOMBAY NATURAL HISTORY SOCIETY

April 1997

Vol. 94

No. 1

FOOD HABITS OF SLOTH BEAR IN MUDUMALAI WILDLIFE SANCTUARY, TAMIL NADU, SOUTHERN INDIA¹

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(With two text-figures)

Key words: India, sloth bear (*Melursus ursinus*), diet, fruiting seasonality

The food habits of sloth bear (*Melursus ursinus*) were studied in Mudumalai Wildlife Sanctuary, Tamil Nadu by analysing 567 fresh scats from five different habitat types between March, 1990 and February, 1991. Fruit was the major food, irrespective of vegetation types. Ants and termites appeared consistently in the diet. The percent occurrence of various diet items varied seasonally. Animal material dominated the second wet season. The fruits of *Syzygium cumini*, *Cassia fistula* and *Ziziphus mauritiana* formed the dominant diet component in most of the habitats. Utilization of plant and animal materials differed significantly between seasons. Though density of fruit trees varied across vegetation types, use of fruits did not, except in the thorn forest. There was no variation in the use of animal materials between vegetation types. Availability of ripe fruits varied significantly between seasons and therefore utilization.

INTRODUCTION

Among the four species of bears in India the sloth bear (*Melursus ursinus*) is the most widely distributed, ranging from the foot hills of the Himalayas to the southern end of the Western Ghats. However, its range is shrinking and population declining in many parts of its range due to the loss and deterioration of habitat (Johnsingh 1986). Poaching for its gall bladder, used in traditional medicines in south Asian countries, is also a serious

problem (WWF, Conservation Year Book 1985-86). Sporadic attacks on humans by the bear has also created fear and animosity among the public in many areas of its range.

The Sloth bear is included in Schedule I of the Indian Wildlife Act 1972 (Amended 1991) and Appendix II of CITES (Servheen 1991). Very little is known about the ecology of the species, the only study being by Laurie and Seidensticker (1977) in the Royal Chitwan National Park, Nepal. Other information is anecdotal, or based on surveys and natural history observations (Prater 1965, Schaller 1967, Spillet 1967, Krishnan 1972, Davidar 1983). The study was carried out to determine food habits of the sloth bear in the tourism zone of Mudumalai Wildlife Sanctuary, South India from March, 1990 to February, 1991.

¹Accepted October, 1995.

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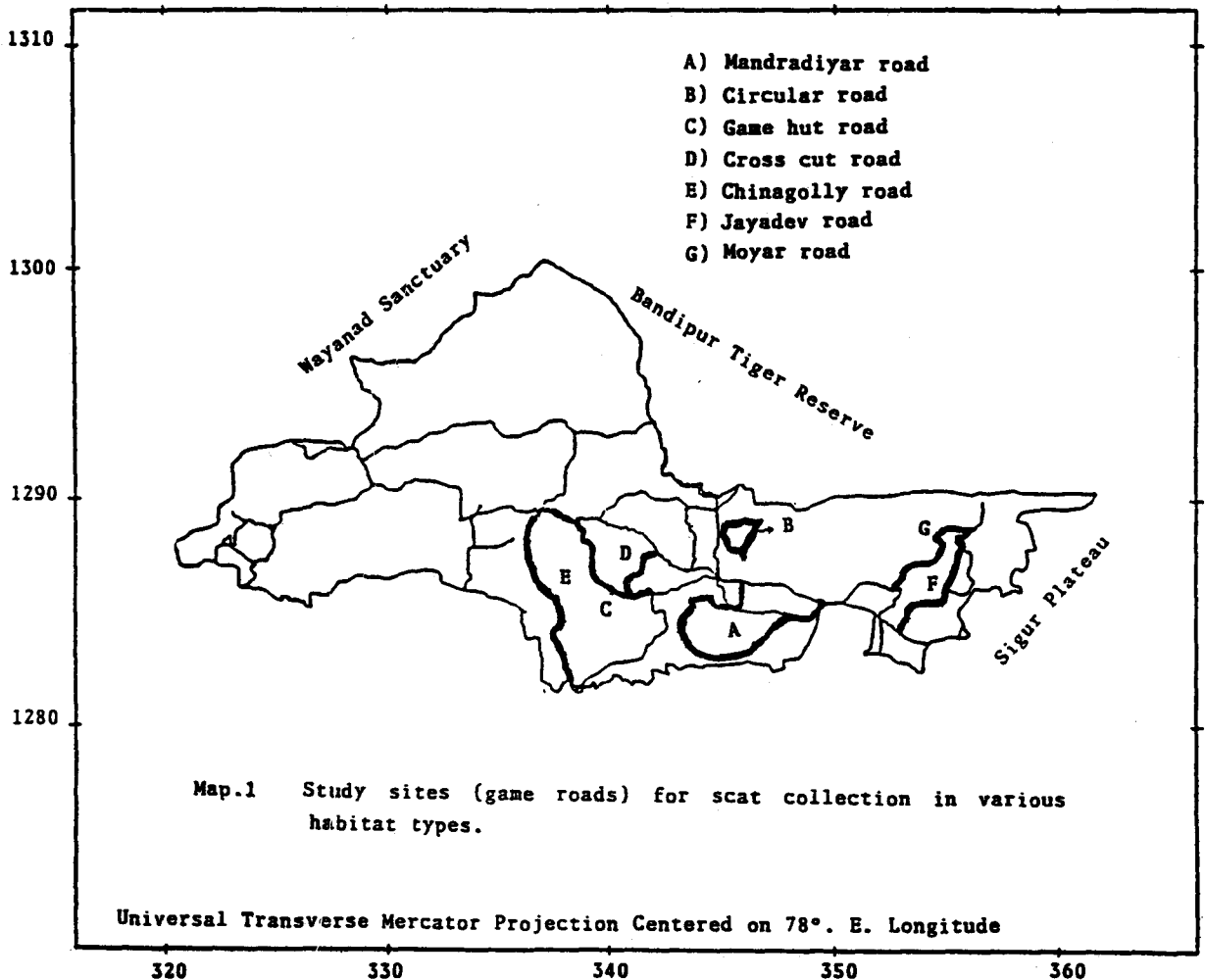


Fig. 1. Map of Mudumalai wildlife Sanctuary showing game roads used for scat collection.

STUDY AREA

The Mudumalai Wildlife Sanctuary is situated ($11^{\circ} 30' N$ to $11^{\circ} 39' N$ and $76^{\circ} 27' E$ and $76^{\circ} 43' E$) in the Nilgiri District of Tamil Nadu and forms a part of the Nilgiri Biosphere Reserve (Fig. 1).

Most of the area has a gentle undulating terrain with elevation ranging from 920 to 1020 m. The temperature varies from 14° - $17^{\circ}C$ in December and January to 24° - $33^{\circ}C$ in March, April and May. Average annual rainfall varies from 900 mm to 1800

mm with most of the rainfall from the southwest monsoon (June to August) followed by the northeast monsoon (October to November). Based on the rainfall, three seasons can be identified: first wet season (May to August), second wet season (September to December) and dry season (January to April). Moyar, a perennial river which flows along the eastern boundary, drains the area.

The study area harbours a spectacular mammalian community consisting of Elephants (*Elephas maximus*), Gaur (*Bos gaurus*), Sambar

(*Cervus unicolor*), Chital (*Axis axis*), Barking deer (*Muntiacus muntjak*), Mouse deer (*Tragulus meminna*), Fourhorned Antelope (*Tetracerus quadricornis*), Common Langur (*Presbytis entellus*), Bonnet Macaque (*Macaca radiata*), Tiger (*Panthera tigris*), Leopard (*Panthera pardus*), Striped Hyena (*Hyaena hyaena*) and Dhole (*Cuon alpinus*).

We conducted field work from March, 1990 to February, 1991 in the tourism zone of the sanctuary, which is approximately 100 sq. km in extent. The study area comprises five broad vegetation types; dry deciduous short grass forest (DSG), dry deciduous forest (DDF), dry deciduous tall grass forest (DTG), moist mixed deciduous forest (MMF) and thorn forest (TFT). The thorn forest is degraded due to cattle grazing. These vegetation types are located close to each other, except the thorn forest which is located on the eastern boundary of the sanctuary. Therefore, scat collection from each of the vegetation types does not really reflect the diet of the bear with regard to habitat, except for the thorn forest. Detailed descriptions of these habitats have been given by Sivaganesan (1991).

METHODS

Food habits

The food habits of sloth bear were studied by examining scats (Landers *et al.* 1979, Maehr & Brady 1984). Scats were collected from the game roads every fortnight. Game roads such as Mandradiyar Avenue in DSG areas, Circular road in DDF, Game hut and Cross cut roads in DTG, Chinagolly road in MMD and Jayadev and Moyar road in TFT were chosen for scat collection and vegetation studies (Fig. 1). In addition five unused watch towers frequented by bears for resting, especially during the wet seasons, were also visited periodically for scat collection.

Fresh scats were collected and preserved in 10% formalin for further examination. Each scat mass was immersed in a plastic tray containing water and food materials were segregated visually. Remains of ants and beetles were also segregated.

Wax and bee remains in the scats were considered as evidence of a honey diet by the bear. Seeds of various fruit trees were also segregated from the scats up to species level. All the segregated food items were kept in a hot air oven at 60°C and later weighed separately.

Diet composition was estimated in terms of percent occurrence (number of times each food item appeared in the diet/total number of scats) and percent dry weight (dry weight of individual food item/total dry weight of all food items). Variation with regard to diet composition was estimated for three seasons; first wet (May to August), second wet (September to December) and dry seasons (January to April).

To assess fruiting seasonality and availability a total of 10 individuals of each species of important fruit trees: *Cassia fistula*, *Cordia domestica*, *Grewia tiliifolia*, *Syzygium cumini*, and *Ziziphus mauritiana* were marked permanently and monitored fortnightly. Phenological phases such as vegetative phase; sprouting, young and mature leaves and reproductive phase; flowers, unripe and ripe fruits were assessed independently by giving percentage rating for each of them (Guy *et al.* 1979, Riper 1980).

Variation in the availability of fruits among seasons and habitats was tested by Two way-ANOVA. The relationship between fruit availability and utilization by the bear was tested with Pearson correlation co-efficient (r).

Density and diversity of trees

Density of trees of > 20 cm GBH (girth at breast height) was estimated using varying lengths of belt transects with 10 m width on either side of the game roads. Species name and GBH for all trees were recorded from the transects. We quantified density of food trees to determine relative proportion of fruit trees available to sloth bear in each habitat.

RESULTS

Overall dietary composition

Examination of all the 567 scats had revealed that fruit remains of various plant taxa dominated

the overall diet of the sloth bear (Table 1), forming 87.9% of the dry weight. Both plant and animal remains were present in all scats.

At least 20 plant and grass species, nearly 3 groups of insects and bird remnants (single occurrence) were recorded. Fruits of pulpy *Cassia fistula*, *Syzygium cumini*, *Ziziphus mauritiana* and *Cordia domestica* were the most frequently used. The

TABLE I

PERCENT FREQUENCY AND PERCENT DRY WEIGHT OF DIFFERENT FOOD ITEMS IN 567 SCATS

Food items	% Frequency	% Dry weight
Trees		
<i>Anogeissus latifolia</i>	0.52	0.01
<i>Bridelia retusa</i>	0.35	0.06
<i>Cassia fistula</i>	23.46	17.12
<i>Cordia domestica</i>	7.05	1.00
<i>Cordia obliqua</i>	0.18	0.05
<i>Diospyros melanoxylon</i>	0.35	0.02
<i>Diospyros montana</i>	0.88	1.00
<i>Ficus</i> spp.	0.88	0.43
<i>Grewia tiliaefolia</i>	3.70	0.80
<i>Schleichera oleosa</i>	0.71	0.001
<i>Semecarpus anacardium</i>	0.18	0.01
<i>Syzygium cumini</i>	22.22	44.68
<i>Ziziphus mauritiana</i>	9.35	18.54
Woody shrubs		
<i>Grewia hirsuta</i>	4.94	2.00
<i>Lantana camara</i>	10.05	1.68
<i>Toddalia asiatica</i>	0.18	0.001
Climbers		
<i>Ziziphus oenoplia</i>	0.35	0.21
<i>Ziziphus rugosa</i>	0.88	0.09
Grasses		
<i>Setaria intermedia</i>	4.41	0.11
<i>Sporobolus</i> sp.	0.18	0.002
Unidentified	7.05	0.09
Animal material		
Ants	69.49	6.88
Beetles / Grubs	1.41	0.04
Honeybees / Wax	7.94	1.47
Termites	44.44	3.68
Unidentified bird feather	0.18	0.02

same four species also dominated the diet in terms of percent dry weight, although there were differences between percent occurrence and percent dry weight. The animal food used by the bear were black and red ants, termites and honey bees. Among animal material, ants and termites occurred often, indicating their importance to the bear as a source of protein rich diet. Ants and termites also formed a major part of percent dry weight.

Occurrence of plant and animal remains did not vary much across vegetation types, indicating similarity in use pattern of food items by sloth bear between vegetation types. But contribution to dry weight by animal matter varied from 9.5% to 21.2% between vegetation types. Ants formed a major part of the animal matter in all the vegetation types except in the thorn forest. With regard to the plant matter used by the sloth bear, 1 to 3 species alone have contributed more than 75% of dry weight irrespective of vegetation types. It is interesting to note that the same food species were found across vegetation types and the major difference was only in minor food species which contributed < 5% of the dry weight.

Forage ratio

Fruit utilization was significantly different across vegetation types in various months (Kruskal one way analysis: $H=25.85$; $df=11$; $P < 0.05$). Likewise, consumption of animal matter varied significantly in different vegetation types across months (Kruskal one way analysis: $H=31.35$; $df=11$; $P < 0.05$). Overall ratio indicated that fruits appeared to be the principal diet of the bear in all vegetation types. By contrast, animal matter formed a small component of the total diet.

Seasonal diet

Relative contribution of animal material was highest in the second wet season (76%.8%) and least in dry season (20.6%) (Table 2).

The same trend was indicated by percent occurrence of animal and plant materials across seasons. Among animal materials ants dominated from more than 65% of animal materials in all seasons (Table 2). Among plants, the total number of species used was highest in dry months.

TABLE 2
PERCENT FREQUENCY AND % DRY WEIGHT OF VARIOUS FOOD ITEMS OF SLOTH BEAR IN VARIOUS SEASONS

Food items	I wet N=272		SEASONS II wet N=131		dry N=164	
	% F	% D.Wt	% F	%D.Wt	% F	%D.Wt
Trees						
<i>Anogeissus latifolia</i>	00.83	00.01	-	-	0.51	00.02
<i>Bridelia retusa</i>	-	-	-	-	2.67	1.56
<i>Cassia fistula</i>	21.32	15.50	01.34	00.06	45.65	37.47
<i>Cordia domestica</i>	14.23	3.45	-	-	2.67	0.78
<i>Cordia obliqua</i>	-	-	-	-	0.29	0.03
<i>Diospyros melanoxylon</i>	-	-	-	-	1.25	0.18
<i>Diospyros montana</i>	-	-	-	-	2.83	3.73
<i>Ficus</i> spp.	2.01	1.75	1.25	0.44	1.12	0.59
<i>Grewia tiliaefolia</i>	7.13	2.49	0.62	0.58	-	-
<i>Schleichera oleosa</i>	1.17	0.03	-	-	-	-
<i>Semecarpus anacardium</i>	-	-	-	-	0.83	0.92
<i>Syzygium cumini</i>	35.70	38.68	6.44	6.42	-	-
<i>Ziziphus mauritiana</i>	-	-	0.71	0.92	15.36	12.50
Shrubs						
<i>Grewia hirsuta</i>	-	-	8.47	7.25	12.31	12.21
<i>Lantana camara</i>	8.03	0.32	17.11	4.28	9.39	4.18
<i>Toddalia asiatica</i>	0.18	0.002	-	-	-	-
Climbers						
<i>Ziziphus oenoplia</i>	-	-	-	-	1.61	4.41
<i>Ziziphus rugosa</i>	-	-	0.56	0.59	2.18	0.32
Grasses						
<i>Setaria intermedia</i>	4.75	0.58	14.77	1.04	0.62	0.01
<i>Sporobolus</i> sp.	-	-	-	-	0.62	0.01
Unidentified matter	4.75	0.58	15.39	1.57	10.71	0.37
Animal material						
Ants	67.76	24.46	91.15	52.04	60.37	15.22
Beetles / grubs	3.40	0.23	-	-	-	-
Honeybees / wax	15.48	4.23	-	-	-	-
Termites	29.86	7.64	65.78	24.78	45.58	5.41
Unidentified bird feather	0.18	0.03	-	-	-	-

(% F - percent frequency. % D.Wt. - Percent dry weight)

During the dry season, fruit remains of 17 plant species were recorded from 164 scats. For instance, *Cassia fistula* was used by the bear in the first wet and dry seasons. Remains of *Syzygium cumini* were noticed in the scats only from wet seasons while *Ziziphus oenoplia* was recorded only in the dry season.

More or less similar plant taxa were used by sloth bear between vegetation types. However, occurrence of these species in the scats differed between the seasons. The use of animal materials increased from the first wet season onwards with ants and termites dominating the diet.

Density of fruit trees

A total of 8 tree species was recorded from 6.2 ha in DSG. The pulpy fruit *Cordia* spp. was the most common food tree (3.6/ha) followed by *Grewia tiliaefolia* (1.8/ha) (Table 3).

TABLE 3
DENSITIES OF FRUIT TREE SPECIES IN VARIOUS
HABITAT TYPES IN MUDUMALAI WILDLIFE
SANCTUARY, TAMIL NADU

Tree Species	DSG	DDF	DTG	MMD	TFT
<i>Bridelia retusa</i>	-	-	2.39	1.00	-
<i>Cordia domestica</i>	0.16	0.56	1.09	17.00	1.25
<i>Cordia</i> spp.	3.58	-	-	-	-
<i>Cassia fistula</i>	0.48	1.27	12.17	7.00	0.97
<i>Ficus</i> spp.	0.64	0.14	-	-	-
<i>Grewia tiliaefolia</i>	1.77	6.62	5.00	19.75	0.28
<i>Odina wodier</i>	0.48	-	0.43	-	-
<i>Schleichera oleosa</i>	0.64	0.14	0.43	0.25	-
<i>Syzygium cumini</i>	0.64	-	7.83	0.75	-
<i>Ziziphus mauritiana</i>	-	-	-	-	2.78
Area sampled (ha)	6.2	14.2	4.6	4.0	7.2

The densities of the other food species did not vary much, revealing that only a few species were common in the DSG. In DDF only 5 fruit tree species were recorded. *Grewia tiliaefolia* was most common (6.6/ha.) followed by *Cassia fistula*. Of the 7 fruit tree species in DTG, *Cassia fistula*, *Syzygium cumini* and *G. tiliaefolia* were the most abundant, indicating rich fruit resources for the sloth bear in DTG. Of the 6 species of fruit trees in MMD, *Cordia domestica* and *Grewia tiliaefolia* were the most abundant. In TFT only 4 species were available and the most abundant was *Ziziphus mauritiana* with a density of 2.8/ha. It is important to note that *Syzygium cumini* is more distributed along wet areas and hence it was not recorded in vegetation study but later found in the diet.

Fruit availability versus utilization

Fruiting seasonality of tree species varied among the vegetation types and utilization of fruits by the bear also varied accordingly (Fig. 2).

Availability of fruits significantly varied across the seasons (Two way-ANOVA; $F=2.82$ $P < 0.05$) but not between vegetation types. There was positive correlation between fruit availability and utilization by the bear in DSF ($r=0.58$; $P < 0.05$) and in TFT ($r=0.59$; $P < 0.05$). Use of various fruits by the bear showed considerable variation at least in some habitats in relation to their availability.

DISCUSSION

Food habits

In the study area the sloth bear is an omnivore, eating plant and animal (insects) food, but plant materials constitute a major part of its diet throughout the year. Prater (1965), Schaller (1969), Prue and Napier (1977) and Davidar (1983) have also reported a similar diet. Plants contribute a part of the diet in several bear species (Himalayan black bear: Schaller 1969, Manjrekar 1989; American black bear: Landers *et al.* 1979, Maehr and Brady 1984; Grizzly bear: Mace and Jonkal 1986 and Brown bear: Cicnjak *et al.*, 1987 and Odhachi and Aoi 1987).

Syzygium cumini, *Ziziphus mauritiana* and *Cassia fistula* were major components of the diet, although these species were unevenly distributed across the study area. Schaller (1969) observed preference for some palatable fruits by Himalayan black bear. Landers *et al.* (1979) reported that the black bear fed on plenty of sweet gallberry.

Seasonal diet

The significant relationship between fruit availability and utilization shows that seasonal diet was influenced by fruiting phenology. The positive correlation between fruit availability and utilization by bears has been reported in some other studies also (Laurie and Seidensticker 1977, Amstrup and Beecham 1976, Cicnjak *et al.*, 1987). In this study, the higher utilization of fruit in the first wet season was related to peak fruiting season.

The higher occurrence of animal materials in the second (II) wet season scats could also be due to poor availability of fruits in that season.

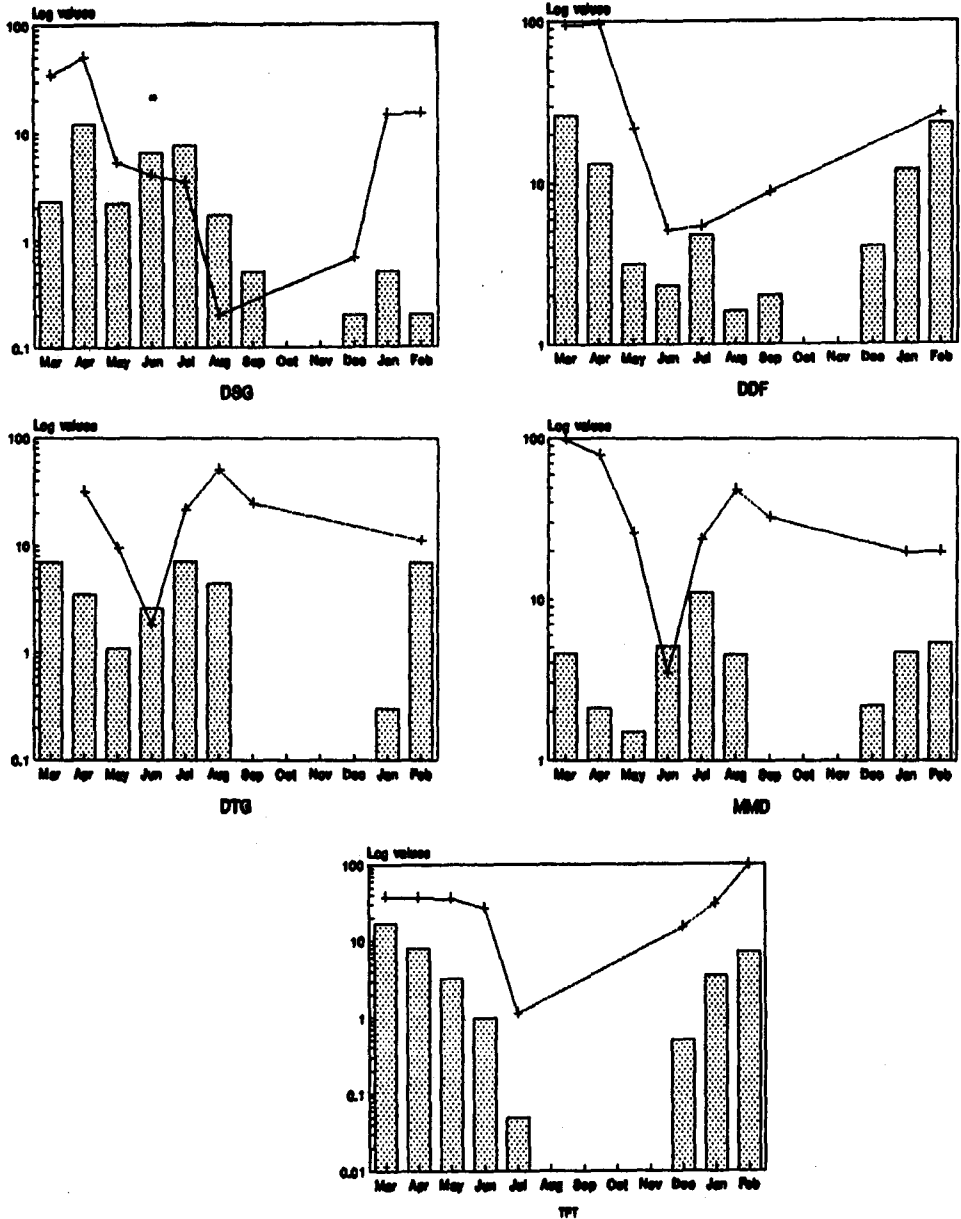
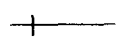


Fig. 2. Ripe fruit availability (%) and utilization (%) of them by sloth bear in various habitat types
 A. DSG - Dry Deciduous Short Grass Forest; B. DDF - Dry Deciduous Forest;
 C. DTG - Dry Deciduous Tall Grass Forest; D. MMD - Moist Mixed Deciduous Forest; E. TFT - Thorn Forest.



Ripe Fruit Availability



Utilization

Furthermore, fleshy fruits such as *S. cumini* were uncommon in II wet season and thus its share in the diet in terms of dry weight was reduced considerably. On the other hand, in the overall ratio fruit remains dominated due to the occurrence of more *S. cumini* which has more seed weight. This could be a reason for the variation of plant and insect ratio between wet and dry seasons. Murali and Sukumar (1993) found a correlation between insect abundance and rainfall during wet seasons in the same study area. Schaller (1967) and Davidar (1983) have reported the utilization of insects by sloth bear during the wet season. It has been reported that the exploitation of animal material could be to get more protein, since ants contain over 50% protein (Southwood 1973). Wackernagel (1961) stated that for the healthy growth of omnivorous animals, including bears, the diet must contain about 15% crude protein. The consistent occurrence of ants and termites in low quantity throughout the study period support the view of Cicnjak *et al.* (1987).

Fruit dominated the food during the dry season because of its availability. Landers *et al.* (1979) reported that summer fruits eaten by black bears contained more sugar, water and high nitrogen free extracts. Robbins (1983) also stated that fruits are rich in soluble carbohydrates and minerals. However, the importance of fruits in the dry season is not necessarily always the case in different regions. For example, in Mundanthurai Plateau at Kalakad - Mundanthurai Tiger Reserve, Tamil Nadu the scats of sloth bear contained more insect material during the dry season (Gokula 1991). The utilization of honey in DTG revealed their accessibility to sloth bear. In many places local people compete with the bear by removing honey combs which could have been available to the animal. The illegal collection of honey by local

people may have a significant impact on the use of animal material by the bear.

Density of fruit trees

The study clearly indicates that DSG and TFT appear to be crucial foraging grounds for the sloth bear, because of greater availability of fruit species namely *Cordia* spp., *Grewia tiliaefolia*, *Ficus* spp., *Schleichera oleosa* and *Syzygium cumini*. The study also revealed the importance of *S. cumini* to the bear throughout the year.

The immediate threat to the bear in thorn forest is loss of ground cover through severe grazing by cattle. In these areas vegetation types intensively used by the bear are nullahs, dry stream beds, gallery forests and valleys. These microhabitats should be preserved and protected from biotic pressures. Forest authorities should enforce strict management policy for banning collection of honey at least from the tourism zone of the sanctuary, where the local people remove a considerable amount of honey from the forests during the wet season.

ACKNOWLEDGEMENTS

We acknowledge financial assistance to the first author (NB) from the Sálím Ali Nature Conservation Fund of the Bombay Natural History Society (BNHS), and especially Mr. J.C. Daniel for his strong support for funding. Dr. V. Krishnamoorthy is thanked for his encouragement and field support. We thank Mr. Ajay A. Desai for critical comments on the manuscript, the staff of the Mudumalai Wildlife Sanctuary for all logistic support and necessary permission to conduct the field study, and Dr. Ajith Kumar for his comments. Trackers Krishnan, Late Chennan and Bomma helped us in the field.

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