

Characteristics of sloth bear day dens and use in disturbed and unprotected habitat of North Bilaspur Forest Division, Chhattisgarh, central India

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Abstract: There is very little published information on denning ecology of sloth bears (*Melursus ursinus*). We identified 109 day dens in Pendra and Marwahi ranges of North Bilaspur Forest Division. Except for 3 dens, all sloth bear day dens were found in hillocks made of boulders. Annual mean temperature outside and inside the dens in daytime was 39.0°C ($n = 104$, $SD = 4.1$) and 28.4°C ($n = 104$, $SD = 3.9$), respectively. Ninety-five of the 109 day dens were characterized by the presence of gusti (*Ficus virens*), pakri (*Ficus tinctoria*), and tendu (*Diospyros melanoxylon*) trees. On average, vegetation cover in a 10-m radius circle around day den centers was 14.8% ($n = 109$, $SD = 8.3$). To provide protection to sloth bear habitat, we recommend that the Forest Department should stop stone extraction and regulate grazing and removal of firewood and timber from hillocks that have day dens.

Key words: aspect, cover, day den, hillock, human settlement, *Melursus ursinus*, sloth bear, temperature

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Denning behavior among bear species varies and has different purposes. Denning to escape adverse climatic condition and scarcity of food is typically associated with hibernation and producing cubs (Smith 1986, Manville 1987). These species typically have some physiological and body adaptation (e.g., accumulation of fats, low rate of metabolism) that are favorable for extended periods of hibernation (i.e., 2–5 months; Hellgren 1988, Ryan 1997, McLoughlin et al. 2002). However, some bear species do not hibernate. Sloth bears (*Melursus ursinus*), an endemic to Indian Subcontinent, are only found in low elevation areas where climates are warm; they do not accumulate fats or change their rate of metabolism and hence do not hibernate (Ward and Kynaston 1995, Middleton 1996). Parturition occurs in day dens but without hibernation. We use the term “day den” to refer to a shelter where sloth bears spend time after nocturnal foraging. Day den availability and use are important components of sloth bear ecology but are poorly understood (Wathen et al. 1986, Kolenosky and Strathearn 1987, Hellgren and Vaughan 1989).

Day dens may be important for sloth bear survival and reproduction especially in unprotected or

disturbed areas. Hence, knowledge of this topic may be important when formulating conservation strategies. To that end, we investigated the denning characteristics of sloth bears.

Study area

The study was carried out in the Pendra and Marwahi ranges of the North Bilaspur Forest Division (Nbfd) of Chhattisgarh between 22°40'N and 23°06'N and 81°44'E and 82°13'E, covering an area of 1,395 km² (Fig. 1). Forest cover was patchy and scattered, covering an area of 337 km². Forest blocks in the area ranged from 11 to 97 ha. The human population was approximately 200,000 and the livestock population was over 150,000.

The study area lies in one of the oldest mountain chains of India, which are known as the Vindhya or Maikal range. This area is a part of the Eastern Deccan Biogeographical Zone (Rodgers and Panwar 1988). The topography is undulating, interspersed with chains of hillocks and rocks, and ranges in elevation from 450 to 1050. Some hillocks were isolated and surrounded by villages. Bouldery hillocks in forests provide day dens to sloth bears.

One major river, the Son, flows through this area, and there are several seasonal streams. Mean temperatures from December to February range

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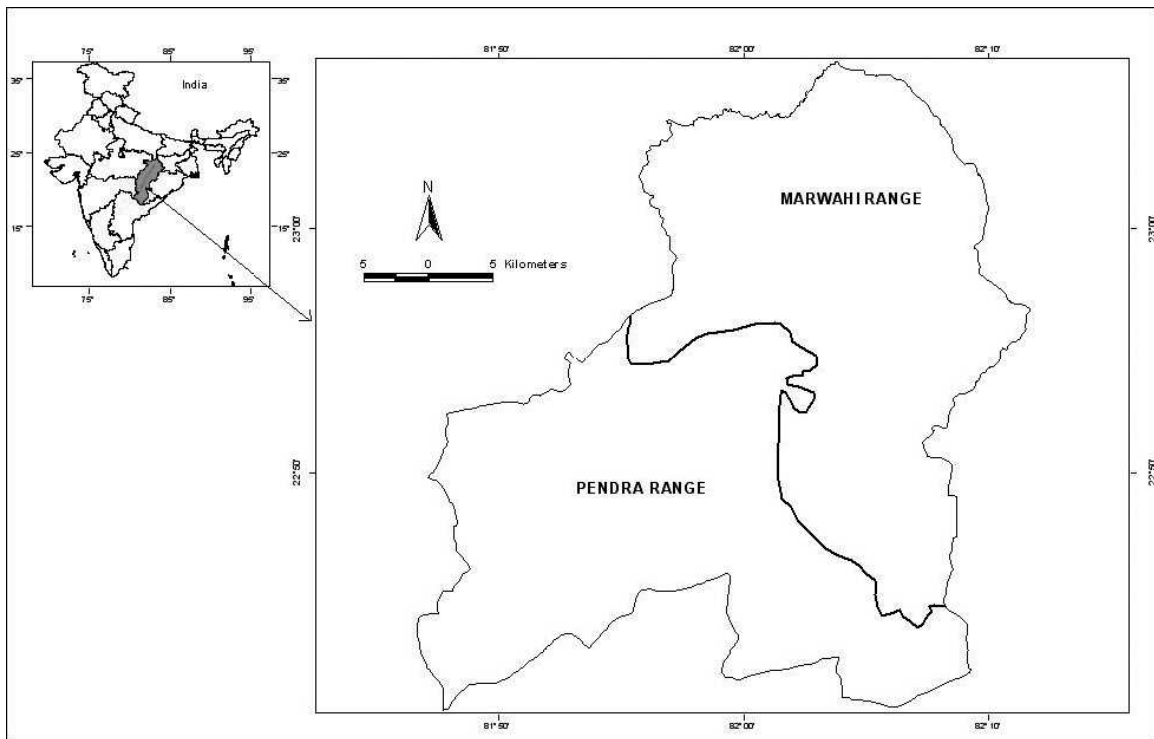


Fig. 1. Study area in North Bilaspur Forest Division, Chhattisgarh, India.

from 24.5°C to 27.1°C. Temperature averages 10.7°C during winter nights (Nov–Feb), but can drop as low as 2°C. Average rainfall of this region is 1,376 mm, 85% of which comes during the monsoon (Jul–Oct). Incidences of ground fire are frequent during summer (Mar–Jun). Champion and Seth (1968) classified the forest types of the area as dry deciduous peninsular sal forest, northern tropical dry mixed deciduous forest, and northern tropical secondary moist mixed deciduous forest.

In addition to sloth bears, other large mammals in this area include leopard (*Panthera pardus*), spotted deer (*Axis axis*), hyaena (*Hyaena hyaena*), jackal (*Canis aureus*), Indian fox (*Vulpes bengalensis*), four-horned antelope (*Tetracerus quadricornis*), wild pig (*Sus scrofa*), common langur (*Semnopithecus entellus*), rhesus macaque (*Macaca mulatta*), toddy cat (*Paradoxurus hermaphroditus*), and Indian porcupine (*Hystrix indica*).

Methods

The entire study area was surveyed using 1-km transects ($n = 78$) in all representative habitats to

locate sloth bear day dens. Local residents were contacted to collect information on bear occurrence and day den use. Sloth bear day dens were identified from sightings of bears as well as the presence of sign (scats, digging, and claws marks). We recorded GPS locations for each den. We recorded tree and shrub species within a 20-m radius of the den and vegetation cover within a 10-m radius. Times of sloth bear emergence and return to day dens were observed during daylight hours, April–August, 2002–2004. Daylight hours in winter, summer, and monsoon seasons were 0630–1730, 0500–1900, and 0545–1830 hr, respectively. We recorded outside and inside temperatures at 10 randomly selected day dens, 2 days each week for every month during 2003. Thermometers were placed inside dens using a bamboo stick and the temperature was recorded at 1-hour intervals from 0900–1500 hrs. We pooled mean temperatures for each day and month. Differences between outside and inside temperatures were tested for significance using paired *t*-tests (SPSS Inc. 1998). Use of bear dens by other animals was also recorded to assess interactions and sharing of dens by other animals.

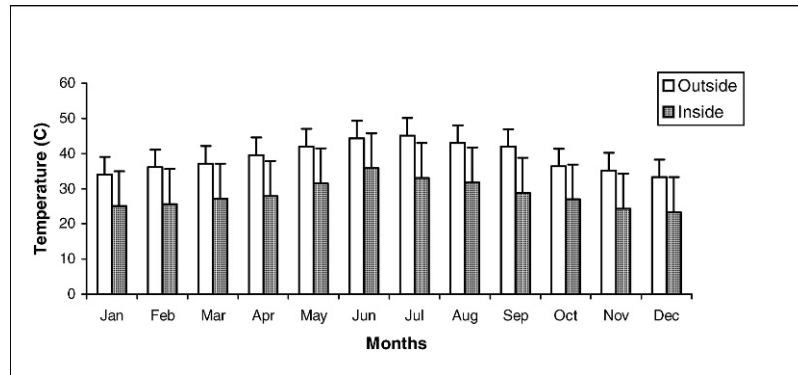


Fig. 2. Temperature inside and outside sloth bear dens in North Bilaspur Forest Division, Chhattisgarh, India, 2003. Error bars are 1 SD.

Results

Of the 109 day dens we identified, 106 were located in forest patches. Of these 109 day dens, we characterized 56 as used 'regularly' whereas bears remained only 5–90 days at the remaining 53 day dens.

Structure of bear dens

Sloth bear dens were found only on hillocks that had boulders >80 cm in perimeter or on hillocks made of stacks of boulders. Generally, a den had multiple, unconnected chambers of various sizes with multiple openings. Chambers varied in size from 1.2–9.8 m³ and all dens in hillocks had >6 compartments. Some hillocks had 2 or more day dens separated by vegetation. Three dens were found in the sand banks of nullas in Sal forests.

Temperatures in and near dens

Annual mean temperatures outside and inside the dens in daytime were 39.0°C ($n = 104$, $SD = 4.1$) and

28.4°C ($n = 104$, $SD = 3.9$), respectively. Mean temperatures were highest (44.0°C, $n = 34$, $SD = 1.3$ outside and 32.3°C, $n = 34$, $SD = 0.9$ inside) during the monsoon (Jul–Oct). In summer (Mar–Jun), temperatures were 38.7°C ($n = 36$, $SD = 1.1$) and 28.0°C ($n = 36$, $SD = 0.7$) and in winter (Nov–Feb), temperatures were 34.7°C ($n = 34$, $SD = 1.2$) and 24.8°C ($n = 34$, $SD = 0.9$), inside and outside, respectively (Fig. 2). Outside den temperatures were significantly hotter than inside during all months (paired $t = 62.5$, 103 df, $P < 0.001$).

Aspect and vegetation at day dens

Forty-three of the 109 dens faced south, followed by 21 facing southeast, and 12 facing north-east (Fig. 3). Ninety-five of the 109 day dens used by bears were characterized by the presence of the tree species *Ficus virens*, pakri (*Ficus tinctoria*), tendu (*Diospyros melanoxylon*), salai (*Boswellia serrata*), bel (*Aegle marmelos*), and gunja (*Lannea*

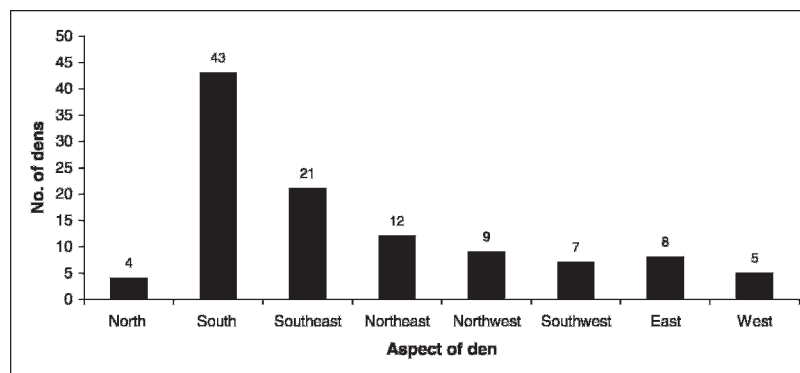


Fig. 3. Aspects of sloth bear dens in North Bilaspur Forest Division, Chhattisgarh, India, 2002–2004.

Table 1. Vegetation cover at sloth bear dens in North Bilaspur Forest Division, Chhattisgarh, India, 2002–2004.

Cover (%)	No. of dens
0–5	10
6–10	32
11–15	27
16–20	18
21–25	10
26–30	6
>31	6
Total	109

coromandelica), and by the presence the shrub species malhin (*Gardenia gummifera*), gothar (*Ziziphus xylopyrus*), jhad beri (*Ziziphus nummularia*), and kirkich (*Acacia pennata*). However, in Sal forest habitat, other species such as karra (*Cleistanthus collinus*), saja (*Terminalia alata*), and ber kateli (*Solanum surattense*) were found. On average, vegetation cover was 14.8% ($n = 109$, $SD = 8.3$; Table 1).

Discussion

Day dens are synonymous with shelters for sloth bears in Nbfd, but the characteristics of dens vary. Sloth bear day dens have been documented in tropical and moist deciduous forest areas in Nepal and Sri Lanka (Eisenberg and Lockhart 1972, Laurie and Seidensticker 1977, Garshelis et al. 1999, Desai et al. 1997), where bears used crevices between big boulders and spaces between terrestrial roots of many tree species for shelter. Moreover, we observed sloth bears making day nests in loose mud in Rajaji National Park (NP), Corbett NP, and Dudhwa NP in northern India, but in the central Indian highlands including Nbfd and south India, sloth bears used bouldery hillocks as day dens. There were more active dens in the forests of Marwahi than in the Pendra range, presumably because of low availability of boulders within the Pendra range.

Bears occupied almost 73% of the Nbfd, but there were no bears near the towns of Basantpur, Pendra, Semra, Gaurela, and Murmur in the Pendra range, or near the towns of Kudri, Kotmi, Kurkai, and Patgawa in the Marwahi range (Akhtar 2004). We speculate that this may relate at least in part to availability of day dens. There were 24 small hillocks in these areas, but they were completely surrounded by human settlement and crop fields and had no day dens. Further, the hillocks had a high degree of

disturbance from stone extraction and grazing. Most of the vegetation in this area had been removed by villagers for firewood and timber. Hence, bears likely were forced to leave such areas. According to residents, these areas were inhabited by sloth bears about 30 years ago.

Locations of day dens and radiotelemetry study of sloth bears in Nbfd revealed that sloth bears covered small home ranges (3.5–19.5 km²) and obtained most of their food from villages (Akhtar et al. 2004, 2007). Food availability in the forests was low, forcing bears to visit villages. Sixty-five of the 109 bear dens had villages within 1 km. Only 13 dens were distant (1.25–2.25 km) from human settlement (Akhtar et al. 2004). We speculate that availability of sloth bear foods associated with villages was a major factor behind sloth bear use of day dens close to villages. Water was not a limiting factor behind the location of dens, as it was plentiful across the study area (Akhtar 2004).

Although rigorous data were not collected, it appeared that bears emerged from shelter sites in late evening, and, after nocturnal foraging, returned to dens in early morning. However, because we did not monitor den sites in the darkness, our observations may not accurately reflect this aspect of the bears' use of day dens. People ventured into the forests for livestock grazing and collection of non-timber forest produce and fuelwood. The presence of villagers on the landscape during daylight may restrict bear movement and result in bears remaining in or near dens until dark. Emergence and activity of bears near den sites may depend on the intensity of human disturbance. Many times it appeared that bears delayed their emergence from dens and hastened their reentry after nocturnal foraging because of disturbance caused by human activity.

Temperature may have played a role in determining when bears emerged in hot weather during the summer (Mar–Jun) and monsoon (Jul–Oct) seasons. Hillocks of boulders provided cool and safe shelter during the summer. Bears were observed to move toward water just after the onset of darkness in summer.

Ficus virens and *F. tinctoria* trees were present at 95 of the 109 dens; bears also eat the fruits of these trees. Most of the day dens were south facing and had little cover. However, these dens had thick vegetation cover in peripheral areas (i.e., beyond the 10-m radius around the den). Hillocks of boulders are not conducive to vegetation growth, and aspect

of dens did not seem to have a role in site selection. Rather, selection of day dens likely depends on availability of boulders and food resources and on human disturbance.

The space under the large boulders of hillocks also provided shelter to other animals. We observed use of 45 of the 109 bear day dens by other animals, including leopard, hyena, jackal, Indian fox, and common Indian mongoose (*Herpestes javanicus*). In 80 observations, other animals were seen either just before or after the bears emerged. On 2 occasions, we observed a leopard and a sloth bear emerging from a day den at the same time and rest for some time on different boulders.

Food availability and intensity of human disturbance may have played a role in determining day den selection and may have influenced when sloth bears emerged from and returned to their dens. Hence, we recommend that the Forest Department restore bear habitat, especially food availability in forests, through planting of fruit-bearing tree species. We also recommend that efforts be made to reduce human dependence on forest products, to regulate human movements in the forests, and to stop or reduce stone extraction, grazing, and removal of firewood and timber from hillocks that have day dens. In addition, local residents need to be educated about bear biology, conservation, and ways to avoid bear encounters. We also recommend that residents be involved in forest and bear management.

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