

## SEASONAL OCCURRENCE OF PLANT SEEDS IN SLOTH BEAR DIETS IN EASTERN INDIA

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### Abstract

*Bears often consume fleshy fruits and disperse significant quantities of the enclosed seeds. In tropical forest of India, sloth bear play an important role in dispersing seeds and play a vital role in maintaining ecosystem structure and functions. Scat analysis showed that sloth bears ate increasing quantity of fruit through winter and summer. Scats commonly contained several species of seeds often of one or more species. Nineteen seed species were recorded representing 10 families in sloth bear scats, the most common of which were *Ziziphus mauritiana*, *Ficus benghalensis*, and *Cassia fistula*. Seed occurrence overall was highest during the summer season, when seasonal fruits are more available. The study suggests that fruit represents an important component of sloth bears diet and may play an important ecosystem role as seed dispersers.*

### INTRODUCTION

Animals play an important role in the seed dispersal of many plants. Seed dispersal by vertebrates is one of the main plant-animal interactions, especially in the tropical forest where fleshy fruits are the main seasonal food resources for birds and mammals. Considerable information has accumulated in recent years on the ecology of frugivory and seed dispersal by vertebrates in temperate and tropical habitats (Estrada & Fleming, 1996). The significance of large herbivorous mammals in seed dispersal has also been documented in detail in recent

years (Sridhara et al., 2016). In contrast, the role of carnivorous mammals in seed dispersal remains unknown (Hämäläinen et al., 2017). Many mammalian carnivores ingest large quantities and varieties of fruits is well established (Hämäläinen et al., 2017; Corlett, 2017). Role as seed-disperser by large carnivore is significant and important for maintaining and establishing the floristic diversity and species composition of forested habitats because their larger foraging ranges and longer seed passage times in their gut (Hutchings et al. 2000). Several carnivores regularly consume plant material, including fruits, seeds, and other plant parts (Willson, 1993; Andresen, 2000). Among the ursidae, many species exhibit flexible and omnivorous diets that frequently include fruit (Young, 1990; McConkey et al. 1999).

The sloth bear (*Melursus ursinus*) is endemic to the Indian subcontinent and has been reported throughout India, occupying diverse habitats from wet or dry tropical forests to savannas, shrublands, and grasslands (Garshelis et al., 1999; Yoganand et al. 2013). However, its historical range has been fragmented and decreased overall because of largescale deforestation to facilitate human development. In addition human-sloth bear conflict, diminished food resources, illegal killing for gall bladders, and taking of young sloth bears from the wild for bear dancing resulted in severe population declines and some local extirpations (Yoganand et al., 2006; Debata et al. 2017). This species is omnivorous and feeds on insects, variety of fruits and berries (Palei et al. 2014). Food habit of sloth bears differs across its distributional range, and need to be understood as it occupies diverse habitats with different vegetation composition.

We present data on the occurrence of seeds in sloth bear from a dry deciduous forest region of eastern India to better understand the importance of fruit as a food item and potential role of sloth bear as a seed disperser. We report the species and frequency of seeds consumed based on an analysis of scats, and tested whether the proportion of seeds in diets varied seasonally. We predicted that fruit consumption would be highest during the winter months for sloth bear, when fruit availability is highest compared with other seasons.

## **MATERIALS AND METHODS**

### **Study area**

Our study area lies in the northern part of the Odisha, eastern India between 20°55'14.94" N to 22°39'22.27" N and 85°13'55.63" E to 87°27'43.30" E extending on three districts of

Keonjhar, Mayurbhanj and Balasore. The hilly and undulating northern and western part of the study area is an extension of Chhotanagpur Plateau of Deccan Peninsula and the belt of eastern plain area is the part of the Gangetic Plains (Sinha, 1971). Elevation of the area ranges from 145 m to 1100 m above sea level. Temperatures range between 10 and 40 °C throughout the region and the annual rainfall varies between 1200 and 1400 mm annually. The climate is described as tropical with three distinct seasons: summer (Mar–Jun), monsoon (Jul–Oct), and winter (Nov–Feb). The region is a complex patchwork of land-use types consisting of forests, agricultural lands and human developments. The area represent a stronghold for sloth bears and other threatened species of large-bodied mammals. However, forest conversion into agricultural farmlands represents a significant threat.

### **Methods**

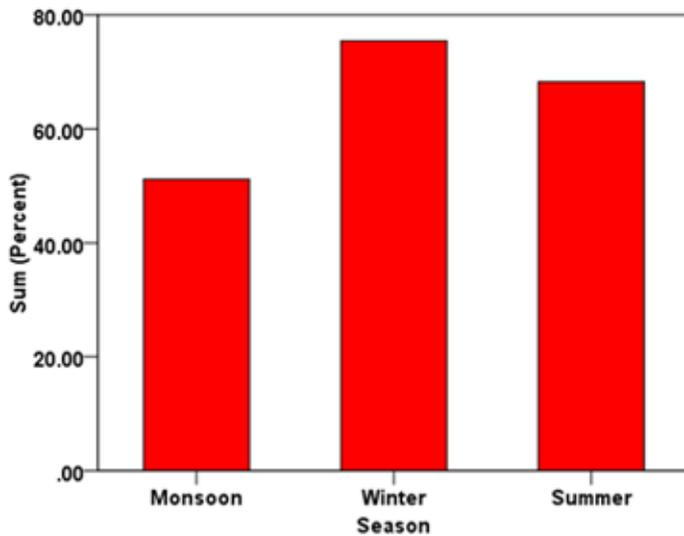
Food of sloth bear was investigated primarily through the analysis of faecal samples. The area was inspected approximately twice a week and searched exhaustively for scats. Fresh scats were collected, sun-dried in the field station and stored individually in freezer bags. Each scat was labelled with records such as location, date of collection and comments on the condition of the scats. In the laboratory, each scat was washed with cold running water through a series of sieves (2.0, 1.0, and 0.5 mm mesh) to clean the mud and debris. Then samples were dried for 24 h in an oven at 40 °C and weighed individually. The cleaned scats were placed in a petri-dish and carefully observed under the microscope. The indigested food items were separated into plant and animal remnants. Plant seeds were identified following Mahapatra and Panda, (2009).

We calculated the proportion of scats with seeds per each species and season. We calculated percent of occurrence of seed species in sloth bear scats. We divided collected scat between three seasons: monsoon (Jul–Oct), and winter (Nov–Feb), summer (Mar–Jun).

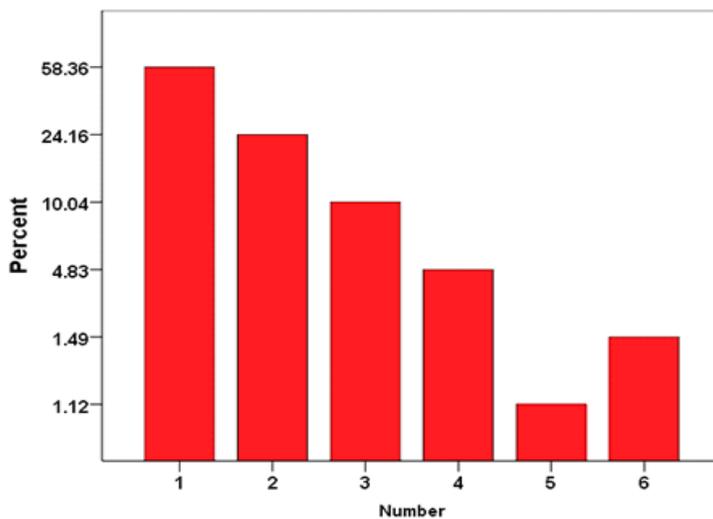
### **RESULTS**

We collected a total of 399 sloth bear scats, of which 88, 163 and 148 were from monsoon, winter and summer respectively. Seeds occurred in 67.4% of sloth bear scats: monsoon (51.1%), winter (75.5) and summer (68.2) (Fig. 1). We recorded 19 seed species representing 10 families in sloth bear scats, the most common of which were *Ziziphus mauritiana*, *Ficus benghalensis*, and *Cassia fistula* (Table 1).

Multiple seed species often occurred in individual scats (Fig 2). Among scats containing seeds, we recorded a mean±SD of 1.18 ±1.15 (range 1–6) species in sloth bear scats: monsoon (0.68±0.76; range 1-3), winter (1.0±0.74; range 1-3) and summer (1.59±1.57, range 1-6). A majority of all seeds collected in scats were whole and intact: only 5% of scats with seeds contained broken seed fragments. Most of the seeds of species like *Arachis hypogaea* (70%) and *Zea mays* (88%) were found broken fragments.



**Fig. 1.** Seasonal occurrence of seeds in sloth bear scats in the study area.



**Fig. 2.** Diversity of seeds observed in sloth bear scats

**Table 1.** Occurrence (O) and percent occurrence (%O) of seeds in sloth bear scats in the study area.

Species	Monsoon		Winter		Summer	
	O	% O	O	% O	O	% O
<b>Rhamnaceae</b>						
<i>Ziziphus mauritiana</i>	0	0	70	42.94	61	41.21
<i>Ziziphus oenoplia</i>	0	0	15	9.2	5	3.37
<i>Ziziphus rugosa</i>	0	0	6	3.68	0	
<b>Arecaeae</b>						
<i>Phoenix acaulis</i>	0	0	0	0	11	7.43
<b>Rutaceae</b>						
<i>Aegle marmelos</i>	0	0	8	4.9	32	21.62
<b>Caesalpinaceae</b>						
<i>Cassia fistula</i>	2	2.27	14	8.58	8	5.4
<b>Moraceae</b>						
<i>Ficus benghalensis</i>	11	12.5	15	9.2	13	8.78
<i>Ficus religiosa</i>	1	1.13	5	3.06	2	1.35
<i>Artocarpus heterophyllus</i>	9	10.22	0	0	11	7.43
<b>Ebenaceae</b>						
<i>Diospyros melanoxylon</i>	0	0	0	0	15	10.13
<i>Diospyros embryopteris</i>	2	2.27	0	0	2	1.35
<b>Anacardiaceae</b>						
<i>Buchanania lanzan</i>	0	0	0	0	15	10.13
<i>Semecarpus anacardium</i>	0	0	9	5.52	13	8.78
<i>Magnifera indica</i>	3	3.4	0	0	11	7.43
<i>Anacardium occidentale</i>	0	0	0	0	10	6.75
<b>Myrtaceae</b>						
<i>Syzygium cumuni</i>	5	5.68	0	0	17	11.48
<i>Syzygium cerasoides</i>	4	4.54	0	0	9	6.081
<b>Fabaceae</b>						
<i>Arachis hypogaea</i>	10	11.36	22	13.5	0	0
<b>Poaceae</b>						
<i>Zea mays</i>	13	14.77	0	0	0	0

## Discussion

Bears are good seed dispersers: they commonly transport germinable seeds up to hundreds of meters from a source, often in appropriate habitat, simultaneously with a load of fertilizer that may influence germination and growth (Willson and Scott, 2004). Although scats

containing numerous seeds produce conditions of high seedling competition, several factors tend to reduce the impact of competition on the effectiveness of dispersal (Harrer and Levi, 2018). Relatively rapid passage through the gut and multiple defecations per day within a bear's home range spread scats over the landscape (Willson and Scott, 2004).

In our study, seeds from a variety of plants regularly occurred in sloth bear diets, including those from species with relatively fleshy fruits like *Ziziphus* sp., *Ficus* sp. and *Syzygium* sp., suggesting that fruit represents an important food item in our study area. Seed occurrence overall was highest during the summer season, when seasonal fruits are more available. Seed occurrence was lowest in the sloth bear diet during the monsoon when insects dominated the diet and wild fruits were not available. In our study area, fruits generally remain started mature through the winter and ripe in summer, indicating that consumption of fruit by sloth bears probably tracks patterns of ripeness (and availability). Studies from other regions reported similar trends (Baskaran et al., 1997; Akhtar et al. 2004; Yoganand et al., 2013; Palei et al., 2014). Most seeds consumed by sloth bear also passed intact and were not visibly destroyed by digestion, further indicating that the species has the potential to act as seed dispersers.

The role of sloth bears as seed dispersers in the tropical ecosystems requires further study, but may partly be evidenced from the high occurrence of some seed species in diet and the potential to transport intact and undamaged seeds to other areas. Sloth bear populations in its range have experienced declines in recent years due to habitat destruction, human-sloth bear conflict, diminished food resources, illegal killing for gall bladders (Garshelis et al., 1999; Yoganand et al., 2013; Palei and Sahu, 2015). Our results suggest that fruit represents an

important component of sloth bears diet and may play an important ecosystem role as seed dispersers.

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