

Diet and feeding habit of Asiatic black bear (*Ursus thibetanus*) in Nanda Devi Biosphere Reserve, Uttarakhand, India

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ABSTRACT

We assessed Asiatic black bear (*Ursus thibetanus*) feeding habit in Nanda Devi Biosphere Reserve (NDBR), Uttarakhand, India, based on sign survey and scat analysis from September 2016 to August 2018. The eight trails were selected, ranged from 1 km to 5 km and covered altogether 71 km ground efforts for collection of black bear feeding signs in forest, based on accessibility, habitat type and geographic representation. A total of 38 scats were collected from the study area, from these, 20 scats were systematically collected from black bear forest habitats and 18 scats were opportunistically collected from agricultural crop fields and villages surroundings. The largest percentage of scats (42%, n = 16) was identified as very fresh (≤ 7 days) to a minimum (10.53%, n = 4) in the very old category (> 3 months). In terms of land use, 18 (47.37%), 2 (5.26%) and 18 (47.37%) scats were found in mixed broad-leaved forests, mixed coniferous forest and agricultural land respectively. Most of the mark on trees were observed in mixed broadleaved forests (66.20%, n = 47), followed by mixed coniferous forests (33.80%, n = 24). Feeding signs were primarily found on Himalayan gooseberry (15.79%). Black bears have a major role in the maintenance of healthy ecosystems as they are seed dispersers and predators, so their conservation may helps in conserving habitats for many other important species of mountainous regions.

Key words: Asiatic black bear, Feeding, NDBR, Percent volume, Signs, Scat analysis

Introduction

In India four bear species are found and Asiatic black bear (*Ursus thibetanus*) is one of them. It lives predominantly in forest areas, especially in hills and mountainous areas are found over a wide area of south and south-eastern Asia, east to Indo-China through much of China, Korea, Russia, and Japan (Sathyakumar, 2001; Garshelis and Steinmetz, 2016). Information on the habitat uses and feeding ecology of the black bear in India is still very less whereas,

studies are available from much of its range countries. Asiatic black bears are opportunistic omnivores and mainly feed on fruits and to some extent to vegetation, insect and animal matter (Schaller *et al.*, 1989; Hwang *et al.*, 2002; Hashimoto *et al.*, 2003; Sathyakumar and Viswanath, 2003; Koike, 2010). Food habits of Asiatic black bears differ substantially in geographic range, seasonal availability, palatability and nutrient content (Hwang *et al.*, 2010; Sharma *et al.*, 2010; Nakajima *et al.*, 2012). Information on the feeding and movement patterns of Asi-

atic black bear in India is limited to two short studies (Manjrekar, 1989; Saberwal, 1989) and some observations by Schaller, (1969) all in Dachigam National Park in Jammu and Kashmir, India. Black bears have a major role in the maintenance of healthy ecosystems as they are seed dispersers and predators (Sathyakumar and Viswanath, 2003). Their conservation helps in conserving habitats for many other important species of mountainous regions.

The present study was done to obtain information on feeding habit of black bear to better understand their ecology. This information may be useful for habitat improvement in terms of food, management of population and in reducing black bear-human conflicts adjacent to its habitat. The information on food items and the occurrence of crops in the black bear's food and its extent are helpful for the development of effective conservation plans. Successful conservation of Asiatic black bears critically depends on proper management and protection of bears and their habitat.

Materials and Methods

Study Area

The study has been conducted in Nanda Devi Biosphere Reserve (NDBR) from September 2016 to August 2018. NDBR lies between 30°05'-31°02'N Latitude, 79°12'-80°19'E Longitude, located in the state of Uttarakhand, India, falls in the biogeographically classified zone, 2B (Rodgers *et al.*, 2000). The reserve is spread over Chamoli district in Garhwal region and Bageshwar and Pithoragarh districts in Kumaun region of the Uttarakhand State. The NDBR with an area of 6020.43 km² is comprised of two core zones i.e. Nanda Devi National Park, 630 km²; Valley of Flowers National Park, 87.5 km²; surrounded by a buffer and a transition zones. Both the core zones have been recognized as World Heritage Site by UNESCO. Settlements (small townships and villages), agricultural land (terrace farms), orchards, plantation and developmental areas are human modified landscapes. Most of the flora and fauna in the NDBR is native and endemic. Human habitations are absent inside the core zones but buffer zone having 47 villages and transition zone having 33 villages with six villages in the immediate buffer of the core zones.

Methodology

The eight trails were selected, ranged from 1 km to 5 km and covered altogether 71 km ground efforts for collection of black bear feeding signs in forest, based on accessibility, habitat type and geographic representation. Sign surveys were organized along animal or human trails, up-step ridge structures and up and down hillsides, to cover the wide range of topographical variation and to observe casual food and feeding habits of Asiatic black bear. Scats surveys were quite difficult during the monsoon season due to increased vegetation cover, lower scat visibility, frequent heavy rainfall and landslides (Huygens *et al.*, 2003), therefore surveys could not organize during the monsoon season (July and August). An inventory of black bear food items was prepared based on fresh feeding signs and remnants of undigested material identified in their scats. We also collected available fruits and their seeds from the plants/trees for the identification of fruits items present in scats, as described by Mealey, (1980); Sathyakumar and Vishwanath, (2003). We also recorded information provided to us by NDBR Forest staff and villagers on black bear food habits (Hwang *et al.*, 2002).

Scat analysis

Scats were soaked for 24 hours in normal water and washed in normal running water through 2 mm and 1 mm mesh sieves to separate individual food items (Hatler, (1972; Aune *et al.*, 1986). Undigested food remains were identified to species level by referring to plants/seeds samples collected from the study area. Some items were not identified in the lower taxonomy of plant fragments and animal matter due to the lack of sufficient references and in some cases, such diet items constituted in trace amounts. The non-food items (bear hairs, stones, soil and wood debris) were not included in the analysis. Plant materials were classified into five categories: wild fruits, vegetation, agricultural and orchard crops, insects and animal matter. The relative volume of each food item was visually estimated and assigned an exact volume because most of the scats contained only 2-3 food items. Items found in trace amounts were given an arbitrary volume of 1-2%. The percent frequency of occurrence (PFO) and percent volume (PV) of each food item was determined (Raine and Kansas, 1990; Huygens *et al.*, 2003).

Frequency = Number of scats having the same item

$$\text{Percent frequency of occurrence} = \frac{\text{Frequency of item}}{\text{Total number of scats}} \times 100$$

$$\text{Percent volume} = \frac{\text{Total percent volume of item}}{\text{Total number of scats}}$$

Results

We analyzed scats for determining the feeding habit of black bears; a total of 38 scats were collected from the study area. The largest percentage of scats (42%, n = 16) was identified as very fresh (≤ 7 days) to a minimum (10.53%, n = 4) in the very old category (> 3 months). In terms of land use, 18 (47.37%), 2 (5.26%) and 18 (47.37%) scats were found in mixed broad-leaved forests, mixed coniferous forest and agricultural land respectively. Individual scats contained one to four food items, where 47% had only one item, 32% had two items, 16% had three items, and 5% had four items. Identified food items from scats included five categories: wild fruits (20 species), agricultural and orchard crops (8 species), vegetations (4 species), insects (2 species) and animal matters (bones and hairs) (Table 1 and Fig. 2). No evidence of conifer tree species was found in black bears diet. The total percent frequency of occurrence (PFO) of wild fruits was 115.79%, followed by vegetation, agricultural and orchard crops, animal and insects with 18.42%, 60.53%, 5.26%, and 15.79% respectively. A similar composition was found in per-

cent volume (PV) of food items where wild fruits, agricultural and orchard crops and vegetation were 46.48%, 9.81%, and 43.06% respectively (Fig. 2). The bones and hairs was found in 5.26% scats (PV = 0.70) in animal category. For insect category black ants was found 5.26% in scats (PV = 0) and honey bee was found in 10.53% of collected scats (PV = 0.28) from the study area. Bamboos *Arundinaria falcata* (PV = 4.22) and *Thamnocalamus spathiflorus* (PV = 4.56) were major items during a food deficient period. The Flower and leaves of *Rhododendron arboreum* (PV = 0.62) and unidentified vegetation (PV = 0.42) were recorded in scats which was in small amount (Table 1). Mostly feeding preferred on Rosaceae family followed by Poaceae found in scat analysis (Fig. 3).

During sign survey total 96 feeding signs were found of black bears, including 20 species of wild fruits, 4 species of vegetation, 8 species of agricultural and orchard crops, 2 items of insects and 6

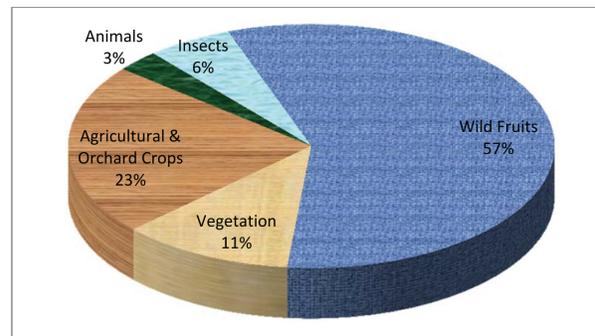


Fig. 2. Feeding preference of Asiatic black bear in NDBR

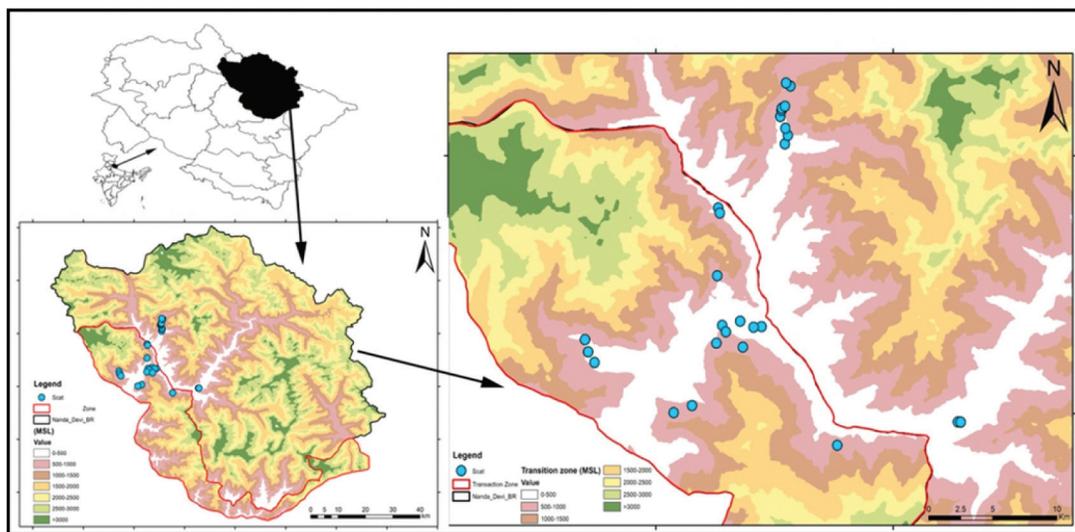


Fig. 1. Map of study area with sign survey and scat collection points

animal carrions. Most of the mark on trees were observed in mixed broadleaved forests (66.20%, n = 47), followed by mixed coniferous forests (33.80%, n = 24). Feeding signs were primarily found on Himalayan gooseberry (*Ribes himalense* - 15.79%). In addition to black ants were found in 15 stone turning

signs, three raided bee nest and three animal (cow/ox and mule) carcasses. It supports the bear preference of insects in mixed broad-leaved forests during the autumn season. Many cases (23) of crop depredation especially on maize (*Zea mays*), apple (*Malus pumila*), frenchbean (*Phaseolus vulgaris*), apricot

Table 1. Percent frequency of occurrence (PFO) and percent volume (PV) of food items of Asiatic black bear in NDBR (n=38)

S. No.	Food items	Family	Life Form	Feeding Parts	F	FO%	PV
Wild Fruits (20)					44	115.79	46.48
1.	<i>Fragaria nubicola</i> Lindl. ex Lacaita	Rosaceae	Herb	Fruits	2	5.26	0.20
2.	<i>Berberis asiatica</i> Roxb. ex DC.	Berberidaceae	Shrub	Fruits	3	7.89	1.70
3.	<i>Berberis jaeschkeana</i> C.K.Schneid.	Berberidaceae	Shrub	Fruits	1	2.63	0.80
4.	<i>Berberis lycium</i> Royle.	Berberidaceae	Shrub	Fruits	2	5.26	1.10
5.	<i>Cotoneaster acuminatus</i> Lindl.	Rosaceae	Shrub	Fruits	1	2.63	0.60
6.	<i>Cotoneaster microphyllus</i> Wall. ex Lindl.	Rosaceae	Shrub	Fruits	1	2.63	0.70
7.	<i>Cotoneaster rotundifolius</i> Wall. ex Lindl.	Rosaceae	Shrub	Fruits	1	2.63	0.04
8.	<i>Prinsepia utilis</i> Royle	Rosaceae	Shrub	Fruits	5	13.16	2.30
9.	<i>Prunus cornuta</i> (Wall. ex Royle) Steud.	Rosaceae	Tree	Fruits	2	5.26	1.40
10.	<i>Pyracantha crenulata</i> (D.Don) M.Roem.	Rosaceae	Shrub	Fruits	3	7.89	1.20
11.	<i>Ribes himalense</i> Royle ex Decne.	Grossulariaceae	Shrub	Fruits	6	15.79	13.74
12.	<i>Rubus nepalensis</i> (Hook. f.) Kuntze	Rosaceae	Shrub	Fruits	3	7.89	2.62
13.	<i>Sorbus foliolosa</i> (Wall.) Spach	Rosaceae	Tree	Fruits	1	2.63	2.48
14.	<i>Morus alba</i> L.	Moraceae	Tree	Fruits	1	2.63	0.88
15.	<i>Juglans regia</i> L.	Juglandaceae	Tree	Fruits	2	5.26	2.14
16.	<i>Quercus floribunda</i> Lindl. ex A. Camus	Fagaceae	Tree	Acorn	1	2.63	0.65
17.	<i>Quercus leucotrichophora</i> A. Camus	Fagaceae	Tree	Acorn	4	10.53	7.77
18.	<i>Pyrus pashia</i> Linnaeus, 1758	Rosaceae	Tree	Fruits	2	5.26	3.22
19.	<i>Rosa</i> spp.	Rosaceae	Shrub	Fruits	2	5.26	2.38
20.	Unidentified - B				1	2.63	0.76
Vegetation (4)					7	18.42	9.81
21.	<i>Arundinaria falcata</i> Nees	Poaceae	Herb	Leaves & Stem	2	5.26	4.22
22.	<i>Thamnochalamus spathiflorus</i> (Trin.) Munro.	Poaceae	Herb	Leaves & Stem	3	7.89	4.56
23.	<i>Rhododendron arboreum</i> Sm.	Ericaceae	Tree	Flower &	1	2.63	0.62
24.	Unidentified - B			Leaves	1	2.63	0.41
Agricultural & Orchard Crops (8)					23	60.53	43.06
25.	<i>Prunus armeniaca</i> L.	Rosaceae	Tree	Fruits	3	7.89	5.12
26.	<i>Malus pumila</i> Mill.	Rosaceae	Tree	Fruits	5	13.16	10.53
27.	<i>Amaranthus</i> sp.	Amaranthaceae	Herb	Fruits	1	2.63	1.42
28.	<i>Eleusine coracana</i> L.	Poaceae	Herb	Fruits	1	2.63	1.24
29.	<i>Zea mays</i> L.	Poaceae	Herb	Seeds	7	18.42	17.23
30.	<i>Cucurbita maxima</i> Duchesne.	Cucurbitaceae	Climber	Fruits	2	5.26	2.68
31.	<i>Cucumis sativus</i> L.	Cucurbitaceae	Climber	Fruits	1	2.63	0.52
32.	<i>Phaseolus vulgaris</i> L.	Fabaceae	Herb	Fruits/ Legumes	3	7.89	4.32
Animals (1)					2	5.26	0.70
33.	Bones & Hairs				2	5.26	0.70
Insects (2)					6	15.79	0.28
34.	Black Ants, Hymenoptera			All parts	2	5.26	0.00
35.	Honey Bees, Hymenoptera			All parts	4	10.53	0.28

F = Frequency, FO% = Percent Frequency Occurrence, PV = Percent Volume

(*Prunus armeniaca*), pumpkin (*Cucurbita maxima*), amaranth (*Amaranthus sp.*), finger millet (*Eleusine coracana*) and cucumber (*Cucumis sativus*) were observed in the monsoon season.

Discussion

Scats were analyzed for determining the feeding habit of black bear. The largest percentage of scats (42%, n = 16) was identified as very fresh (≤ 7 days) to a minimum (10.53%, n = 4) in the very old category (> 3 months). In terms of land use, 18 (47.37%), 2 (5.26%) and 18 (47.37%) scats were found in mixed broad-leaved forests, mixed coniferous forest and agricultural land respectively, similar to Kadariya, (2018). Individual scats contained one to four food items, where 47% had only one item, 32% had two items, 16% had three items and 5% had four items. We found totally 35 identified food items from scats included five categories: wild fruits (20 species), agricultural and orchard crops (8 species), vegetations (4 species), insects (2 species) and animal matters (bones and hairs) (Table 1 & Fig. 2). Similarly, Hwang *et al.*, (2002) found that individual scats contained 1-4 food items, but 77% had only 1 item and 19% had 2 items from Taiwan. A study by Ghadirian *et al.*, (2017) from Southern Iran also identified 27 food items in 5 categories: cultivated fruits (4 items), wild fruits (6 items), other plants (7 items), vertebrates (5 items) and invertebrates (5 items). No evidence of feeding on coniferous tree species was discovered in black bears scats. The total percent frequency of occurrence (PFO) of wild fruits was

115.79%, followed by vegetation (18.42%), agricultural & orchard crops (60.53%), animal (5.26%) and insects (15.79%). Results of present study are comparable with Kadariya, (2018) found the PFO of wild fruits was (68.6%), followed by vegetation (27.2%), agricultural crops (24.9%), animals (4.6%) and insects (3.8%) in six months (July-December) from Annapurna Conservation Area, Nepal. Similarly Ali *et al.*, (2017) identified 21 different types of items in the scats, with maize (22.64 PFO) and white mulberry (*Morus alba*, 16.98 PFO) being the most frequently identified food items. Present study recorded maximum PFO on *Zea mays* (18.42 PFO) followed by *Ribes himalense* (15.79 PFO). Similarly Yadav *et al.*, (2019) categorized the food items found in scats into thirteen major groups: achene, berries, capsule, drupe, nut, pome, rosehip, other plants, crops, livestock, insects, others and unidentified items and based on scat analysis identified 38 different types of food items, with maximum frequency of occurrence (50%) for *Zea mays* followed by *Ribes himalense*, *Malus pumila*, Honey Bees and Honey with similar frequency of occurrence (47.37%) and *Phaseolus vulgaris* (44.74%) from Nanda Devi Biosphere Reserve. Present study showed similar composition in percent volume (PV) of food items occurs in scats which were wild fruits (46.48%) followed by vegetation (43.06%) and agricultural and orchard crops (9.81%) (Fig. 2). Present study recorded maximum PV on *Zea mays* (17.23 PV) followed by *Ribes himalense* (13.74 PV). Whereas Kadariya, (2018) was found maximum percent volume (PV) for Oak-bull (*Quercus lamellosa*) (22 PV)

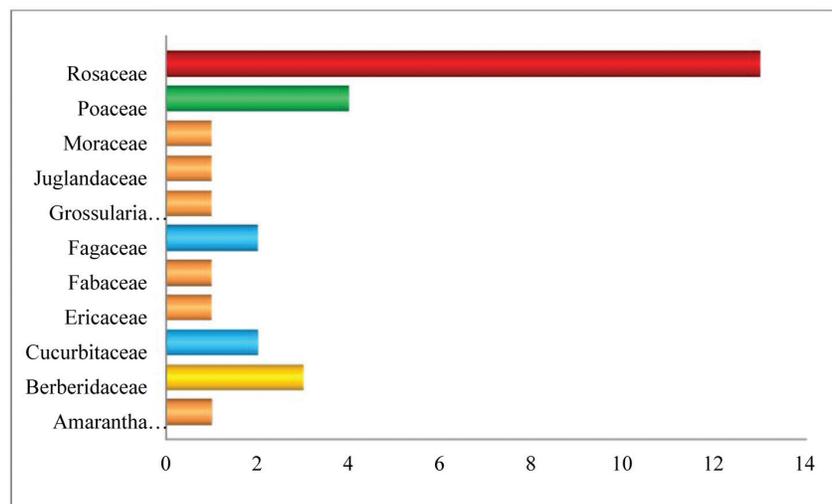


Fig. 3. Family preference of Asiatic black bear

followed by *Zea mays* (16.40 PV) from Annapurna Conservation Area, Nepal.

A small amount of animal matter and insects were also recorded, which vary from season and location (Hwang *et al.*, 2002; Huygens *et al.*, 2003; Steinmetz *et al.*, 2011; Sathyakumar *et al.* 2013; Ali *et al.*, 2017; Kadariya, 2018). The bones and hairs was found in 5.26% scats (PV = 0.70) in animal category. For insect category black ants was found 5.26% in scats (PV = 0) and honey bee was found in 10.53% of collected scats (PV = 0.28) from the study area. Bamboos *Arundinaria falcata* (PV = 4.22) and *Thamnocalamus spathiflorus* (PV = 4.56) were major items during a food deficient period. Bamboo seems to be major alternative food sources when food becomes scarce black bears tend to rely on more green vegetation, agricultural crops, or riskier foods (Hwang *et al.*, 2002; Sathyakumar *et al.*, 2013; Kadariya, 2018). The flower of *Rhododendron arboreum* (PV = 0.62) and unidentified vegetation (PV = 0.42) were recorded in scats which was a small amount in the scat, could not identified when fresh shoots of bamboos were found (Table 1). We also observed that, black bear feeding on human related food like garbage and food remains from kitchen thrown out from house by villagers (Hwang *et al.*, 2002). Black bears depended on human resources based on availability, when hard mast become scarce in forest, it turn to less preferred, less accessible, or riskier human-related foods. When hard mast not available, they tend to depends more on green vegetation, soft mast or agricultural crops (Vaughan, 2002; Hwang *et al.*, 2002; Dasgupta *et al.*, 2015). The present study revealed that, black bear were seen to depend on variety of food items in the NDBR. Based on our study we suggest that, there is need to conserve the habitat of black bear and its resources to reduce the movement towards human habitations.

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