Seasonal diets of Asiatic black bear (Ursus thibetanus) in the Khangchendzonga National Park, Eastern Himalaya India

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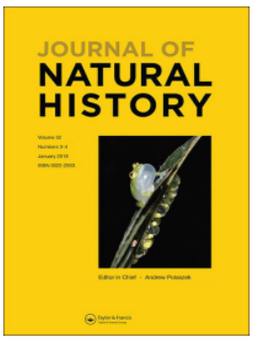

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ABSTRACT

This study aimed to investigate the seasonal diet of the Asiatic black bear (*Ursus thibetanus*) using scat analysis in the Khangchendzonga National Park (KNP) and its surrounding. The study was carried out from 2017 to 2019 and 32 plant species were identified, along with animal matter from collected scats samples (n = 163). The identified food samples were placed into six categories: (i) vegetation (leaves of trees, shrubs, herbs and bamboo), (ii) hard mast (tree fruits and seeds), (iii) berries and soft mast (shrub fruits and seeds), (iv) agriculture and horticulture crops, (v) animal matter (insects & livestock), and (vi) unidentified items (roots, barks, twigs, etc.). The food preference of *U. thibetanus* comprises berries and succulent vegetation during the pre-monsoon and monsoon seasons, whereas hard mast was mostly preferred in the post-monsoon and winter seasons. The present study showed that the diet of *U. thibetanus* depends on the availability and propensities of food items, especially vegetation and hard mast trees in their habitat, in and around the KNP. The extensive cultivations of large cardamom (*Amomum* spp.) in the fringe villages of KNP are more abundant than the cultivation of other agriculture and horticulture crops. As a result, this may lead towards more crop-raiding by *U. thibetanus* and force the bears to move towards settlements to a greater extent. The findings of the present study may help in better understanding the feeding ecology of *U. thibetanus* for their effective conservation, and aid in the management of human-black bear conflicts in the Eastern Himalayas.

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Introduction

Large mammals are extensive consumers and choose their food on the basis of seasonal availability, nutritional aspects, and abundance of items in their habitat (Aryal et al. 2012; Furusaka et al. 2017). Bears are mostly omnivorous mammals of the family Ursidae. Currently, there are only eight extant species of bears, and they inhabit a wide variety of habitats across the globe (Waits et al. 1999). The Asiatic black bear (*Ursus thibetanus*) is distributed throughout the 18 countries of southern and eastern Asia, ranging from southeastern Iran to the southern islands of Japan and Taiwan (Garshelis and Steinmetz 2020). In India, four species of bears are recorded viz. Asiatic black bear (*Ursus thibetanus*),

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Sloth bear (*Melursus ursinus)*, Himalayan brown bear (*Ursus arctos*), and Sun bear (*Ursus malayanus*) (Servheen et al. 1999). In the Himalayan regions, its habitat overlaps with the Red panda (Bista et al. 2018) and the Sun bear (Sethy and Chauhan 2018). Owing to the significant decline in the population of *U. thibetanus* over the years, it has been listed in Appendix I of CITES and categorised as vulnerable in the IUCN Red List (Garshelis and Steinmetz 2020). Furthermore, *U. thibetanus* has also protected under the Wild Life (Protection) Act, 1972 (amended in 2006) in India as Schedule I species.

Ursus thibetanus is adapted for arboreal and vigorous feeding habits (Mattson 1988). During food shortages in their natural habitats, these bears move towards agricultural and human settlements for the foraging of food which leads to human-wildlife conflicts (Hwang et al. 2002; Sunar et al. 2012; Basnett et al. 2020). Scat analysis is one of the most widely used and popular methods for analysing the feeding behaviour of mammals (Litvaitis 2000; Gau et al. 2002; Trites and Joy 2005) and is a particularly effective approach for elusive carnivorous and omnivorous species to better understand their seasonal dietary spectrum. Many studies have been carried out on the feeding behaviour and ecology of *U. thibetanus* across its global distributional ranges (Japan- Huygens et al. 2003; Iran- Ghadirian et al. 2017; Taiwan- Hwang et al. 2002; Pakistan- Ali et al. 2017; Nepal- Panthi et al. 2019; India- Sathyakumar et al. 2013). However, studies on ecology and respective distribution range of *U. thibetanus* are limited in India and only a few studies have been conducted over the years (Sathyakumar and Viswanath 2003; Sathyakumar and Choudhury 2007).

The few previous studies on *U. thibetanus* in India have focused on the distribution, population status, food habit and sources of human-bear conflict. These geographical studies are mainly focused on the western parts of Indian Himalaya in Dachingam National Park and Kedarnath Wildlife Sanctuary (Sathyakumar and Viswanath 2003; Sathyakumar et al. 2013) and northern West-Bengal in Senchal Wildlife Sanctuary (Sunar et al. 2012). However, no intensive study has been carried out on the seasonal dietary patterns and preference of food by *U. thibetanus* in the Eastern Himalayan region, and particularly from the Khangchendzonga National Park (KNP).

Therefore, the present study was conducted to investigate the seasonal dietary patterns and food preferences of *U. thibetanus* in KNP and its surrounding areas to better understand its dietary preferences. As the feeding and foraging ecology of the animal represents one of the key comportment to understand not only ecological questions but also helps in understanding the management and conservation strategies (Owens 2006; Berger-Tal et al. 2011). Thus, dietary data could be useful to both maximising the fitness and survivability of individuals through habitat management and manipulation (food plant species), and in developing mitigation strategies to manage human-bear interaction in the area.

Materials and methods

Study area

The present study was conducted in and around the Khangchendzonga National Park (KNP), Sikkim, India, which intensively includes the area of the core zone, buffer zone, and the fringe village area of the park (Figure 1). It is geographically located between 27° 30′ to

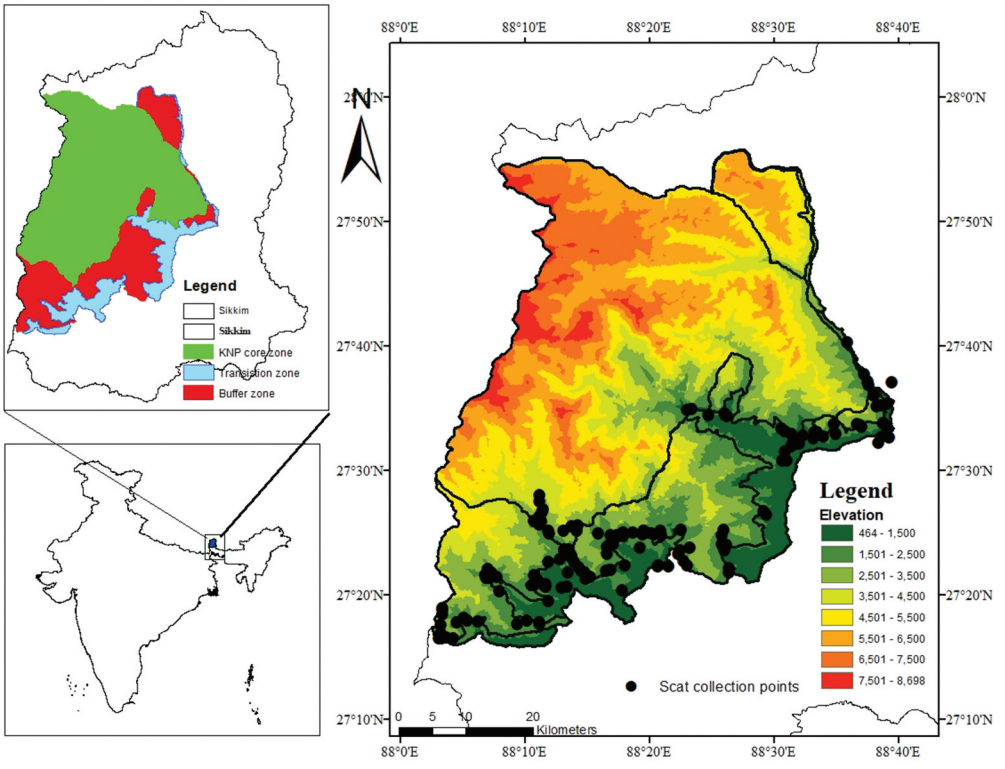

Figure 1. Map showing the study area of Khangchendzonga National Park (Sikkim) and its surrounding with scat collection location points.

27°50′ N and 88° 30′ to 88°37′ E). The study sites are distributed throughout the West and North districts of Sikkim and comprise three ranges, namely the Yuksom (in West District), Dzongu, and Chungthang ranges (in North District) of the KNP. The study site comprises a remarkable range of vegetation and climate from sub-tropical to Trans-Himalayan (Cold Desert) within a small geographical area (Tambe and Rawat 2009; Sathyakumar et al. 2011). Most of the core area is covered with snow and isolated terrain. The study sites include vegetation dominated by *Castanopsis hystrix, Arundinaria* spp., *Machilus* spp., *Rhododendron* spp., *Symplocos* spp., *Michelia excelsa, Quercus lamellosa*, varieties of bamboo species, alpine scrubs, and meadows. These areas harbour many rare and endangered species like *Panthera pardus, Uncia uncia, Ursus thibetanus, Capricornis thar, Moschus leucogaster, Naemorhedus goral, Semnopithecus schistaceus*, and *Ailurus fulgens* (Tambe 2007). The area is recognised as a global biodiversity hotspots (Myers et al. 2000) and also among the Global 200 Ecoregions (Olson et al. 2001). The area records an average annual rainfall and temperature of about 3000 mm and 15° to −20 °C, respectively (Tambe 2007). There are 26 villages in the fringe areas of the KNP. These villages are mostly inhabited by Lepchas, Bhutias, and Nepalese ethnic groups which constitute 90% of the total population of fringe villages of KNP, and 10% of the population is inhabited by defence personnel and business communities. These ethnic groups primarily depend on

agriculture practices, as well as forest resources and services from the KNP for sustenance and their livelihood.

Methods

The study was conducted from 2017 to 2019, using the following methods outlined in Hwang et al. (2002) and Ali et al. (2017): (i) interviews with local people and herders who regularly visit and inhabit the fringe villages of the park and have a wide knowledge of the vegetation and wild animals from the park, (ii) direct field observation of feeding signs of *U. thibetanus* and (iii) scat collection. During the study period, we also observed phenology (particularly fruiting) of hard mast food trees, including *Symplocos theifolia, Castonopsis hystrix, Machilus odoratissima*, and *Machilus edulis* to understand the seasonal availability of food in the habitat.

Interviews and field observation

Interviews with local communities primarily targeted individuals over 30 yrs. old, including herders, trekkers, and experience old aged individuals who regularly visited the KNP and its surrounding and possessed adequate knowledge of the food and diet of *U. thibetanus*. The photographs of *U. thibetanus* and *U. arctos* were also used to confirm the presence of species and to avoid the misrepresentation of two species during the interview. The questionnaires mainly comprised of the information regarding the details of food plants for bears, such as their local name, morphology, distribution and the season of fruiting and possible presence/distribution of bears (Hwang et al. 2002; Long et al. 2008; Ali et al. 2017). After interviews, visits to the location identified by the respondents were conducted, to confirm the presence of bears, to record the phenological stages of hard mast trees, and to collect bear scat. These surveys and sample collections were conducted within the altitudinal distribution ranging between 1500 m and 4610 m. The presence of bears during the survey was confirmed either by the direct sighting, camera traps, indirect evidence like a claw or bites marks in tree trunks, animal kills, leftovers, broken twigs and branches for the nest or to reach fruits, scats, trail mark or footprint in the deep vegetation, human-bear conflict incidents, crop depredation or leftover dens (Basnett et al. 2020). Samples of nearby plants were collected for identification, which was conducted with the help of plant taxonomists.

Scat collection and analysis

Scat samples were collected following previously outlined procedures (Hwang et al. 2002; Huygens et al. 2003; Bargali et al. 2004; Ali et al. 2017) from various locations within the KNP (Figure 1). These samples were mostly collected from dens, riverside, feeding sites, and trails in the habitat, as well as agricultural fields. Scat samples collected were sorted seasonally, viz. pre-monsoon (March-May), (9%), monsoon (June-August), (45%), post-monsoon (September-November) (27%), and winter (December-February) (9%) and geographically viz – core zone (34%), buffer zone (64%) and fringe area of the park-like agriculture fields (3%). These bear scats were collected in Ziploc plastic bags along with tags and information including geographic location, time of collection for every scat

collected, as well as other variables for further analysis (Ciucci et al. 1996; Giannatos et al. 2010). Furthermore, information on the moisture, colour, shape, and degradation rate of scats was also recorded during collection (Hwang et al. 2002; Huygens et al. 2003; Trent 2010; Ali et al. 2017). The collections of scat during the monsoon seasons were quite challenging due to the dense vegetation, understory, and continuous rainfall which easily flushes the scat.

Laboratory data analysis

First, the scats were soaked in water for 10–15 hrs. and washed thoroughly in tap water through a series of wooden stand sieves (0.5, 2.0, 5.0., 10.0 mm) as described in the literature (Hashimoto et al. 2003; Paralikidis et al. 2010; Ali et al. 2017; Ghadirian et al. 2017). After washing, the sample were sun-dried for 24 hrs. and dehydrated at 50°–60 °C in the oven. The collected food items were classified into six categories: (i) vegetation (leaves of trees, shrubs, herbs, bamboo), (ii) hard mast (tree fruits and seeds), (iii) berries and soft mast (shrub fruits and seeds), (iv) agriculture and horticulture crops, (v) animal matter (insects and livestock) and (vi) unidentified items (roots, barks, twigs, etc.). The unidentified food items were identified by cross-matching samples with herbarium and reference plants collected from the study area as per Hashimoto and Anrui (2013) (Figure 2). A Magnus MSZ-BI Stereo microscope and a compound microscope were used for in-depth identification of food items below 2.0–3.0 mm (Beeman and Pelton 1980). The relative frequency of occurrence (% FO) for each species in the scat was calculated using the formula (Dahle et al. 1998; Hwang et al. 2002):

$$\mathbf{FO}\% = \frac{Ni}{N} \text{ X } 100$$

Where FO% is the frequency of occurrence, *Ni* is the number of species in samples and N is the total number of samples.

Results

Most of the respondents during the interview (80%) confirmed the presence of *U. thibetanus* in all three forest ranges of the KNP (i.e. Yuksom, Dzongu, and Chungthang). Their presence was further confirmed by the recording of 472 incidences of both direct (5) and indirect sighting (scats-163, claw marks on trees-77, broken twigs and small branches-51, pugmarks-29, crop raiding-21, livestock kill-18, trail markings-8, dens-6 and bear roaring sounds-6) of *U. thibetanus* in the study area. The highest number of direct and indirect signs of *U. thibetanus* were recorded between 2100 m and 2500 m asl (Figure 3).

Annual dietary pattern

A total of 32 species of plants (including three unidentified plant species) and animal remains comprising 22 families were recorded in the diet of *U. thibetanus* through field observations, scats analysis, and interviews. The family Rosaceae contained the most species (4 spp.) in the diet of *U. thibetanus*, while the families Cucurbitaceae, Fagaceae,

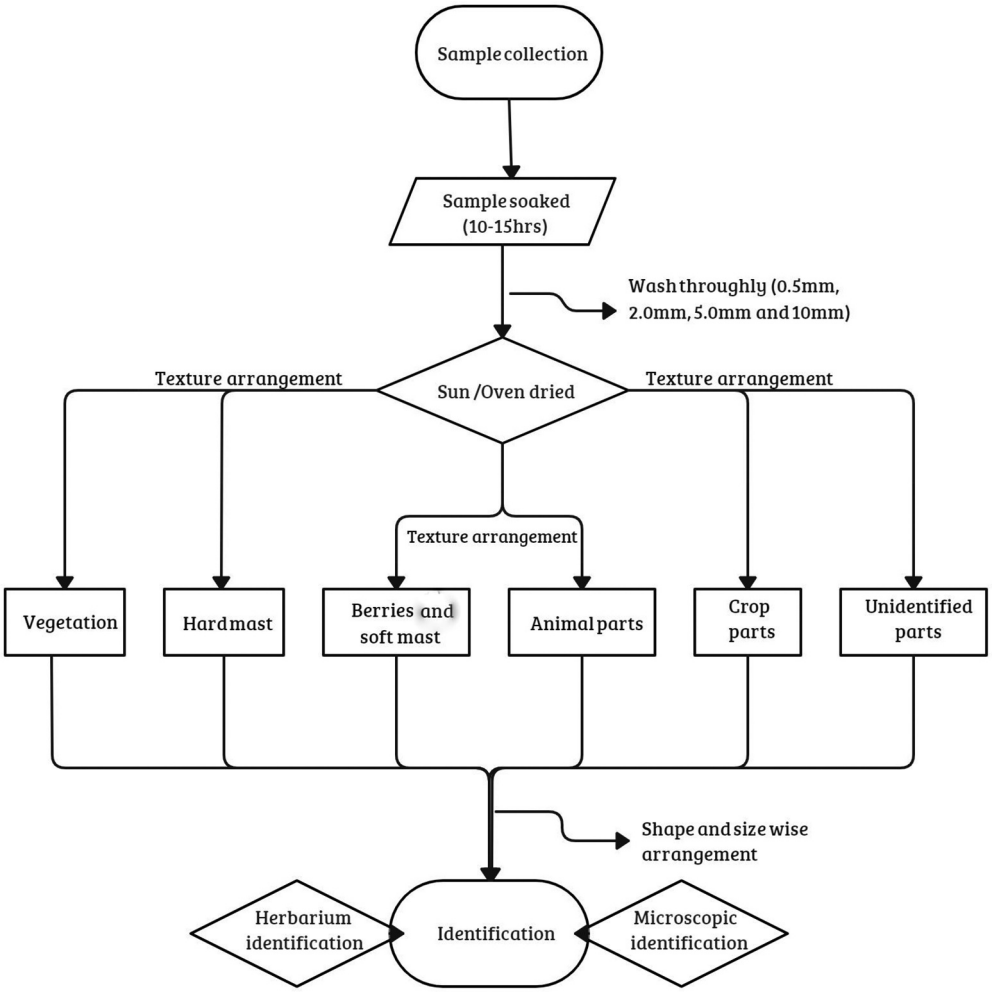

Figure 2. Flow chart of scat analysis procedure in the laboratory.

Lauraceae, Moraceae, Poaceae, Polygonaceae, Symplocaceae composed 2 spp. each and the remaining families contributed a single species in the diet for the plant category. Animal matters included ants (Formicidae), livestock (Bovidae), and chickens (Phasianidae). When restricting the results to the scat analysis, a total of 24 species (16 families) were identified in the diet of *U. thibetanus*, which included 22 species of plants and 2 species of animals. Of the 16 families, a maximum of 4 species were recorded under the family Rosaceae, followed by Fagaceae, Lauraceaea Moraceae, Poaceae, and Symplocaceae with 2 spp. each and the remaining other families were represented by a single species (Table 1). Among the different food items eaten by *U. thibetanus*, the greatest proportion of the diet was vegetation (53%), followed by hard mast (23%), berries and soft mast (10%), agriculture and horticulture crops (9%), animal matter (2%) and the remaining 3% of food items were roots and bark of unidentified plant species (Figure 4). Of the 24 plant species recorded in the diet of *U. thibetanus* through scats analysis, 8 species were eaten from the vegetation and hard mast categories, followed by 6 species

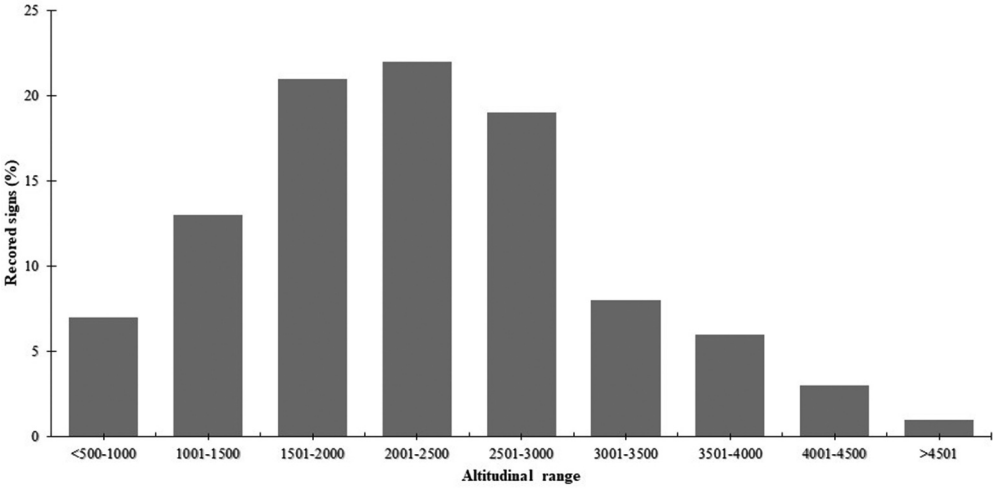

Figure 3. Altitudinal distribution pattern of recorded signs of *U. thibetanus* in the KNP and surrounding areas.

for berries and soft mast, and 2 species for agriculture crops (Table 1). Animal matter included ants, bees, and livestock (sheep and goats). Livestock and crops are mostly damaged in the fringe villages of the park during night time when bears visited for foraging. Over 32% of respondents showed a negative perception towards *U. thibetanus* because of crop depredation and lost livestock.

Seasonal dietary pattern

Vegetation was recorded to be the most consumed category in the diet of *U. thibetanus* during the monsoon and pre-monsoon seasons, which includes berries and soft mast, while the hard mast was mostly consumed during the post-monsoon and winter seasons (1). Over 70% of respondents reported that agricultural and horticulture crops, viz. *Zea mays, Amomum* spp., *Psidium guajava, Sechium edule, Eleusine coracana, Hordeum vulgare*, and *Fagopyrum esculentum* comprise the majority of the diet of *U. thibetanus* during the post-monsoon season, followed by nuts and hard mast. However, we only found two species of agricultural and horticultural crops (*Zea mays* and *Psidium guajava*) in the diet of *U. thibetanus* during the post-monsoon season during scat analysis (Table 1). During the post-monsoon and winter seasons, hard mast and nut trees were the most abundant group in the diet of *U. thibetanus*. Crop and livestock depredation were always recorded in the late post-monsoon season when the availability of hard mast was very low in the forests. A Kruskal–Wallis test revealed that there was no significant difference ($p > 0.05$) in the diet composition of the *U. thibetanus* between four seasons ($X2 = 1.962$, $df = 3$, $p = 0.5804$, $\alpha = 0.5$). The diet composition during all four seasons was more or less the same and the hard mast and vegetation categories were the only major changes in the diet composition of *U. thibetanus* across all four seasons.

In the post-monsoon and winter seasons the highest percentage frequency of occurrence for vegetation was *Machilus odoratissima* (20.67%) along with *Machilus edulis*

Table 1. Plants and animals species eaten, seasonal food items and average frequency of food percentage occurrence of different food items in the diet of *U. thibetanus* (n = 251).

					Methods		
Food category	Scientific name	Family	Part eaten	Season	Direct observations	Interviews	Scat analysis (FO%)
Berries & soft mast	*Nephrolepis cordifolia*	Davalliaceae	F	W	-	Yes	-
	Rubus spp.	Rosaceae	F	PrM/M	Yes	Yes	10.9
	Prunus spp.	Rosaceae	F	PrM/M	Yes	Yes	6.35
	Morus spp.	Moraceae	F	PrM/M	Yes	Yes	8.33
	Ficus spp.	Moraceae	F	M/PoM	Yes	Yes	4.89
	Fragaria vesca	Rosaceae	F, L	PrM/M/PoM	Yes	Yes	3.58
Hard mast	*Symplocos theifolia*	Symplocaceae	F	PoM/W	Yes	Yes	3.97
	Castonopsis hystrix	Fagaceae	F	PoM/W	Yes	Yes	5.5
	Machilus odoratissima	Lauraceaea	F/L	PoM/W	Yes	Yes	20.67
	Machilus edulis	Lauraceaea	F/L	PoM/W	Yes	Yes	14.52
	Prunus nepalensis	Rosaceae	F/L	PoM	Yes	Yes	3.09
	Elaeocarpus sikkimensis	Elaeocarpaceae	F	PoM			5.38
	Quercus fenestrata	Fagaceae	F	PoM/W	Yes	Yes	2.36
	Symplocos taurina	Symplocaceae	F	PoM	Yes	Yes	2.19
Vegetation	*Arundinaria* spp.	Poaceae	L, S	M/W	Yes	Yes	15.46
	Arisema spp.	Araceae	AP	PrM/M	Yes	Yes	13.41
	Asplenium spp.	Monachosoraceae	L	W	-	-	2.48
	Rohododendron spp.	Ericaceae	L	PoM	-	-	1.73
	Aconogonum molle	Polygonaceae	AP	PrM/M/PoM	Yes	Yes	15.96
	Carex spp.	Cyperaceae	F	PrM/M	-	Yes	15.23
	Elatostema platyphyllum	Urticaceae	AP	PrM/M	Yes	-	13.21
	Globba hookeri	Zingiberaceae	R/St	PrM/M	Yes		
Animal matters	Ant	Formicidae	AP	M/PoM/	Yes	Yes	1.84
	Livestock	Bovidae	AP	PrM/M/PoM/W	-	Yes	3.26
	Chicken	Phasianidae	WB	M/PoM	Yes	Yes	
Agriculture & horticulture crops	*Zea mays*	Poaceae	F/L	PoM	Yes	Yes	10.38
	Psidium guajava	Myrtaceae	F	PoM	-	Yes	4.88
	Sechium edule	Cucurbitaceae	L	PoM	Yes	Yes	-
	Fagopyrum esculentum	Poaceae	F/L	PoM		Yes	
	Eleusine coracana	Myrtaceae	F/L	PoM		Yes	
	Fagopyrum esculentum	Polygonaceae	F/L	PoM	-	Yes	-
Unidentified items	Roots & barks	-	-	PrM/M/PoM/W	Yes	Yes	-
Total	32				22	28	24

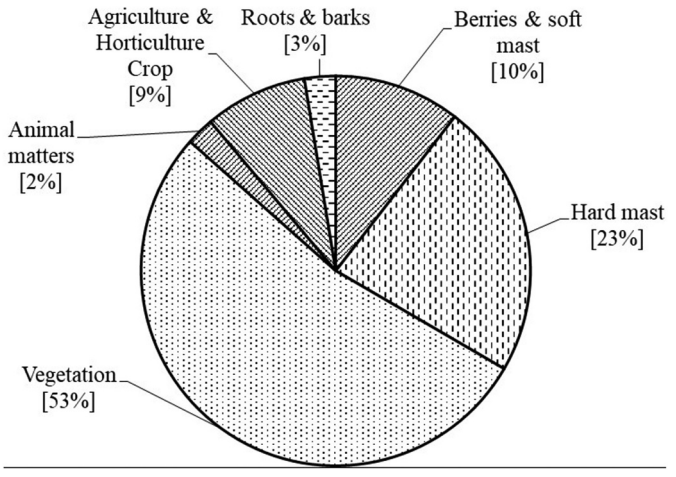

Figure 4. Percentage of food items presence in the *U. thibetanus* based on the scats collected from KNP and surrounding areas.

(14.52%). While vegetation such as *Aconogonum molle* (15.96%) and *Arundinaria* spp. (15.46%), *Rubus* spp.(10.9%), and *Morus* spp.(8.3%) were recorded in the monsoon and pre-monsoon seasons (Table 1). During the monsoon season, green succulent vegetation, along with small herbs, contributed a high proportion of the diet. During the winter season, we also recorded the seed of *Symplocos theifolia* and *Castonopsis hystrix* in very few numbers during the analysis. The diet of the *U. thibetanus* in the KNP and surrounding areas changed according to the seasons and availability of food items. It was also observed that the feeding habits on hard mast species consumed by *U. thibetanus* changed yearly in post-monsoon and winter seasons due to the alternation of fruiting mechanisms in the hard mast and oaks trees. The present result of food habit shows that *U. thibetanus* of Sikkim is omnivorous and highly dependent upon the seasonal availability of food in the region. Of the 24 species recorded in the diet of *U. thibetanus* during the study period through scats analysis, a maximum of 20 species (15 families) were found in the post-monsoon season, followed by monsoon (12 spp., 9 families), pre-monsoon (9 spp., 8 families) and winter seasons (8 spp., 7 families; Table 1). The most common family was Bovidae (Livestocks) which was eaten throughout the year in all four seasons while *Aconogonum molle* (Polygonaceae) and *Fragaria vesca* (Rosaceae) were eaten consistently in three seasons (pre-monsoon, monsoon, and post-monsoon).

Discussions

In the Himalaya region, signs of *U. thibetanus* have previously been recorded between 1000 m and 4500 m asl. (Bista and Aryal 2013; Ali et al. 2017; Garshelis and Steinmetz 2020), which is similar to the findings of the present study (Figure 3). The highest altitude of scat samples were collected from the Dzongri–Thansing–Lamuney trekking trail, which is 4215 m asl, and a leftover den was also found in the same area at 4380 m asl. Based on this study, it can be confirmed that *U. thibetanus* in Khangchendzonga National Park and surrounding areas is mainly dependent upon vegetation (53%), along with hard mast

(23%), and berries and soft mast (10%) food items. However, the diet of *U. thibetanus* in the present study is less similar to studies conducted in the Western Indian Himalayas and Nepal Himalayas (Sathyakumar and Viswanath 2003; Sathyakumar et al. 2013; Panthi et al. 2019). The frequency of occurrence of human-related food items in the diet of *U. thibetanus* through scat analysis was found to be much less in the present study compared to populations of *U. thibetanus* in the Western Himalayas (Sathyakumar and Viswanath 2003; Sathyakumar et al. 2013) and Nepal (Panthi et al. 2019). The present study depicted a maximum of 32 species of plants and animals in the diet of *U. thibetanus* at KNP, while Sathyakumar and Viswanath (2003) and Hwang et al. (2002) have recorded a significantly higher number of species (41 and 83 species, respectively). However, several studies have also reported a lesser number of species in the diet of *U. thibetanus* in comparison to the present study (e.g. 13 spp.- Panthi et al. 2019; 21 spp.-Ali et al. 2017; 22 spp.- Sathyakumar and Viswanath 2003; 25 spp.-Huygens et al. 2003; 25 spp.- Ghadirian et al. 2017). Plant species (e.g. *Rubus* spp. *Carex baccans, Morus* spp. *Arundinaria* spp. *Arisema* spp. *Aconogonum molle, Castonopsis hystrix, Symplocos theifolia, Machilus* spp., *Prunus* spp.) were recorded to be the most preferred species in the diet of *U. thibetanus* during our present study. Similar food species like *Arundinaria* spp., *Machilus* spp. *Rubus* spp., *Morus* spp. *Arisema* spp. were also reported to be the preferred food by *U. thibetanus* in Japan (Huygens et al. 2003), Nepal (Panthi et al. 2019), Western Himalaya, India (Sathyakumar and Viswanath 2003), and Taiwan (Hwang et al. 2002). During the winter season, hard mast and nuts were the major food source of *U. thibetanus* (Koike 2010). Bears move towards human habitation for foraging because of the non-availability of hard mast food in their natural habitat during these periods. Hard masts are usually available in alternative years due to their fruiting mechanism. It was also observed that *U. thibetanus* is facing significant competition for food items with barking deer (*Muntiacus muntjak*) and wild boar (*Sus scrofa*) during the post-monsoon and winter seasons. This was confirmed by the presence of significant numbers of pellets of barking deer (*Muntiacus muntjak*) and wild boars (*Sus scrofa*) in the same areas near the bear's preferred food trees, and can be assumed due to the similar food niche of these species during these specific seasons. This potential competition for food resources may be the reason of *U. thibetanus* moves towards human habitation during these periods, as this is also when more livestock kills and crop raids were recorded (Basnett et al. 2020). Agricultural crops like *Zea mays, Paspalum scrobiculatum*, and *Musa* spp. have also been commonly observed in the diet of *U. thibetanus* from the sub-tropical region (Ghadirian et al. 2017). However, only two species viz. *Zea mays* and *Psidium guajava* were found in the diet of the *U. thibetanus* through scat analysis during our study, but fringe villagers reported that bears also feed on *Sechium edule, Fagopyrum esculentum, Eleusine coracana*, and *Fagopyrum esculentum*. In some fringe villages of KNP few respondents also mentioned the killing of the pig (*Sus scrofa domesticus*) by the U. thibetanus.

Our dietary analyses show that seasonal dietary shifts, mostly seen from forbs and succulent vegetation in the pre-monsoon and monsoon seasons, to hard mast items in the post-monsoon and winter seasons, is similar to the findings of other studies (Schaller et al. 1989; Huygens et al. 2003; Panthi et al. 2019). During the post-monsoon and winter seasons, the high number of broken tree branches and tree nest/roosting sites were recorded, which confirmed the arboreal activities of *U. thibetanus* as they are highly dependent on tree fruits in these seasons (Koike and Masaki 2019). Most of these arboreal

activities were recorded in the area with hard mast and nut trees as these provide significant food for the species and also a suitable roosting/nesting site. Tochigi et al. (2018) also stated that the arboreal feeding sign of *U. thibetanus* depends on the mast availability and energy value.

Conclusion

The present findings on the food habits of *U. thibetanus* from the KNP find the diet of this species to be omnivorous and highly dependent on the seasonal availability of food items for their survival. High numbers of livestock depredation by *U. thibetanus* were recorded during the post-monsoon and winter seasons. This can be linked to the scarcity of nuts and hard mast fruits in their habitats during the seasons. *Ursus thibetanus* is an important mammal of the forests from Sikkim Himalaya and plays a significant role in dispersing seed in the forests due to their larger home ranges (Naoe et al. 2019), which necessitates its conservation and preservation. Therefore, the collection of hard mast and nuts by local villagers from the KNP should be restricted and properly monitored, particularly during the post-monsoon and winter seasons to avoid continued livestock depredation. The outcomes of the present study on the feeding ecology of *U. thibetanus* thus may be useful in habitat management and conservation planning of this species, as well as developing strategies for mitigating human-bear conflicts.

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Disclosure statement

No potential conflict of interest was reported by the authors.

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