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RESEARCH ARTICLE

Food and Feeding Habits of Indian Crested Porcupine in Pench Tiger Reserve, Madhya Pradesh, India

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Study Area: Pench Tiger Reserve, Satpura Hill range, Madhya Pradesh.
Coordinates: 78°55'E - 79°35'E & 21°35'N -22°00'N

Key words: Feeding ecology, Faecal analysis, Dietary diversity, Diet assessment.

Abstract

Dietary habits of Indian Crested Porcupine (*Hystrix indica*) were studied in the Pench Tiger Reserve India (dry tropical forest), by the faecal analysis. The results of the study suggest that the porcupines have a diverse diet and the tree barks and seeds were the most consumed items. It was followed by leaves, twigs, flowers and grasses. Seasonally, barks (34.9%), twigs (17.2%), seeds (17.1%), leaves (9.4%), grasses (8.7%), bones (4.9%) and roots (2.6%), stones and others unidentified things (2.2%) and hairs of animals (0.7%) were fed more in winter than summer where as seeds (27.3%), barks (23.1%), leaves (11.7 %), grasses (9.9%), roots (6.8%), twigs (6.7%), bones (6.03%), flowers (1.4%) and stones/other things (0.8%), hairs (0.4%) were fed more in summer than winter season. Only barks and twigs were found to be significantly different seasonally. Furthermore, the Berger-Parker index (d) of each season was calculated to ensure the variation in diet, by the species dominance in each faecal matter group. Through this method, diversity in food items of the porcupine reflected that the diet of porcupine in summer season (2.2) was more diversified as compared to the porcupine diet in the winter season (1.835). Overall the diet of the porcupine comprises 92% vegetative matter and remaining 6.3% comprises of animal matters and 1.5% other materials (stones, threads, etc). Hence, it is considered as a generalist herbivore.

Introduction:

Indian crested porcupine is a widely distributed rodent in the subcontinent, inhabiting temperate scrublands, grasslands, forests, Steppe Mountains, sandy deserts (Gurung & Singh, 1996) and caves (Alkon, 1999; Harries *et al.*, 2008; Biswas & Shrotriya, 2011). It is a generalist forager, exploiting a wide variety of cultivated and wild plants and consuming both hypogeal and epigeal plant tissues (Gutterman, 1982; Alkon & Salt, 1985; Khan *et al.*, 2000). It has long been recognized as forest and agricultural pests in many countries (Prakash, 1976; Sharma & Prasad, 1992; Khan *et al.*, 2000; Idris & Rana, 2001; Siddique & Arshad, 2004; Girish *et al.*, 2005; Chakrborthy *et al.*, 2007), as it causes damage to forest plantations by feeding on roots and bark of succulent plants, resulting in girdles in trees, uprooting of nursery seedlings and planted saplings (Ahmed & Chaudhry, 1977; Greaves & Khan, 1978), fruit trees and agricultural crops (Khan *et al.*, 2000). In Iran, *H.indica* is one of the important pests on reforestation in western oak forests (Khan *et al.*, 2014). Alkon & Saltz (1985) stated that the porcupine in the desert of highland of Israel fed intensively on cultivated potatoes. Gutterman & Herr (1981) reported that the porcupines fed preferably on the older underground bulbs.

There have been little studied on porcupine because of their shy nature, nocturnal habits and tendency to live in remote and inaccessible places and, as rodents are unwelcome associates of mankind, serious pests of food, fodder and plantation crops and are carriers of a number of diseases, so rodents have not attracted public attention to the extent which is desired and according to the literature, porcupine is also considered as an economic pest. Hence, the rationale for porcupine's diet studies was done to know the importance of food in assessing its biological roles in natural and cultivated ecosystems.

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Methodology:

Study area: the study was conducted in Pench Tiger Reserve, Madhya Pradesh. The Reserve is located in the southern lower reaches of the Satpura Hill range. It has a total area of 757.85 sq. km, which includes the Sanctuary (183 sq. km), the National Park (245.85 sq. km) and Reserved Forest (229 sq. km). The Tiger Reserve has three ranges, the National Park consisting of Karmajhiri and Gumtara range in Seoni and Chindwara districts respectively; Kurai range makes up the Sanctuary to the east of the National Park. Karmajhiri range was selected as an extensive study area for the reason that it is present at the centre of the reserve. This range was divided into five intensive study sites on the basis of their habitat types.

Data Collection: in order to investigate feeding ecology of the porcupine, data were recorded only by an indirect method that is faecal matter. The data was collected on the basis of indirect evidence from December 2013 to June 2014. The area was divided into 5 different habitats and in each habitat, three line transects were laid and on each transect, 10 circular plots of 10 m radius, were plotted. However, overall 150 plots were sampled. For the assessment of feeding ecology, all the faecal matter of porcupine was collected from the plots. So first of all faecal matter were identified in the field on the basis of size, shape, smell, composition and locality. The fresh faecal pellets of the porcupine were collected from different areas according to availability; packed in airtight polyethene bags, labelled appropriately and brought back to the laboratory, where these were stored at 40°C until their analysis. Then randomization process was done. After that, faecal matters were soaked in distilled water and washed with water over a fine mesh screen. After washing the samples were kept in the oven for about 24 hours for drying. When samples were dried placed it on the filter paper then took a small portion randomly, placed it on another piece of paper after that disintegrated and examined that small portion to sort out the fragments of plant materials, bones, hair etc using a magnifying glass and binocular microscope. The materials recovered from the faecal samples were identified and photographed.

Data analysis: the results were presented as the relative frequency that is the number of occurrences of a particular item as a percentage of all identifiable items recorded. The overall percent relative frequency of each fragment was calculated as: Relative frequency (%) = (Total number of each fragments/ Total number of fragments analysed)*100 The relative frequency of different food items recorded from the faecal matter was compared in two seasons to work out the feeding preference of the species. To determine the degree of dominance of food items seasonally in the faecal matter samples, Berger parker index (1970) was applied. To calculate index number (d), a total number of fragments of each food item was calculated from the equation.

$$d = N (max)/N$$

Where: N = total number of fragments of all food items and N (max) = number of fragments of the most abundant food items. In order to ensure that the index X (1/d) increases with the increasing diversity, the reciprocal of the index value (d) was used.

Statistical analysis: the level of significance of results was analysed with the help of independent t test sampled using SPSS software at 95% confidence limit (SPSS, 1996). It was performed to know the significant difference between the number of different food items seasonally.

Results:

Composition of different food items in different seasons: during winter season bark (34.89%) was more frequently consumed followed by twigs (17.18%) and seeds (17.06%). Leaves (9.44%), grasses (8.67%), bones (4.85%) were found moderately ingested while roots (2.59%) was found to be less frequently consumed. Interestingly, there was no consumption of flowers. Stones and others unidentified things (2.17%) and hairs of animals (0.69%) were also recovered in faecal matter samples of porcupine (Figure 2). In summer season, seeds (27.30%) were found to be consumed with high frequency followed by barks (23.13%) while leaves (11.71%), grasses (9.94%), roots (6.76%), twigs (6.73%), bones (6.03%), ingested moderately whereas flowers (1.39%), stones/other things (0.82%), hairs (0.43%) were found less frequently consumed (Fig.-1).

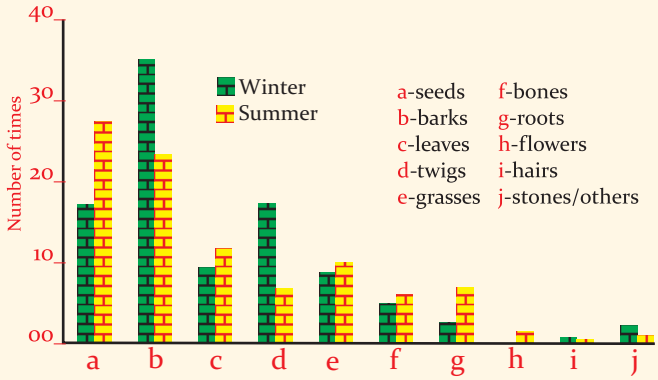

Figure-1: Relative frequency of different food items recovered from the faecal matter of Indian Crested Porcupine

Overall, consumption of barks and seeds was high whereas hairs, flowers and stones were less consumed by the porcupine and other items such as leaves, grasses, twigs, roots and bones were moderately consumed. The mean number of barks (4.12±.38), twigs (1.72±0.27), animal matter (such as hairs) (0.08±0.06) and stones or other unidentified things (0.24±0.11) were found to be maximum in winter season's diet than summer and the result of t-test shows that bark (t = 3.39, P= 0.001) and twigs

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(t = 4.66, P< 0.001) were found to be significant. However, the mean number of seeds (3.74±0.46), leaves (1.22±0.16), grasses (1.06±0.17), roots (0.75±0.13), bones (0.77±0.13) of animals and flowers (0.12±0.04) were found to be maximum in summer's diet than winter (Table 1). Overall the diet of Porcupine comprises with 92% vegetative matter and remaining 6.31% comprises of animal matters and 1.54% other materials (stones, threads, etc).

Diversity of food items in different season: the analysis of faecal pellets of porcupines collected during the two seasons that were summer and winter is presented. In order to ensure the variation in diet, diversity index was calculated from Berger-Parker equation (Table-1). The Berger-Parker index (d) of each season was calculated by the species dominance according to the habitat of porcupines. Through this method, diversity in food items of the porcupine reflected that the diet of porcupine in summer season (2.22) was more diversified as compared to the porcupine diet in the winter season (1.835). It confirms the finding of Hafeez (2011) in forest habitat.

Table-1: Mean number ± SE of different food items recovered from faecal matter of Indian Crested Porcupine in PTR

Food Items	Seasons		t-test
	Winter	Summer	
Bark	4.12±.38	2.45±0.24	3.40
Seed	2.08±0.37	3.74±0.46	-1.89
Leaves	1.2±0.23	1.22±0.16	-0.07
Twigs	1.72±0.27	0.69±0.09	4.66
Grasses	0.96±0.26	1.06±0.17	-0.29
Bones	0.4±0.12	0.77±0.13	-1.53
Roots	0.32±0.14	0.75±0.13	-1.73
Flowers	0±.0	0.12±0.04	-1.81
Hairs	0.08±0.06	0.07±0.03	0.14
Others	0.24±0.11	0.09±0.04	1.58

Table 2: Berger-Parker index of diversity in seasonal samples of the fecal pellets of Indian Crested Porcupine

Season	Total no. of food particles (N)	Max. food items (Nmax)	Berger-Parker index d= Nmax/N	1/d
Winter	279	152	0.544803	1.835526
Summer	977	440	0.450358	2.220455

Discussion:

The dietary ecology of the porcupine is highly diverse around the world. It has been suggested a herbivore species since dietary spectrum is comprised of 92% vegetative matter including bark, seeds, twigs, leaves, grasses, roots and herbs and only 6.3% animal matter such as bones, hairs etc, it indicate that the porcupine is a generalist consumer that can change its feeding habits, depending on the availability of food materials There are only limited studies carried out on food and feeding habits of porcupine to compare this study, which was mostly carried out in Pakistan (Arshad *et al*., 1990; Khan *et al*., 2000; Hafeez, 2011). Feeding habits of the porcupine is not species specific. They change their diet from habitat to habitat and from time to time (Prakash and Rana, 1970), so its dietary habit is related to temporal and spatial variation of food availability (Ben-David *et al*., 1997 and Hanson *et al*., 1999). Porcupine consider to be herbivorous (Guttermann, 1982; Alkon & Saltz, 1985; Khan *et al*., 2000; Hafeez, 2011) but in current study they also feed on animal matter such as bones (dead carcasses, shaded antlers), hairs of animals were also found in the faecal matter of porcupines. Some authors suggested that vegetative material is not sufficient to fulfil the mineral requirement like Calcium which supports the growth of quills (Grzimck, 1990; Gurung & Singh, 1996; Prater, 1965). An another reason to gnaw the bones is that it serves to sharpen and trim their incisors to grow throughout life.

Porcupine is an adaptable opportunist species which has more diverse diet in summer than the winter season. It may be due to the availability of more food items in the study area during summer. Moreover, duration of activity reflected through seasonal changes, during winter, forage availability and quality decline, and animals lower their activity correspondingly (Alkon & Saltz, 1988; Kielland *et al*., 2006). Since the activity duration of porcupine in summer was more than in winter spatially they remained closer to den on bright nights than on dark nights (Alkon, 1999) so due to the more time in summer they explored more area to forage and hence more diversification in food items.

The most abundant food item in winter is bark, twigs and unnecessary items whereas seeds, leaves, grasses, herbs were used more in summer season which supports the study of Switzer (1996), according to Switzer, Porcupines feeds on grasses and forbs in the spring and summer season and bark and woody shrubs during the fall and winter. Through this study, it was found that overall the diet of the porcupine to be dominated by barks of trees that agreed with the previous studies such as Sharma and Prasad (1992); Sheikher (1998); Girish *et al.,* (2005); Chakravarthy *et al.,* (2007). Porcupines feed on barks greatly as compare to other herbivore mammals because of their dentition and manual dexterity that allows them to consume the highly digestible portion of the woody browse (bark/cambium), and discard the largely indigestible portion that is wood (Kielland *et al.*, 2006). However, the bark has less nutritive as compared to other parts of plants and its consumption produces negative impact on vegetation. The critter's affinity for feeding on bark and twigs slows tree growth, damages or kills tree limbs, and can even cause tree mortality. On the other hand, this feeding behaviour does have an ecological significance; the dead or injured branches and trees attract a variety of insects that serve as food for many insectivorous birds, such as woodpeckers, nuthatches and

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chickadees. Cavities associated with the dead and dying limbs also benefit wildlife species that use them for nesting and denning, as well as salamanders and other creatures that rely on rotting logs. The accumulation of the dead vegetation on the forest floor also helps nourish forest soils (McCann & Thomas, 2014) According to Powell (1982), bark consumption in the natural system to be ecological; it helps in preventing or reducing the annual sporulation of the pine stem rust by gnawing the bark in Canada.

The present study found that maximum contribution in the food habit of porcupine was of Bark followed by seeds. All the above-discussed studies also found the high consumption of bark in the diet of the Indian porcupine None of the above discuss studies have shown presence of seeds in the diet of the Indian porcupine except one Chaudhary (2014), he reported 48.14% seed consumption in the diet of Indian porcupine in Gir Forest, India. Consumption of seeds by porcupine is also important. It makes porcupine ecologically significant since seeds present in the faecal matter were not destroyed so this species may act as a seed disperser and play an important role in ecosystem functioning. It showed a positive relationship with seed availability both temporally and spatially (Gutterman &Herr, 1981).

As far as concern subterranean and herbaceous parts of plants such as consumption of roots, bulbs, tubers and herbs were found to be moderately in the diet of porcupine in present study because of the availabilities in the study area it is in contrast with some studies that was carried out in arid and semi-arid habitat of Israel where they feed mostly on the underground storage organs of geophytes and hemicryptophytes (Gutterman, 1982) and tubers of cultivated potatoes (Alkon & Saltz, 1985). However, studies of the feeding effect of porcupines suggest that they play a minor role in the population dynamics of perennial plants that reduce plant fitness (Gutterman, 1988). In contrast to the trophic effect, the pits created on the soil surface as the porcupines dig for food have a marked impact on the plant community (Alkon, 1999). Pits dug by porcupines persist from several years to decades, depending on the substrate (Alkon, 1999). Due to the consumption of underground part of the plant, digs/ pits formation in the soil that creates a new microhabitat for the other organisms. There were found many digs in our study area also, these diggings of the porcupines provided a relatively good habitat for the germination and survival of the seedlings. They serve as wind traps and develop into favourable microhabitats in which organic matter, such as dry plant material as well as dispersal units and seeds are accumulated through the wind during summer, and run-off water can accumulate during the season with rain, mainly in winter (Gutterman & Herr, 1981). In these diggings, much more organic matter was found than in other areas surrounding it, which raises the field capacity of the soil and the amount of nutrition. The rate of water infiltration in porcupine diggings found twice as high as on undisturbed areas (Bragg *et al.,* 2005). Hence, porcupines help renew the population by eating the old plants and producing a better habitat for the germination, growth, and survival of young seedlings that is it act as potential sites for plant germination, recruitment, productivity and diversity (Gutterman & Herr, 1981; Bragg *et al.*, 2005).

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