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Full Length Research Paper

Opportunistic animal's diet depend on prey availability: Spring dietary composition of the red fox (*Vulpes vulpes*) in the Dhorpatan hunting reserve, Nepal

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The red fox (*Vulpes vulpes*) is a least concerned omnivore, distributed widely between 2,500 m and 4,500 m in different protected areas of Nepal. We investigated the spring feeding habits of the red fox in the Dhorpatan Hunting Reserve of Nepal. Livestock depredation by red fox, wolf and leopard, and the consequently retaliatory killings of these carnivores by local livestock herders, is becoming a serious issue for the conservation of these carnivores. At the same time, it leads to an increase in the number of prey animals by reducing the predators. Due to this situation, red fox change their dietary preference towards pika (*Ochotona roylei*), wild boar (*Sus scrofa*), and other ungulates. However, its main diet consists of insects (Coleoptera and Orthoptera) in other parts of its range. There is no significant difference (χ^2 = 0.86, df = 12, p > 0.05) in the frequency of occurrence of different prey species in the scats of red foxes. The pika (*Ochotona roylei*) made up 30% of the scats of fox, making it the most abundant species in their diet.

Keys words: Omnivores, diet, *Vulpes vulpes,* prey, predators.

INTRODUCTION

The red fox (*Vulpes vulpes)* is a generalist and opportunistic omnivore (Delibes-Mateos et al., 2008; Macdonald et al., 2008), common and widely spread throughout most parts of Asia and in other parts of the world (Lloyd, 1980; Voigt, 1987). Red foxes have been recorded in habitats such as the tundra, desert, forest, and in city centres as well (Example, London, Paris, Stockholm, etc.), with their ideal natural habitat being a dry, mixed landscape with abundant "edges" of scrub and woodland. They are also abundant on moorlands, mountains (even above the tree line as they are known to cross alpine passes), sand dunes, and farmlands from sea level to 4,500 m (Macdonald et al., 2008).

The red fox has been introduced in Australia and has been implicated as one of the contributors to the decline of native species throughout the country, particularly the critical weight range (35 - 5,500 g) herbivores (Burbidge and McKenzie, 1989; Morton, 1990) and ground-dwelling birds (Catling and Burt, 1995). Food utilization is an important aspect in the study of carnivore ecology, being that trophic resources dominate several aspects of their biology (Macdonald, 1983; Bekoffetal, 1984). Therefore, a detailed understanding of the dietary composition of the red fox is fundamental for a better understanding of this species as a predator and also for the management of both prey and predator populations.

The red fox is largely distributed in the Dhorpatan hunting reserve of Western Nepal. Due to lack of research and management in the region, it is one of the species of least concern. Thus, this pioneering work on the dietary analysis of the red fox was conducted to identifying the dietary behavior in spring season in the Dhorpatan hunting reserve from March - June, 2008.

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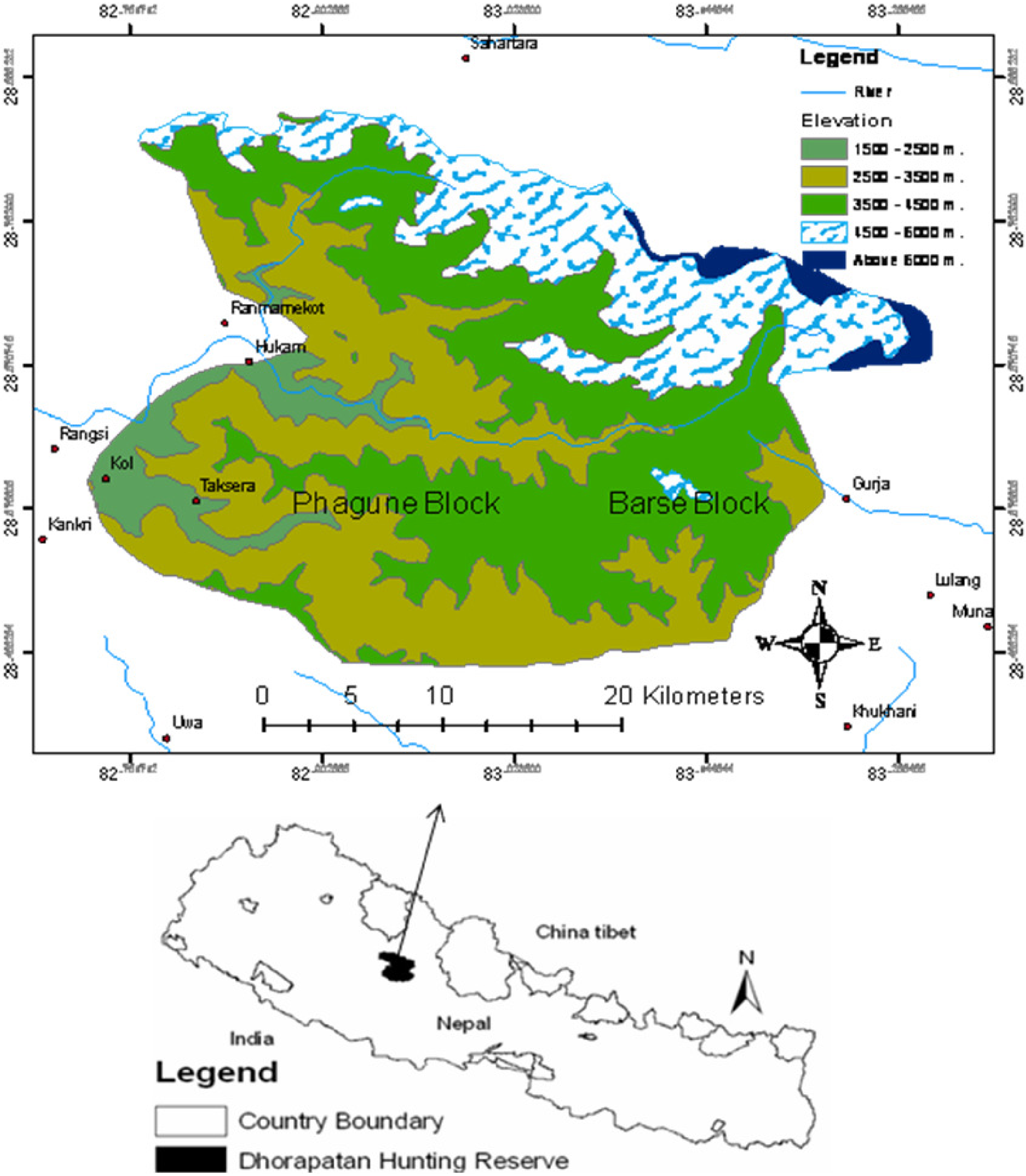

Figure 1. The location of the Dhorpatan hunting reserve in Nepal and the two blocks phagune block and barse block.

MATERIALS AND METHODS

Study area

This study was conducted in the Dhorpatan Hunting Reserve of Nepal. Located in the Baglung District in the Dhaulagiri Himalaya of Western Nepal (23°30'N - 28°50'N, 82°50'E - 83°15'E), this hunting reserve covers an area of 1325 km^2 with the altitude ranging from 2,850 - 5,500 m (Wegge, 1979). The reserve consists of seven different blocks, two of which that were similar in habitats were used in this study: the Phagune block and the Barse block. Collectively, these two blocks cover an area of 115 km^2 (Figure 1).

Phagune

In west along the trail up north from Uttar Ganga at Taka across the Phagune ridge at about 12,500 ft.; down to Pelma river, there turning east upstream along Pelma and Gustung river to an about 3.2 - 4 km east sheep ridge east of tributary, along east side of the ridge to the Dhorpatan trail intersection than following trail south to Dhorpatan and back down along Uttar Ganga.

Barse

Along the eastern part of Phagune block, up from gusting southwards along the Kharka trail to Dhorpatan, eastwards along Uttar Ganga to Barse Mount trail take-off, following trail along the ridge northwards across pass to eastern tributary of Gustung Khola, along the tributary and Gustung down back to Phagune block boundary.

Climate The reserve is located in front of an only moderately high saddle connecting the high Dhaulagiri and Hiuchuli. It is also shielded by several lekhs South of Utter Ganga. The Sheep area therefore receives less precipitation than others areas of the Nepal Midlands (Stainton 1972). Wegge (1976) extrapolates the annual precipitation to somewhat less than 1000 m.

During winter or dry season, which lasts from mid-September to early June, there is very little human activity in the hills above the timberline. The weather is dry and cold, with light snow during midwinter, and unpredictable heavier snowstorms into late spring (Wegge 1976).

Vegetation The area is characterized by many plant species of the drier climatic belt to the north, but remnants of the more humid zone are also present, giving the area a mixed vegetation cover. Falling in a transition zone, the dry northern elements are more pronounced at higher altitudes and on south-easterly aspects. In more moist and shaded habitats mixed hardwoods form well-developed strands at lower elevation, yielding first to fir *Abies spectabilis* and then to birch/rhododendron at higher altitudes. The upper northern slopes are densely covered with birch *Betula utilis* and rhododendron *Rhododendron campanulatum* to the tree line, between 3,050 m and 3,660m; below is a belt of fir and hemlock *Tsuga dumosa*, which gives way to a rich mixed-hardwood forest next to the river. The southern slopes, on the contrary, in a wide belt from approximately 3,500 - 2,440 m, consist of a very sparse scrub forest of oak *Quercus semecarpifolia*, interspersed with isolated blue pine *Pinus excelsa* trees and occasionally rhododendron *Rhododendron arboreum.*

Fauna Dhorpatan is noted for its blue sheep *Pseudois nayaur* population. Other ungulates include *Goral Nemorhaedus goral*, Himalayan tahr *Hemitragus jemlahicus*, and wild boar *Sus scrofa* (particularly common in the upper coniferous zone, especially in the Gurbad and Uttar Ganga catchments), Himalayan musk deer *Moschus chrysogaster* (widely distributed), Serow *Capricornis sumatraensis* and Indian muntjac *Muntiacus muntjak*. Common leopard *Panthera pardus* is common and widely distributed up to altitudes of 4,420 m. Other predators include lynx *Felis lynx* (known to occur in the Upper Seng Valley). Wild dog *Cuon alpinus* (V), red fox *Vulpes vulpes*, wolf *Canis lupus* (V) and snow leopard *Uncia uncia* (E) are occasional visitors to the area. Himalayan black bear *Selenarctos thibetanus* is common in forested areas. Red panda *Ailurus fulgens* is reported to be fairly common in the upper forests of the Lower Seng and Upper Bakre valleys (Wegge, 1976; Fox, 1985).

Data collection

Sign (scats, pugmarks, scrapings, and scent spray) surveys were also carried out in study area to distinguish different predator's scats and to estimate scat density. Different predators' signs were identified based on their size, colour, pugmarks and other features (wherever available). Confusion with dog and lynx scats were avoided because herders and livestock were in downhill and there was no record of lynx or wild dogs in Barse or Phagune blocks. An existing human and livestock trail was used as a transect line for collecting different predators' scats. Considering that the maximum altitude of red fox distribution is 4500 m, research was only carried out up to this elevation. The red fox scat survey was carried out in the Barse and Phagune blocks of the Dhorpatan Hunting research (115 sq. km collectively). Scats of red foxes were indentified on basis of certain characters such as a relatively smaller size, long and final pointed tips, scats covered with grasses and fruit material, etc. A total of 85 red fox scats were collected from the field for dietary analyses. The field data were collected from March - June, 2008, from different altitude 2000 - 4000 m. Scats were prepared according to Mukherjee et al. (1994) for identification of prey. A standard micro-histological method was then used to identify which prey species were present in the scat samples by comparing the hairs from the collected faeces with reference hair samples. Specifically, the hair surface scale patterns of the guard hairs were compared with those from a reference hair collection comprising all the potential prey species from the area.

The hair samples from the scats were first washed in hot water. Subsequently, they were thoroughly air dried and then cleared in ether for one hour to remove any wax depositions and traces of the moisture. Finally, the hairs were passed through Xylol for 24 h and mounted with DPX into permanent slides to see the medulla structure of the hairs. A gelatin solution was used to prepare the slides for cuticular structure visualization and cuticular scales were observed using impression techniques. The slides were observed under a light microscope (400x) and digital photos were taken to visualize the cuticular and medulla pattern of the hair samples. At least twenty hair samples were taken from each fecal sample for analysis. The prey residue composition of the predator scats was extrapolated in terms of the frequency of occurrence of the prey species in the scat samples (Fi), calculated by equation I (Karanth and Sunquist, 1995; Mizutani, 1999; Pikunov and Korkishko, 1992; Ramakrishan et al., 1999; Aryal and Kreigenhofer, 2009).

$$Fi = ni \times 100 / N \qquad (1)$$

Where ni is the number of scats where a given i-th prey species residue occurs and N is the total number of all scats samples.

RESULTS

Diet composition of the red fox (*Vulpes vulpes*)

The frequency of occurrence of different prey species in the scats of the red foxes of this study are found in Table 1. Excluding zero values, there are no significant differences between the frequencies of different prey species in the red fox diet ($\chi^2 = 0.86$, df = 12, $p > 0.05$). The pika (*Ochotona roylei*), which was found in 30% of the samples, was the most frequently found prey species in the red fox diet. Wild boar (*Sus scrofa*) was the second most frequently occurring prey animal (11%). The remaining high frequency items found in these fecal samples were vegetation (25%) and non-food items (13%). Other prey items found include insects, serow, and musk deer, amongst others (Table 1).

DISCUSSION

There is a significant increase in the abundance of scats

Table 1. Occurrence of prey frequency in red fox scats (n-85).

Prey species	Frequency	%
Pika	508	29.88
Vegetation	421	24.76
Non food item	221	13.00
Wild boar	192	11.29
Insect	176	5.41
Himalayan Serow	62	3.65
Monkey	45	2.65
Himalayan Musk deer	41	2.41
Birds	44	2.59
Goral	26	1.53
Goat	23	1.35
Blue sheep	25	1.47

during summer and autumn compared to winter and spring (White, 2006). A similar trend was expected in this study site thus scat density in our study area was assumed to be higher in summer compared to other seasons.

Important dietary components of the red foxes in this area are pika and vegetation, while wild boar is in third position of their diet. Home et al. (2009) stated that arthropods were the most frequently occurring prey in fox's diet, however, our study found that the most frequently occurring prey is the pika, followed by vegetation and wild boar. It is because of livestock depredation by wolves and leopards, and the antagonism it generates (that is, the retaliatory killing of these carnivores by local livestock herders), that there is now an increase in the number of prey species (as well as serious conservation issues for these carnivorous species). Due to this situation, the red fox has changed its dietary preference towards pika, wild boar, and other ungulates.. The populations of wild boar, pika, and other prey species have increased and these species are now seen above the tree line in the Barse and Phagune blocks.

The fecal samples in this study contained some unexpected results. Specifically, 3.7% of the samples contained Himalayan serow, 2.4% contained musk deer, and 1.5% contained goral. We assume that the red foxes scavenged the remaining parts of these animals which were killed by other large carnivores. Another possibility is that red foxes prey upon the juveniles of these prey species. This study showed that 1.4% of diet of the red foxes in this region consisted of livestock (goats) which is surprising as these foxes have an abundance of wild prey species in the area. The reason behind this might be easy access to and availability of goats. If this pattern of livestock depredation increases in future, local herders may start killing red foxes by poisoning and others means which can critically threaten the survival of the red fox in the Dhopratan Hunting reserve of Nepal.

The study strongly recommends that concerned governments initiate conservation programmes for carnivores in this area, including the red fox.

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