

Diet of Striped hyena (*Hyaena hyaena*) in a semi-arid protected area of Western India

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Abstract

Striped hyena (*Hyaena hyaena*), having the largest distribution and most diverse in the social organisation among hyenids, remains the least studied. The availability of food is known widely as one of the key determining factors of social organization in animals. In the present study, the food habits of striped hyena were investigated by analysing the scat samples collected (n=303) during 2013-15 from the semi-arid region of Sariska Tiger Reserve, Western India. Totally, the prey remains belonged to 23 species were identified from hyena scats. It was found that the striped hyena had a catholic choice of diet with great reliance on large mammals (sambar, *Rusa unicornis*; chital, *Axis axis*; nilgai, *Boselaphus tragocamelus*; wild pig, *Sus scrofa*; and livestock; 56%) in the Indian semi-arid region. Rodents, birds, reptiles, hare and small carnivores contributed 21.45% of the diet of striped hyena. Vegetative matter consisted primarily of grass and *Zizyphus* seeds contributed 17.95% to the striped hyena diet. The scat analysis showed that the overall diversity of food items in striped hyena diet was 2.22 (Shannon-Winner Index, H). It was also found that 39 kills were belonged to 12 different prey species at the den sites (n=27). Striped hyenas were observed to predate on wild ungulate fawns/calves (48.72%) followed by ground-dwelling birds (28.21%), small carnivores (7.69%), primates (5.13%), reptiles (5.13%), Rufous-tailed hare (2.56%) and livestock (goat, 2.56%). The present study also revealed that though the hyenas are scavengers and primarily dependent on large mammals, they also actively predate on smaller prey species.

Key words: Feeding ecology, striped hyena, scatology, carnivore kill, semi-arid region

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INTRODUCTION

Studies on food habit are crucial to understand the carnivore ecology and for conservation and management of the species (Mills, 1992; Levitus, 2000). Knowledge of diet is essential when carnivore sociality (Wagner *et al.*, 2008) or predator-prey relationships are studied (Jedrzejewski *et al.*, 2002), or when predators are perceived as a threat to livestock (Marker *et al.*, 2003), or when rare prey species are required protection (Napolitano *et al.*, 2008), or when strategies are evolved to mitigate human-animal conflict. Carnivores have witnessed a massive decline in their population globally and are now confined to fragmented populations in a human-dominated landscape. In human-dominated landscape, the most vulnerable species are the largest and most specialised species, often top predators (Cardillo, 2003) such as striped hyena.

Striped hyena (*Hyaena hyaena*) is a nocturnal scavenger with a patchy geographic range among the hyenids (Mills and Hofer, 1998). Striped hyena

exhibits little fear of humans and are human tolerant. It is often found within the proximity of urban centres and can survive on human organic waste generated at these sites (Mendelsohn and Yom Tov, 1999). Most of the populations of hyena in India live outside the protected areas in the agro-pastoral landscape. Arid regions of North-western India are important habitats for hyena persistence (Singh, 2010; Gupta *et al.*, 2009), which is among the most densely populated arid regions of the world both for humans as well as livestock (Rahmani and Soni, 1997). Striped hyenas have been reported to consume a wide variety of vertebrates, invertebrates, vegetative matter, fruits and human originated organic wastes (Ilani, 1975), and the limited data have led to the interpretation that striped hyenas are essentially omnivorous scavengers. However, recent studies suggest that they feed on variety of food item from small sized to large-bodied prey depending on the availability (Wagner, 2006; Bopanna, 2013; Jhala, 2013). Based on prior studies, striped hyena is found to demonstrate an opportunistic behaviour and scavenges on livestock and wild animals, and predate on small mammals, livestock, reptiles and ground-nesting or feeding birds (Leakey *et al.*, 1999; Kruuk, 1972; Sankar and Jethwa, 2002;

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Wagner, 2006). However, hyenas sometimes predate on small livestock like goats, sheep, cattle calf and dogs and hunt hare, gazelle, jackal, nilgai calves and wild pig. In Kachchh, cattle and dogs contributed over 70% of the hyena's diet (Jhala, 2013).

Striped hyena often comes into conflict with humans due to their habit of livestock depredation, targeted retaliatory killing directed at other carnivores and road accidents. The literature on striped hyena diet is limited and often restricted to studies confined to outside protected area (Bopanna, 2013; Gajera *et al.*, 2009). The present article deals with the results of the investigation on food habit of striped hyena in a semi-arid protected area of North-Western India so as to understand their diet composition and reliance on livestock for long-term conservation of this near threatened (Abisaid and Dlonai, 2015) species in this landscape.

MATERIALS AND METHODS

Study Area

The study was carried out in the Sariska Tiger Reserve (STR), (76.28° to 76.56° E and 27.08° to 27.55° N) which is situated in the Aravalli Hill Range and lies in the semi-arid part of north-western India. The total area of the Tiger Reserve is 1200 km². The terrain is undulating to hilly, has numerous narrow valleys and two large plateaus. The altitude of Sariska ranges from 540 to 777 m. The vegetation of Sariska corresponds to northern tropical dry deciduous forests (subgroups 5 B: 5/E1 and 5/E2) and Northern Tropical thorn forest (subgroup 6 B) (Champion and Seth, 1968). Wild herbivores found in Sariska include chital (*Axis axis*), sambar (*Rusa unicorn*), and nilgai (*Boselaphus tragocamelus*). Omnivores found include wild pig (*Sus scrofa*) and jackal (*Canis aureus*). Large carnivores found include reintroduced tigers (*Panthera tigris*), leopard (*Panthera pardus*), striped hyena (*Hyaena hyaena*). STR sustains a comparatively higher density (15 individuals/ 100 km²) of striped hyenas (Gupta *et al.*, 2009). Small carnivores include caracal (*Caracal caracal*), jungle cat (*Felis chaus*), common mongoose (*Herpestes edwardsi*), small Indian mongoose (*H. auropunctatus*), ruddy mongoose (*H. smithi*), common palm civet (*Paradoxurus hermaphroditus*), small Indian civet (*Viverricula indica*) and ratel (*Mellivora capensis*). Rhesus macaque (*Macaca mulatta*) and common langur (*Semnopithecus entellus*), Procupine (*Hystrix indica*), rufous tailed hare (*Lepus nigricollis ruficaudatus*), Indian gerbil (*Tatera indica*), Indian bush rat (*Golunda ellioti*), spiny tailed mouse (*Mus platythrix*), house mice (*Mus musculus*), little Indian field mice (*Mus booduga*) long tailed tree mouse (*Vandeleuria oleracea*), sand coloured Rat (*Millardia gleadowi*), soft fur field rat

(*Millardia meltada*), brown rat (*Rattus norvegicus*), house rat (*Rattus rattus*) and pygmy gerbil (*Gerbillus nanus*) are also found in STR.

There are two State Highways, which are over 44 km in length and traverse through the heart of the reserve. There are 29 villages within the Tiger Reserve boundary and approximately 170 villages and a city situated along the periphery of the reserve (**Figure 1**). The human population is over 8500 in the villages inside STR along with a population of 30000 domestic livestock including buffalo, brahmini cattle, goat and sheep (Sankar *et al.*, 2008). The people inhabiting these villages are traditionally pastoralist, and their primary source of income is selling milk and its products like condensed milk and clarified butter.

Usually, dead live-stocks are dumped outside the villages (n=29) which are located inside STR. We recorded 39 livestock carcass around 11 villages during the study.

Diet

Diet of striped hyena was studied using scat analysis (Wagner, 2006; Chourasia *et al.*, 2012). Hyena scats (n=303) were collected on animal trails and roads (n=44) by systematic search resulting in an effort of 227.25 km during winter and summer from 2013 to 2015 in the entire study area. Hyena scats were identified by the patterns of shape, size and colour, mostly oval to cylindrical-shaped with white or off-white in colour (Bopanna 2013). Each collected scat sample was labelled with date and location (Area, Beat, Range and GPS coordinates). Collected scats were sun-dried and later broken down and washed under running water through a sieve of 1 mm. The scat contents were then teased apart and the remains of different food items such as hair, feather, scales of reptiles, hoof and vegetative matters (grass and fruit seeds) were separated (Mukherjee *et al.*, 1994). Scat contents were then studied under a microscope, identified and recorded following standard methods (Mukherjee *et al.*, 1994). Percent frequency of occurrence (%FO) and relative frequency of occurrence (RFO) were calculated for each food item to understand as to how often striped hyena feeds on a certain food item and relative importance of the food item in their diet (Loveridge and Macdonald, 2003). The %FO is defined as the number of times a particular prey item occurred in the scat in terms of percentage of prey remains. The RFO is defined as the number of times a prey item was encountered in a sample of scats expressed as percentage of total occurrence of all food items. Niche breadth of the species was estimated using Shannon-Winner Index (H) (Krebs, 1999). Following the scat analysis, we randomised the original order of scat samples, and the adequacy of scat samples to assess species richness using rarefaction and extrapolation curve (Chao *et al.*, 2014).

We also visited hyena den sites (n=27) to record the predated prey item every week in all seasons. Striped hyenas are known to bring back food to their den sites (Kruuk, 1976; Ilani, 1975). We considered predation whenever we found fresh and intact prey species with canine bite marks of striped hyena.

RESULTS

Altogether, 303 scat samples of striped hyena were collected and analysed. The proportion of different prey species in scats got stabilised once a sample of

150 scats was analysed (Fig.2). In total 23 food items were identified in the striped hyena scat samples, wherein remains of large mammals were found frequently. Wild ungulates (sambar, chital, nilgai and wild pig) and domestic livestock (buffalo, cattle and goat) together contributed the most (~56%) in the striped hyena diet. Rodents, birds, reptiles, hare and small carnivores contributed 21.45% of striped hyena diet that is unlikely to be scavenged. Vegetative matter consisting primarily of grass and Zizyphus sp seeds contributed 17.95% to the diet of striped hyena. Relative

Table.1. Percent frequency of occurrence and Relative Frequency of Occurrence (RFO) of food items in striped hyena diet from scat analysis (n=303)

Broad Prey Category	Prey Item	RFO	% Occurrence
		10.72	15.18
Domestic Livestock	Buffalo (<i>Bubalus bubalis</i>)	1.17	1.65
	Cattle (<i>Bos taurus</i>)	6.29	8.91
	Goat (<i>Capra aegagrus hircus</i>)	3.26	4.62
		45.22	64.03
Ungulate	Chital (<i>Axis axis</i>)	17.25	24.42
	Nilgai (<i>Boselaphus tragocamelus</i>)	1.17	1.65
	Sambar (<i>Rusa unicorn</i>)	26.34	37.29
	Wild Pig (<i>Sus scrofa</i>)	0.47	0.66
		11.89	16.83
Rodent	Indian Bushrat (<i>Golunda ellioti</i>)	0.23	0.33
	House Rat (<i>Rattus rattus</i>)	0.47	0.66
	Indian Gerbil (<i>Tatera indica</i>)	0.23	0.33
	Rat (Unidentified)	10.96	15.51
		3.96	5.61
Primates	Common Langur (<i>Semnopithecus entellus</i>)	3.73	5.28
	Rhesus macaque (<i>Macaca mulatta</i>)	0.23	0.33
		7.69	10.89
Birds	Cattle Egret (<i>Bubulcus ibis</i>)	0.23	0.33
	Peafowl (<i>Pavocristatus</i>)	6.76	9.57
	Parakeet (<i>Psittacula</i> sp.)	0.23	0.33
	Grey Francolin (<i>Francolinus pondicerianus</i>)	0.23	0.33
	Rufous Treepie (<i>Dendrocitta vagabunda</i>)	0.23	0.33
Rufous tailed hare (<i>Lepus nigricollis ruficaudatus</i>)		1.4	1.98
Domestic Cat (<i>Felis catus</i>)		0.23	0.33
Reptiles		0.23	0.33
Insects		0.7	0.99
Vegetative Matter		17.95	25.41

frequency of occurrence and percent frequency of occurrence of each food item found in striped hyena scats are given in Table 1 and Fig.3. The overall diversity of food items in striped hyena diet was 2.22 (H).

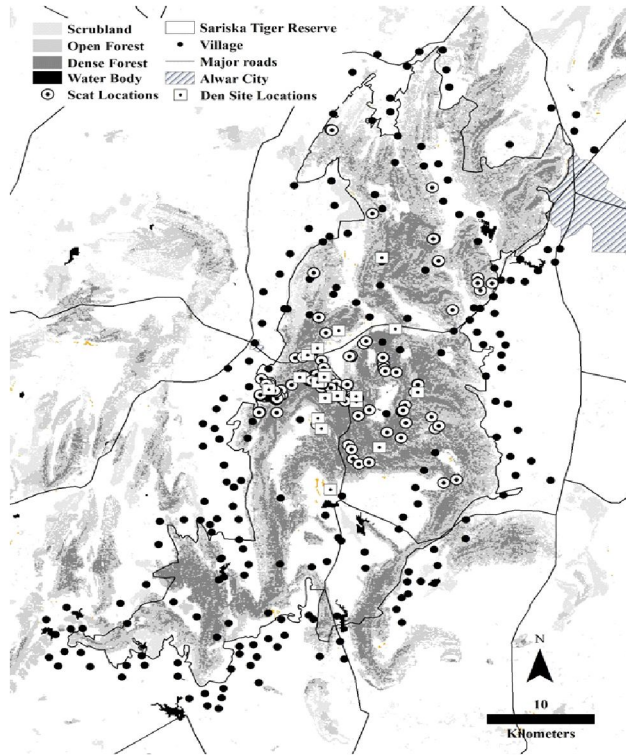


Fig. 1. Sariska Tiger Reserve with villages inside the park and in the periphery

In total, we recorded 39 cases of predation by striped hyena during the study period. Striped hyenas were observed to predate on wild ungulate fawns/calves (48.72%), reptiles (5.13%), ground-dwelling birds such

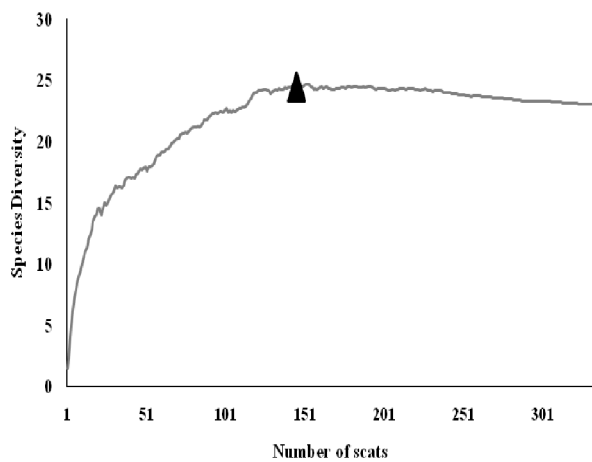


Fig.2. Diet stabilization curve of striped hyena in Sariska Tiger Reserve, Rajasthan

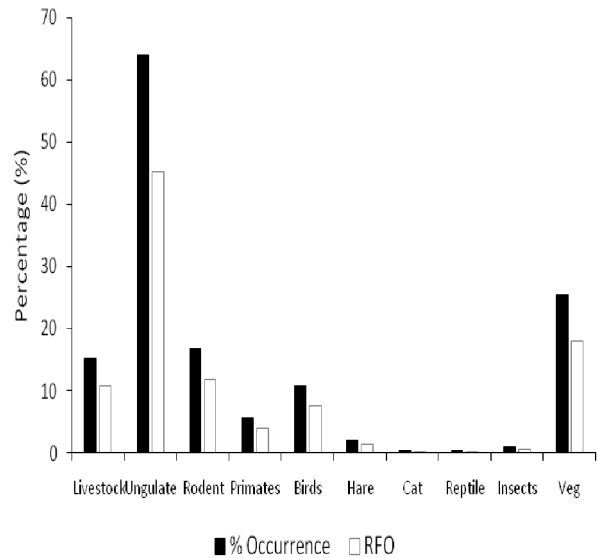


Fig. 3. Percent Frequency of Occurrence (% Occurrence) and Relative Frequency of occurrence (RFO) of different food items in the scat samples (n=303) of striped hyena in STR.

as peafowl and grey partridge (28.21%), small carnivores (7.69), primates (Rhesus macaque juvenile, 5.13%), Rufous-tailed hare (2.56%) and livestock (goat, 2.56%). We recorded fawn/calf (sambar, chital and nilgai, n=18) predation during the onset of winter during November and December when fawns/calves were less than six months old (Fig. 4 & 5).

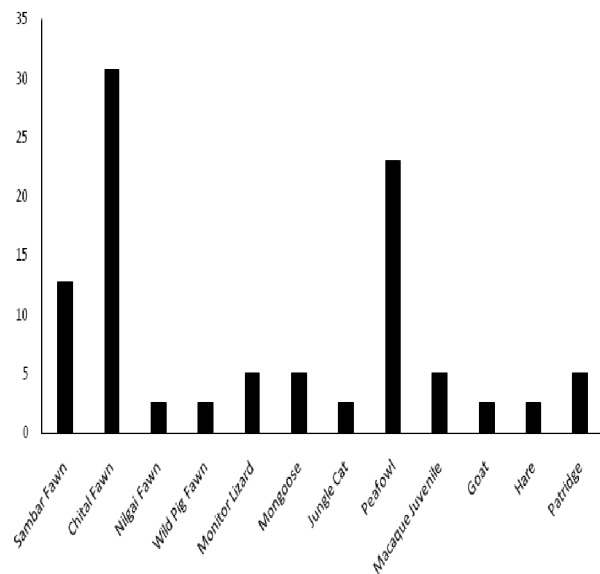


Fig. 4. Percentage of different food items in the kills (n=39) of striped hyena



Fig. 5. Camera trap photograph showing active predation of spotted deer fawn by striped hyena

DISCUSSION

Knowledge about striped hyena ecology is largely known based on studies done in Africa (Kruuk, 1976; Leakey, 1999; Wagner, 2006; Califf, 2013). Our study showed that striped hyenas maintain a catholic diet which is dominated by large mammals (~56%) in the semi-arid region of North-Western India. Inside PA's they rely more on wild ungulates (45.22%) as shown in the present study. However, their reliance on livestock was comparatively less (10.72%), although STR supports a high density of livestock, which was 222 animals/ Km², (Sankar *et al.*, 2008). This might be attributed to the fact that other carnivores (tiger and leopard) rely less on livestock (~7% and 19% respectively) and more on wild ungulates (approximately 60–70%) in the study area (Mondal *et al.*, 2012). STR sustains comparatively high wild ungulates density, 56.2 animals/ Km² (Jhala *et al.*, 2015). Striped hyena being a scavenger, may likely access these carcass killed by tiger and leopard. Earlier dietary studies on spotted hyena suggest that the striped hyena requires approximately 946g of dry meat/ Day (Nagy *et al.*, 1999). Striped hyena likely requires access to a similar quantity of dietary resources which can be easily met through available food resources (active predation) and tiger and leopard kills (scavenging) in STR.

When comparing the frequency of occurrence of prey species in striped hyena diet with previous studies conducted in STR, it is evident that the utilization rate of both ungulate was 49% during 1990 (Sankar and Jethwa, 2002), 70.9% during 2010–11 (Chaurasia *et*

al., 2012), and livestock 31% during 1990 (Sankar and Jethwa, 2002) 33.7% during 2010–11, (Chaurasia *et al.*, 2012) which was in decreasing trend, while rodents, 1.2% during 2010–11, (Chaurasia *et al.*, 2012) and birds, 2.3% during 2010–11, (Chaurasia *et al.*, 2012) showed increasing trend over the years (Table 1). Owing to the opportunistic nature of striped hyena, total number of prey species recorded depends very much on the sample size. Both the studies recorded only nine food items in hyena diet and had a low sample size (n=26 and n=86) as compared to the present study (n=303). Our study reveals that the proportion of different prey species in scats got stabilised when a sample containing 150 scats of striped hyena were analysed. Hence, it is suggested that the sample size of at least 150 scats should be analysed so as to understand the food habits of striped hyena in the study area.

The diet diversity of striped hyena in STR (2.22) and Gir National Park (2.64) can be compared (Alam *et al.*, 2015). STR and Gir PAs support high availability of wild prey. However, striped hyena diet diversity outside PA in Kachchh [3.08 (H) with 32 food items] was higher (Bopanna, 2013) as compared to both STR and Gir indicating their reliance on a broader spectrum of food resources which may be attributed to the species adaptability and versatility. Traditionally, dead livestock is dumped near villages in India which also serves as food source for scavengers (Chhangani, 2009).

CONCLUSION

Diet of striped hyenas in the semi-arid areas predominantly consists of large mammals (Alam, 2015; Bopanna, 2013), smaller and rare prey species in African systems (Wagner, 2006). Diet and dispersion of food are widely recognised as a key determinant of group formation (Crook, 1965; Gittleman, 1989; Mills, 1989). Given the difference in diet, greater resource availability and heterogeneity in the Indian semi-arid with African systems, the social organisation of striped hyena may likely to be influenced by the former. Thus, our findings set the stage for further investigation of their sociality in this habitat concomitant to extant resources.

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