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FOOD HABITS AND DIET OVERLAP OF TWO SYMPATRIC CARNIVORE SPECIES IN CHITRAL, PAKISTAN

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ABSTRACT

Two carnivore species i.e. Grey wolf (*Canis lupus*) and Asiatic jackal (*Canis aureus*) spread over wide range of habitats in Pakistan, showing sympatric distribution in many areas including Chitral area of Hindu Kush Range. The present study determined the food habits and diet overlap of these two species in Chitral, Pakistan. Fifty scat samples, 25 each of wolf and jackal, were collected and analyzed to determine their diet composition. Hair characteristics such as medullae and scale patterns were used to identify the mammalian preys consumed by these predators. Wolf consumed 14 prey species while jackal consumed 13, among which 11 species were common in their diets. Domestic sheep, Palm civet and Golden marmot dominated the diet of wolf while Palm civet, Golden marmot, Cape hare and Wood mouse were main prey species found in the scats of jackal. Diet overlap factor indicated a high prey overlap between the two species, providing chances of competition. The potential habitats along with their natural prey species need to be protected for the conservation of these two species, especially the Endangered one, the Grey wolf. Compensation to the owners of livestock killed by wolf could help in saving this species from retaliating killing.

Key words: Grey wolf, Asiatic jackal, Diet composition, Diet overlap, Conservation, Chitral Pakistan.

INTRODUCTION

In Pakistan, genus *Canis* consists of two species i.e. Grey wolf (*Canis lupus*) and Asiatic jackal (*Canis aureus*). The Grey wolf has the largest historical geographic range and exists in a wide range of habitats from cold tundra to the warm deserts of the Old and New World (Kolenosky and Stand field, 1975). Wolf ascends into all the mountainous regions of Pakistan from Balochistan up to Chitral, Gilgit and Baltistan in the north (Roberts, 1997).Year-round pair bond insures that more hunting units include at least two adults (IUCN, 2004). Large wild herbivores are of great importance for the wolf's population maintenance in most of its distribution range. Selection for wild ungulate species is partially affected by their abundance, but other factors such as prey's social behavior, adaptability to the habitat and body size could have an important role in species selection by wolves (Meriggi *et al*., 1996).

Wolves feed upon livestock mainly from late spring to autumn but in some areas, where winter is mild, predation of domestic ungulates occur year round (Meriggi and Lovari, 1996). Predation on domestic ungulates leads to extensive retaliation killing of wolves**.** The reintroduction of wild large herbivores has been advocated as a means of reducing attacks on livestock, but predation may remain high if domestic ungulates are locally abundant (Meriggi and Lovari, 1996). Grey wolf is classified as "Least Concern" globally (IUCN, 2011) but rated as "Endangered" in Pakistan (Sheikh and Molur, 2005).

In Pakistan, Asiatic jackal is found throughout the plains of Punjab and Sindh, and in hilly areas of Blochistan and Khyber-Pakhtunkhwa provinces (Roberts, 1997). Their adaptability to locally abundant food permits them to occupy a wide variety of habitats and utilize a variety of food including vegetable matter in their diet (IUCN, 2004). Jackals are omnivorous and opportunistic foragers, and their diet varies according to season and habitat (Wyman, 1967; Moehlman, 1983). The bulk of jackal diet comprises rodents and reptiles secured through hunting, supplementing their diet with fruit and insects when available (Roberts, 1997).

Jackal populations seem to be very flexible, can recover quickly from population declines, can live in high-densities, so areas required for maintaining minimum viable populations could be quite small (Giannatos, 2004). Jackal is not as controversial or damaging as its larger counterpart, the Grey wolf, although in high-densities predation on small-sized stock does occur (Genov and Vassilev, 1991). Due to the low level of human jackal conflicts it seems that conservation measures for the species would be easier to enforce than with other sympatric canids (Giannatos, 2004). Asiatic jackal is listed as "near Threatened" in Pakistan (Sheikh and Molur, 2005).

Distribution of both of these carnivores overlaps in Chitral region, raising the possibility of competition for natural prey which can further force the wolf to kill domestic livestock. Present study determined the food

composition of Grey wolf and Asiatic jackal and extent of diet overlap between these two species in Chitral area. This information can support their conservation efforts.

MATERIALS AND METHODS

Study Area: The study was conducted in Chitral Gol National Park (CGNP) and Tushi Game Reserve (TGR) in Khyber-Pakhtunkhwa province of Pakistan. Chitral Gol NP is situated at 35° 56'N &71'40°E, with total area of 7,750ha (Fig. 1). Tushi GR is located close to CGNP, with an area of 1,545ha.The climate is dry temperate, characterized by hot summers in lower areas and cold summers in upper elevations. Mean annual temperature is 16.8^{0}C and mean annual precipitation is 445 mm (Ali, 2008). Summer and autumn are dry, receiving barely 10-25 mm monthly rainfall (GoNWFP and IUCN-P, 2004). Oak forest (*Quercus ilex*) exists up to 2,400 m elevation which grades into coniferous forest including *Cedrus deodara* and *Pinus gerardiana* at higher elevations.

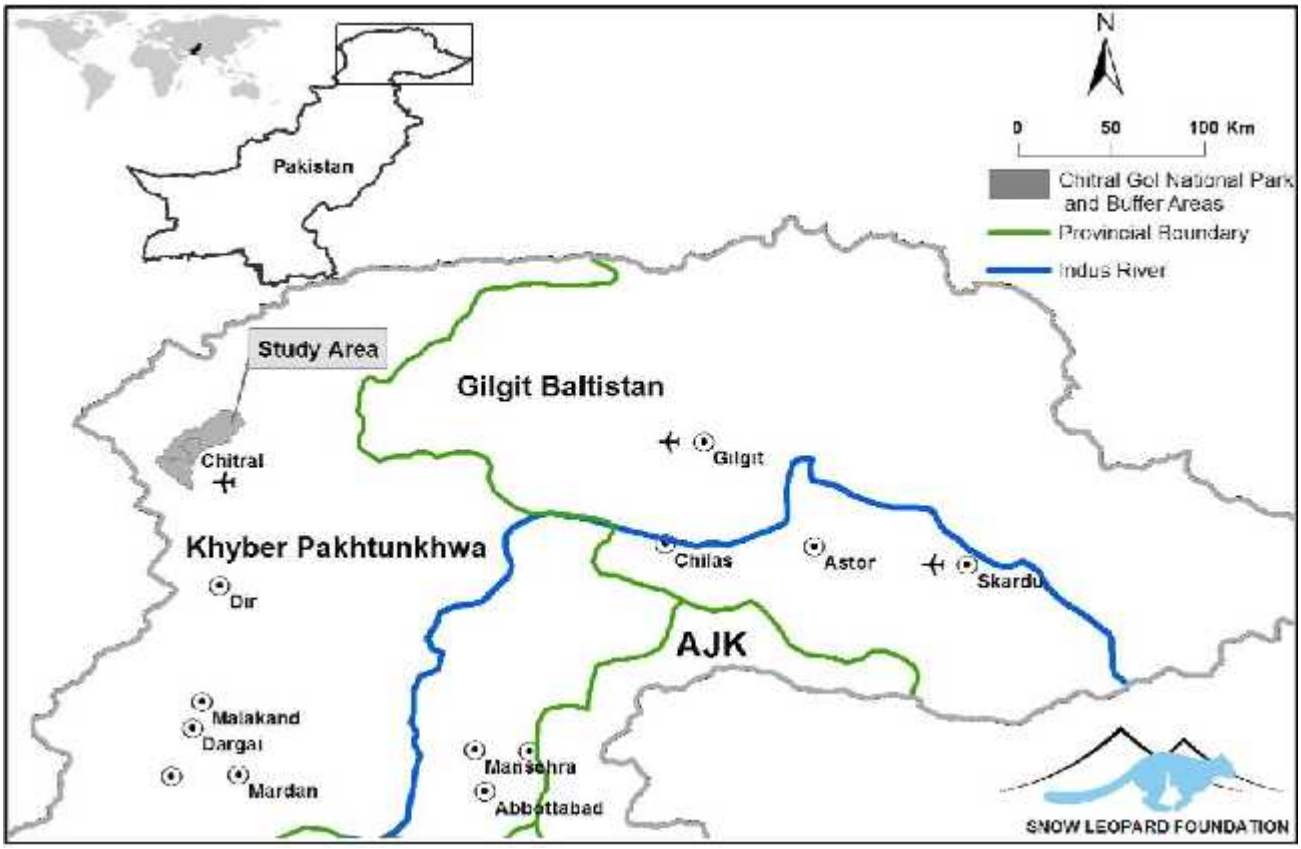

Fig. 1.Location of the study area in district Chitral, Pakistan.

Fauna of the study area has affinities to Palearctic region and major species include; Snow leopard (*Uncia uncia*), Black bear (*Ursus thibetanus*), Himalayan lynx (*Lynx lynx*), Grey wolf (*Canus lupus*), Asiatic jackal (*Canus aureus*), Markhor (*Capra falconeri*), Himalayan ibex (*Capra ibex sibirica*), Cape hare (*Lepus capensis*), Snow cock (*Tetraogallous himalayensis*) and Chukar partridge (*Alectoris chukar*) (GoNWFP, 2006; Din and Nawaz, 2010). Cattle, sheep and goats are the main domestic livestock species which are kept for meat, milk, hides, wool and for draught purposes. They graze freely on natural vegetation during summer (GoNWFP and IUCN-P, 2004).

Methods: Diet compositions of the target species were determined through scat analysis. A total of 50 scats, 25each of wolf and jackal, were collected between April 2009 and December 2010 from CGNP and TGR. Identification of scats as of wolf or jackal was based mainly on their dimensions, shape and structure. Additional criteria included the nature of scat deposit site and presence of tracks or sign of activity in nearby area. Scat samples were double-bagged, labeled, and frozen. To identify the remains of prey species in the scat samples, reference hairs of potential prey species found in the study area were collected (Table 1). The reference slides of hairs of potential prey species and those found in the scats were prepared following Lavoie (1971). The

scats were washed under flowing water and sieved through cotton cloth to remove un-necessary particles and dust. Then contents were segregated into hairs and bones. The scale patterns of hairs were prepared after (Lavoie, 1971). The medullary patterns and scale replication of the hairs were observed under high power microscope (40x or 100x) and identification of prey species was carried out following Moore *et al*., (1974). Microphotographs of representative medulla and scale patterns of hairs were taken by OLYMPUS BH-2 microscope. The reference key was used to identify unknown hairs in scat samples and prey consumed. As an example, microphotographs of hair scale pattern of four prey species (of known hair and a hair found in scat sample) are given in Fig. 2.

The contents of wolf and jackal scats were presented as frequency of occurrence (percentage of scats in which an item was found) and percent occurrence (number of times the hair of a given prey was found as percentage of all prey items found) of each food item. Diet overlap between the two species was estimated by calculating the modified Morisita index of overlap (Horn, 1966). The index $C\lambda$ varies from 0.0 for completely distinct pairs (no food species in common) to 1.0 for complete overlap:

$$C\lambda = \frac{2\sum xy}{\sum x^2 + \sum y^2}$$

Where x and y are frequencies of prey species in the total diet of wolf and jackal, respectively.

Table 1. Animal species of study area included in the hair identification key

Vernacular name	Scientific name
Domestic goat	*Capra hircus*
Domestic sheep	*Ovis aries*
Kashmir markhor	*Capra falconeri cashmiriensis*
Common Red fox	*Vulpes vulpes*
Rhesus monkey	*Macaca mulatta*
Himalayan Black bear	*Ursus thibetanus*
Cape hare	*Lepus capensis*
Golden marmot	*Marmota caudata*
Small Kashmir flying squirrel	*Hylopetes fimbriatus*
Himalayan palm civet	*Pagum alarvata*
Royle'spika	*Ochotona roylei*
Royle's Mountain vole	*Alticola roylei*
Asiatic White-toothed shrew	*Crocidura pullata*
Grey hamster	*Cricetulus migratorius*
House mouse	*Mus musculus*
Himalayan Wood mouse	*Apodemus rusiges*
Turkestan rat	*Rattus turkestanicus*

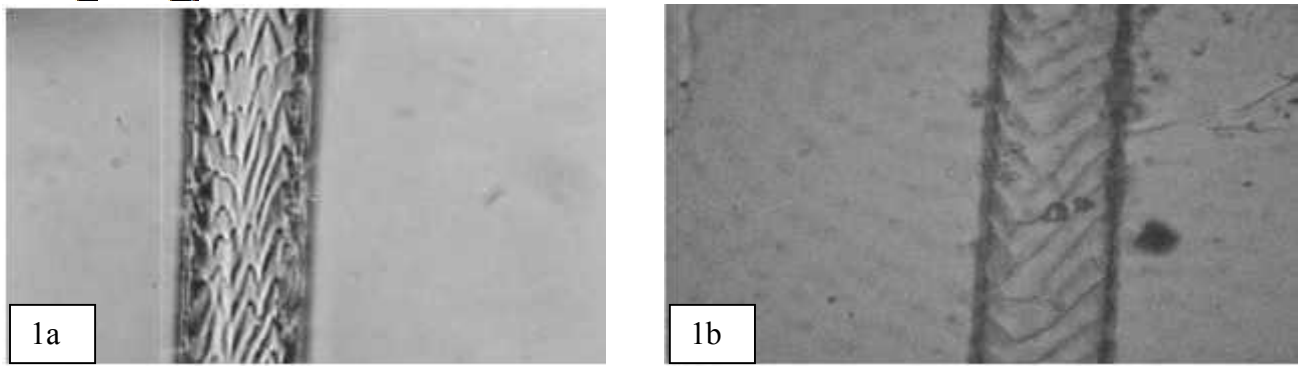

Plate 1: Microphotographs of hair scale pattern of Cape hare (*Lepus capensis)*: 1a) reference hair (10x40 x), 1b) hair found in scat sample (10x40x).

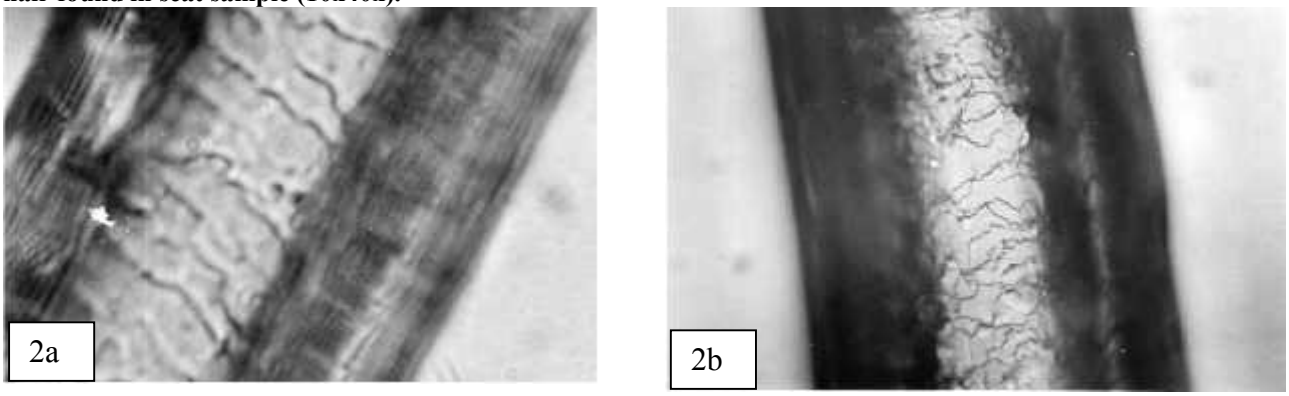

Plate 2: Microphotographs of hair scale patternof Palm civet *(Paguma larvata*); 2a) reference hair ((10x100 x), 2b) hair found in scat sample (10x100x).

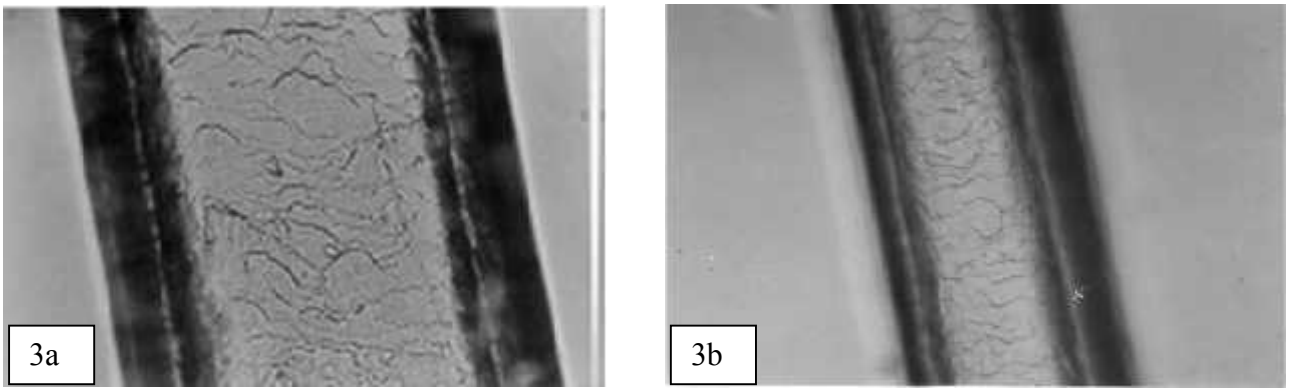

Plate 3: Microphotographs of hair scale pattern of domestic Goat *(Capra hircus domesticus)*; 3a) reference hair ((10x40 x), 3b) hair found in scat sample (10x40x).

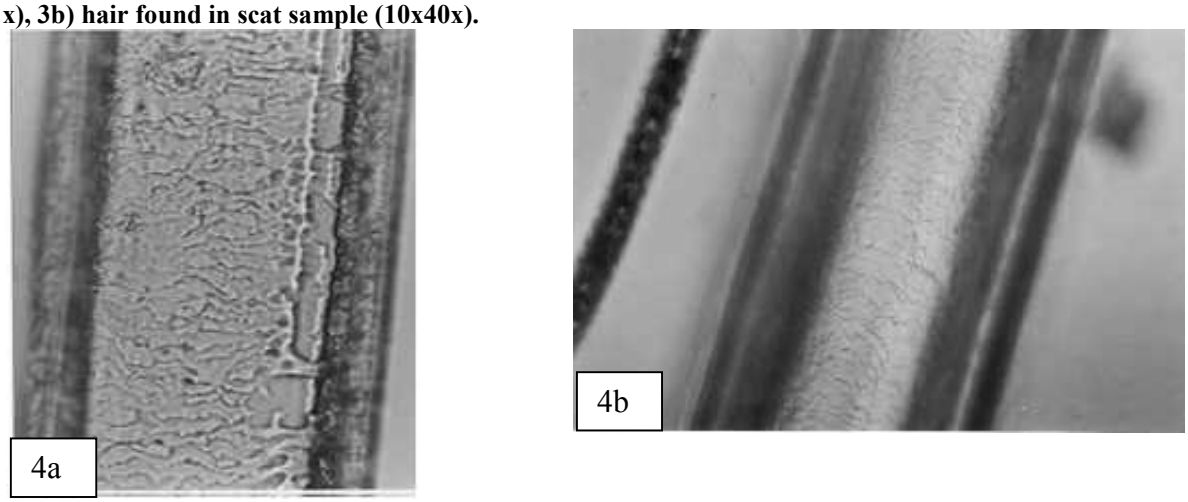

Plate4:Microphotographs of hair scale pattern of Golden marmot *(Marmot acaudata)*; 4a) reference hair ((10x100 x), 4b) hair found in scat sample (10x100x).

Fig 2. Microphotographs of hair scale patterns of four prey species (of known hair and of hair found in scat sample).

RESULTS AND DISCUSSION

Diet Composition: One difficulty in interpretation of scats analysis based carnivore diet is that only indigestible materials can be recorded and soft tissue from large carcasses without hairs are difficult to detect. Secondly, small prey contain a relatively higher proportion of indigestible matter (hairs, bones and teeth) and their remains are over represented in scats (Floyd *et al*., 1978) which makes analysis of diet involving percent volume or percent weight of prey remains in scats biased towards smaller prey.

Grey wolf: A total of 47 prey items (13 spp.) were identified in the analyzed scats of Grey wolf (Table 2). Contribution of domestic and wild prey was 17.01% and 82.99%, while that of large, medium and small mammals was 21.33%, 34.02% and 23.89%, respectively in the diet of wolf. Among large mammals domestic sheep (10.63%) and domestic goat (6.38%) were dominant followed by markhor (2.12%) and red fox (2.12%) (Table 2). Among meso-mammals, Palm civet was the dominant food (10.63%) followed by Golden marmot (8.51%), Cape hare (6.38%), Royal pika (4.25%) and Small Kashmir flying squirrel (4.25%). Among small mammals, Wood mouse (6.38%), Royal mountain vole (6.38%) and House mouse (6.38%) contributed equally and major portion in the diet of wolf, followed by hamster (4.25%). Unidentified bird remains contributed 10.63 % while 10.63% of the items could not be identified (Table 2).

High occurrence of wild prey (82.99%) as compared to domestic ungulates (17%) was noted in wolf's diet. Schaller (1976) also reported a high proportion of natural prey (60 %: Himalayan ibex [37%], marmots [17%], as compared to domestic stock (38 %) in their diet in Chitral area and Khunjerab National Park. Similarly, Roberts (1997) reported that in higher remote mountainous regions bulk of wolves' diet is made up of wild ungulates, however, they also feed on domestic goats and sheep whenever get opportunity and for this reason have been hunted ruthlessly in those areas of

Pakistan. Present study revealed that medium sized mammals made up the largest proportion of their food (34.02%) which supports the earlier investigations (Pezzo *et al*. 2003; Riley and McBride, 1972). Diet of wolf may also vary seasonally and ratio of small mammals including rodents became higher in summer (Anderson and Ozolins, 2004).

Present study showed a low percentage of markhor (2.12%) in wolf's diet which was probably due to the fact that it is the only wild ungulate with scarce population found in the study area while domestic livestock is easily available particularly during the summer in high alpine pastures. However, consumption of livestock species by wolf becomes lower where there is abundance and diversity of wild ungulates (Merrigi *et al.* 1996). A study in south Europe reported that niche breadth of wolf increases with decrease of large prey in their diet (Pezzo *et al*.2003). Even if the wolf seems to adapt locally on fruit, garbage, livestock and small and medium size mammals, the wild ungulates are still preferred food source and predation on livestock seems to be negatively correlated with the presence of wild ungulates in the diet.

Table 2. Food Items found in scats of Grey wolf and Asiatic jackal in Chitral area during 2009-2010

Prey species	Frequency of occurrence		Percent Frequency	
	Wolf	Jackal	Wolf	Jackal
Large Mammals				
Domestic sheep	5	3	10.63	6.38
Domestic goat	3	-	6.38	-
Markhor	1	-	2.12	-
Red fox	1	-	2.12	-
Meso-mammals				
Cape hare	3	4	6.38	8.51
Royal pika	2	1	4.25	2.12
Small Kashmir flying squirrel	2	1	4.25	2.12
Golden marmot	4	4	8.51	8.51
Himalayan palm civet	5	4	10.63	8.51
Small mammals				
Wood mouse	3	4	6.38	8.51
Royal Mountain vole	3	1	6.38	2.12
House mouse	3	3	6.38	6.38
Hamster	2	2	4.25	4.25
Others				
Unidentified birds	5	6	10.63	12.76
Unidentified insects	-	3	-	6.38
Plant matter	-	6	-	12.76
Other unidentified remains	5	5	10.63	10.63
Totals	**47**	**47**		

Asiatic jackal: The jackal scats also contained 47 prey items including mammals birds, insects and plant matter (Table 2). Domestic and wild prey contributed 6.38% and 93.92%, respectively in their food. The share of large, medium and small mammals was 6.38%, 29.77% and 21.26%, respectively. Cape hare, Golden marmot and Palm civet (8.51% each) were the dominant prey among meso mammals. Wood mouse was dominant (8.51%) among small mammals followed by House mouse (6.38%), Hamster (4.25%) and Royal mountain vole (2.12%). Unidentified bird species contributed 12.76 %, insects 6.38% and plant matter 12.76 % (Table 2).

Being omnivorous and opportunistic foragers (Wyman, 1967; Moehlman, 1983), jackals adapt to local abundance of food resources which permits them to occupy a wide variety of habitats and food resources. Earlier studies revealed that small mammals, particularly the rodents were dominant in the diet of jackal in different ecosystems (Roberts, 1997; Khan, 1982; Lanszki and Heltai, 2002; Mukherjee, 1988; Poche *et al.*, 1987)). Birds (12.76 %) also contributed in the diet of jackal in present study which supports the Mukherjee (1988) who reported that jackal's diet in India comprised of 19% birds, investigations in Pakistan (Roberts, 1997; Khan, 1982) and South Africa (Rowe-Rowe, 1976). Present analysis also showed large quantity of vegetable matter (12.76) in the diet of jackal. Earlier studies have also reported the presence of vegetable matter, fruits and pods of various plant species in jackal's diet in India (Schaller, 1967; Sankar, 1988; IUCN, 2004), and in Pakistan by Roberts (1997) that the bulk of jackal's diet comprises rodents and reptiles but they freely supplement their diet with fruit and insects when available.

Diet Overlap: The value of diet overlap factor was 0.81 (=0.81), indicating a high degree of overlap in the diets of wolf and jackal for some prey species. However, significant difference ($P < 0.05$, $\chi^2=36.69$, df=15) was found in the consumption of prey species including Domestic goat, Markhor, Red fox, Royal mountain vole, insects and plant matter ($P <0.05$, $\chi^2 =6.37\text{-}12.75$, df =1) among the two species. While frequency of prey items such as Domestic sheep, Cape hare, Royal pika, Small Kashmir flying squirrel, Golden marmot, Palm civet, Wood mouse, House mouse, Hamster and unidentified birds showed non-significant difference in the diets of both carnivores ($P > 0.05$, $\chi^2 =0\text{-}2.83$, df =1). Eleven prey items were common in the diets of both species including; Domestic sheep, Cape hare, Royal pika, Royal mountain vole, Small Kashmir flying squirrel, Golden marmot, Palm civet, Wood mouse, House mouse, Hamster and unidentified birds remains. Domestic sheep, Palm civet and bird remains were dominant in wolf's diet while Cape hare, Golden marmot, Palm civet, Wood mouse and bird remains were dominant in the diet of jackal (Fig. 3).

The estimated diet overlap factor 0.81 (C_{xy} =0.81) is indicating a high degree of trophic overlap existing between wolf and jackal. Diet frequencies of wolf and jackal for medium and small mammals were 68.54% and 57.41%, respectively showing competition between them for meso and small mammals in the study area. Lanszki *et al*., (2006) reported that in Hungary, the canid species consumed more small mammals and diet overlap among the canid species was high (mean, 73%) and varied with the decreasing availability and consumption of small mammals. Generally, wolf preys on large mammals; however, in areas where human hunting pressure is high, it seems that wolf has been forced to switch to smaller prey, which leads to competition with jackal. Animal diet of wolf has more breadth as compared to jackal which probably permits both the canids to survive in the similar niche. Earlier investigations of winter diets of wolf and lynx (*Lynx lynx*) in Latvia and Estonia revealed that wolf's diet was more diverse; besides *cervids* (44% in Latvia, 63% in Estonia) it included wild boar (*Sus scrofa*) (32% in Latvia, 17% in Estonia), carrion, small rodents, and other food items (Valdmann *et al*., 2005). A high degree of diet overlap between the two species also indicates a substantial degree of niche overlap between them in the study area. Competition for small mammals seems to be high as the relative proportions of small mammals in their diets were almost same.

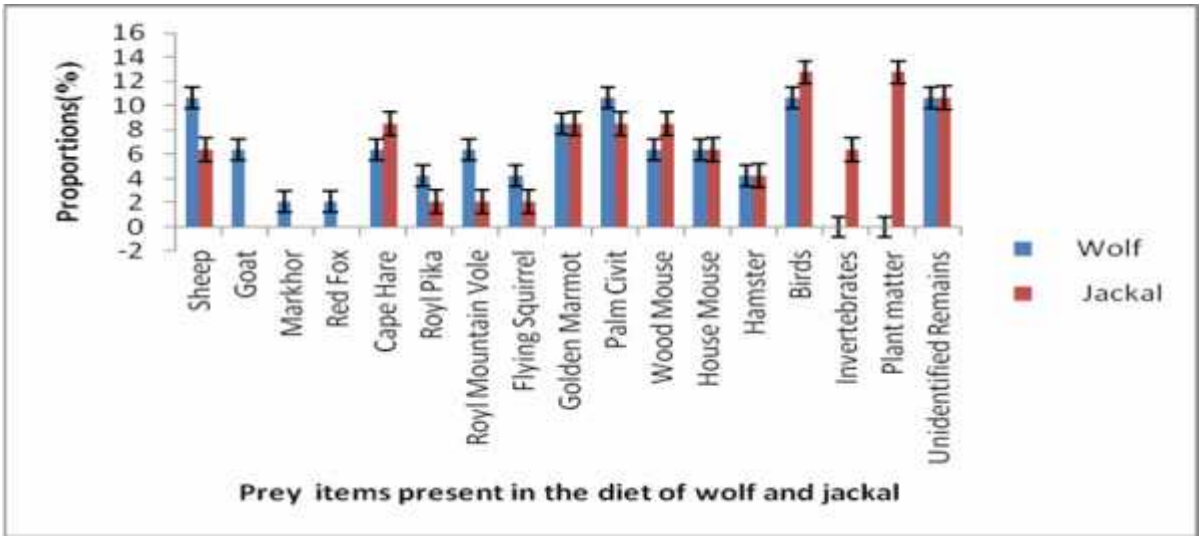

Fig. 3. Proportions of prey species found in the diet of Grey wolf and Asiatic jackal in Chitral area during 2009-2010

Management implications: Results of the study suggested a high degree of diet overlap for meso-mammals and small mammals between Grey wolf and Asiatic jackal in Chitral area. It is recommended that the habitat and natural prey species of both should be protected for their conservation. Payment of compensation to the owners of livestock killed by wolf can be another concrete step to save this endangered species from retaliating killing. These studies represent only the feeding trends of these two predators and more intensive and long term studies are needed to make solid decisions about niche breadth and overlap in their diet. Further research on their natural prey species and their population monitoring is also suggested. Public awareness about threatened species of the area must be raised to win their support and cooperation in conservation efforts.

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