TÜBİTAK

Research Article

Turk J Zool
2012; 36(6): 798-805
© TÜBİTAK
doi:10.3906/zoo-1109-16

Season- and locality-related changes in the diet of Asiatic jackal (*Canis aureus*) in Potohar, Pakistan

Muhammad Sajid NADEEM[1,*], Ruqqya NAZ[1], Syed Israr SHAH[1], Mirza Azhar BEG[1], Amjad Rashid KAYANI[1], Muhammad MUSHTAQ[1], Tariq MAHMOOD[2]

[1]Department of Zoology, PMAS–Arid Agriculture University, Murree Road, Rawalpindi 46300 – PAKISTAN

[2]Department of Wildlife Management, PMAS–Arid Agriculture University, Murree Road, Rawalpindi 46300 – PAKISTAN

Received: 20.09.2011 ● Accepted: 13.05.2012

Abstract: Feeding habits of the Asiatic jackal were studied through 98 scats collected between January 2009 and March 2010 from different sites in Potohar, Pakistan. The overall frequency of occurrence of plant items was 54.0%; the animal prey item frequency was 46.2%. Among the plant foods, *Ziziphus* was eaten year round, whereas wild olive, grasses, and wheat grains were the chief components of the diet during all seasons except summer. Among the animal food items, livestock carcasses were consumed year round; the highest consumption was observed during the summer and autumn seasons and the lowest in winter. Small mammals, particularly rodents, were also eaten year round, but not as intensively as livestock carcasses. Overall biomass consumption of these 2 food sources was 67.7% and 8.4%, respectively. Mammalian biomass was consumed in significantly higher proportions in all seasons and localities.

Key words: Frequency, biomass, seasonal variation, protected and unprotected areas

Introduction

The Asiatic jackal (*Canis aureus*), also known as the golden, oriental, or common jackal, is present in South Asia up to Myanmar (formerly Burma), North and East Africa, and southern Europe. The largest of the jackals, it is represented by 13 subspecies outside of Africa (Wilson and Reeder, 2005). Although it is often grouped with the black-backed and side-striped jackals, DNA studies align it more closely with the wolf and dog groups.

Jackals are well adapted to dry open countries and are present in plains and deserts throughout Pakistan (Roberts, 1997). Attracted by refuse and garbage, they often visit villages and small towns in search of food. Generally, the jackal is thought to be harmful to human beings, probably due to its role as a carrier of diseases, including rabies. Jackals also destroy sugar cane and orchard crops. They can also cause economic loss by attacking poultry and livestock. However, their beneficial role in seed dispersal and rodent population control cannot be neglected (Roberts, 1997).

The Asiatic jackal is an omnivorous and opportunistic forager and its diet varies according to season and habitat. A single jackal typically hunts smaller prey, e.g., rodents, birds, and hares. It can hunt old and weak ungulates that are about 4–5 times heavier than its body weight. Jackal packs are more successful in hunting than single jackals. Over 60%

* E-mail: sajidn@uaar.edu.pk

of their diet in East Africa consists of rodents, lizards, birds (from quail to flamingoes), snakes, hare, and Thomson's gazelles (Jhala and Mohelmen, 2004), although they also consume invertebrates and fruits.

Although the Asiatic jackal is common in Pakistan, relatively little information is available about its ecology. This study provides information on season- and locality-related variations in the diet of the jackal population of Potohar. It may be useful in future studies for assessing the role of the species in the ecosystem, competition with other carnivores, impact on prey populations, and carnivore management strategies.

Materials and methods

This study was carried out on the Potohar Plateau of the province of Punjab, Pakistan (Figure 1). Potohar's eastern and western sides are flanked by the rivers Jhelum and Indus, respectively. To the north are the Margilla Hills and Kala Chita Ranges, and to the south are the Salt Ranges. Potohar consists of 4 administrative districts: Attock, Chakwal, Jhelum, and Rawalpindi. Its area is about 13,000 km^2, and its elevation ranges from 305 to 610 m above sea level. The subhumid climate of the northern part of Potohar gradually becomes drier as the distance from the sub-Himalayan region increases. The average rainfall varies from 150 cm in the northeast to about 38 cm in the southwest (Punjab Barani Commission, 1976). The Potohar Plateau is regarded as pasture land, and many people in the area are dependent on livestock.

In all, 98 scats from Asiatic jackal were collected during the period between January 2009 and March 2010 from different areas of the Potohar region, excluding croplands. The jackal scats, which consisted of a few pieces from the same dropping, were distinguished from other carnivores (e.g., roaming dogs, foxes, civets, and jungle cats) on the basis of size, shape, characteristic contents, and spoors around the scat. Officials from the Punjab Wildlife Department and the local field guides were very helpful in identifying jackal scats. Moreover, scats were picked only from those localities where jackals were sighted, while localities inhabited by roaming dogs were avoided. The scats were wrapped in paper, placed in sealed plastic bags, and labeled with date and locality. The GPS location of the collection sites was recorded using GPS (Garmin 12-Channel GPS). The scats were brought to the laboratory and temporarily placed in a warm, dry place to obviate damage to their contents by fungus before being dried in an oven at 60 °C and stored.

For analysis, the scats were soaked in water for 24–36 h depending upon their age. After 24 h they were washed with tap water in a fine sieve (mesh size: 100 μm). Each sample was cleaned further in an ether and alcohol mixture (1:1) and dried between absorbent papers before examination. The hairs and remnants of bones and plant materials were identified by comparing them with reference materials (Oli, 1993; Jackson, 1996; Anwer et al., 2011, 2012a, 2012b; Mahmood et al., 2011; Nadeem et al., 2012). Unidentified seeds recovered from the scats were grown in pots for plant species identification. Contents of the scats were presented according to frequency of occurrence, i.e. the percentage of occurrence of each food item in all scats (Carvalho and Gomes, 2004; Breuer, 2005; Giannatos et al., 2010; Radovic and Kovacic, 2010). The biomass of food consumed by the jackals was estimated by multiplying the dry weights of prey remains with the coefficients of digestibility, which were 23 for small mammals (rodents), 50 for medium-sized mammals (hare), 35 for birds, 5 for insects, 18 for reptiles, and 14 for plant materials (Goszezyinski, 1974; Jedrizejewski and Jedrizeaski, 1998; Lanszki and Heltai, 2002; Lanszki et al., 2009; Goldenberg et al., 2010; Borkowski et al., 2011). Following Jędrzejewski and Jędrzejewska (1992), Jędrzejewska and Jędrzejewski (1998), Goldenberg et al. (2010), and Borkowski et al. (2011), the coefficient for antelope carcasses (Punjab urial: *Ovis vignei punjabiensis*; placed in this group as it is similar in size to antelopes) was 15; for domestic stock (goat, sheep, and cow) it was 118. We assumed that goat, sheep, and cow biomass in the diet was contributed through scavenged carcasses rather than hunting. However, according to some local people, jackals occasionally prey on sheep and goats, especially the young ones. Seasonal- and locality-related variations in the diet of the Asiatic jackal were also determined. Magurran (1988) was followed to assess and compare diversity in the jackal diet by using species richness (S), Shannon's index (H'), and Pielou's evenness (E) indices. Student's t-test was used to compare diet variation among seasons and localities.

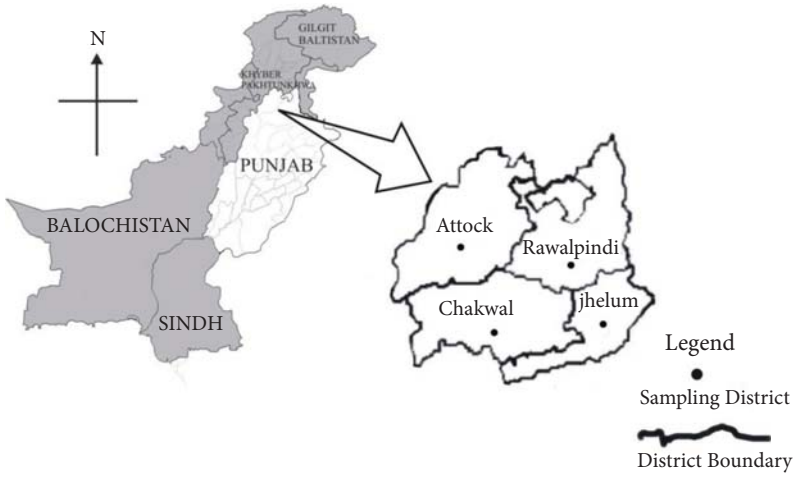

Figure 1. Map of Pakistan showing the study districts included in the Potohar region.

Results

From the remnants in the jackal scats, 17 different types of food item were identified. The frequency of occurrence of plant matter was 51.0%, while animal food occurred with 46.2% frequency (Table 1). Consumption of fruits (*Ziziphus* spp., *Olea cuspidata*, *Citrullus lanatus*, *Psidium guajava*, and *Cucumis melo*) was greater (39.3%) than of grass seed (*Triticum indicum*, *Acacia nilotica*, and *Melia azedarach*) consumption (9.6%). Among the animal foods, mammals were eaten more frequently (30.4%) than poultry and other birds (7.5%) (Table 1). Animal biomass was consumed more intensively (91.7%) than plant biomass (8.3%). Mammals contributed 81.7% to the biomass, followed by poultry and other birds (9.2%). Carcasses of domestic stock (goat, sheep, and cow) accounted for 67.7% of the animal diet of jackals.

Seasonal variation

In the winter, fruits occurred with a frequency of 57.4%, while seeds contributed 14.7% and mammals 13.0% to the jackal diet. The share of birds was 3.7%, while reptiles and insects were consumed in equal proportion (1.8%). Mammals contributed 52.9% of the biomass followed by fruits (35.1%), birds (6.2%), reptiles (3.7%), and seeds (2.0%).

During the spring season, both the frequency of occurrence of plant remnants and their contribution to biomass consumption in the diet declined. Animals were a more important source of food in the spring than in the winter; mammalian and bird biomass consumption rose to 78.2% and 16.0%, respectively. Mammalian carcasses and birds gained importance as a jackal food source, while small mammals became a less important source (Table 1).

In summer the importance of plants as a component of the jackal diet declined further, while the utilization of animal food improved (Table 1). This improvement was due to a more intensive utilization of mammalian biomass (91.1%) and poultry (8.5%).

During the autumn season, the frequency of occurrence of plant food items in the jackal diet improved due to better utilization of fruits (39.5%). As a result, both the frequency of occurrence and biomass consumption of plant food in autumn approximated findings from the spring season. As in the other 3 seasons, the proportion of mammalian biomass remained higher (90.3%), although the frequency of occurrence (38.7%) was slightly lower than the frequency of occurrence of fruits.

The highest prey diversity was recorded during the spring and autumn seasons (Figure 2). The evenness index ranged between 0.77 (in winter) and 0.90 (in spring). Overall, frequency of occurrence of animal prey was significantly dominant ($t = 3.18$, $df = 3$, $P < 0.05$) in the jackal's diet throughout the year except in the winter season, when plants, especially fruits, were consumed in a significantly higher proportion

Table 1. Seasonal changes in frequency of occurrence of prey remnants (N%) and estimate of their biomass consumption (B%) in Asiatic jackal in the Potohar region; n: number of scats.

Prey items	Winter (n = 35)			Spring (n = 19)			Summer (n = 19)			Autumn (n = 25)			Total (n = 98)		
	N	N%	B%	N	N%	B%	N	N%	B%	N	N%	B%	N	N%	B%
Plant remains															
Ziziphus spp.	19	35.2	19.1	5	15.6	5.0	5	17.8	0.2	7	22.6	2.0	36	24.8	5.0
Olea cuspidata	12	22.2	16.0	1	3.1	0.0	-	-	-	4	12.9	0.8	17	11.7	2.9
Grass	4	7.4	1.1	2	6.3	0.0	-	-	-	1	3.2	0.0	7	4.8	0.2
Triticum indicum	2	3.7	0.1	3	9.4	0.1	-	-	-	-	-	-	5	3.4	0.0
Citrullus lanatus	-	-	-	1	3.1	0.0	1	3.6	0.0	-	-	-	2	1.4	0.0
Melia azedarach	1	1.8	0.6	-	-	-	-	-	-	-	-	-	1	0.7	0.1
Acacia nilotica	1	1.8	0.2	-	-	-	-	-	-	-	-	-	1	0.7	0.0
Psidium guajava	-	-	-	1	3.1	0.0	-	-	-	-	-	-	1	0.7	0.0
Cucumis melo	-	-	-	-	-	-	1	3.6	0.1	-	-	-	1	0.7	0.0
Unidentified	1	1.8	0.0	1	3.1	0.1	-	-	-	1	3.2	0.1	3	2.1	0.1
Subtotal (a)	**40**	**74.1**	**37.1**	**14**	**43.7**	**5.2**	**7**	**25.0**	**0.3**	**13**	**41.9**	**2.9**	**74**	**51.0**	**8.3**
Animal remains															
Small mammals	5	9.3	12.0	5	15.6	6.7	5	17.8	4.9	5	16.1	11.4	20	13.8	8.4
Medium-sized mammals	-	-	-	-	-	-	1	3.6	14.1	-	-	-	1	0.7	4.5
Antelope carcasses	-	-	-	1	3.1	4.8	-	-	-	-	-	-	1	0.7	1.1
Goat, sheep, cow carcasses	2	3.7	40.9	5	15.6	66.7	8	28.6	72.1	7	22.6	78.9	22	15.2	67.7
Wild birds	2	3.7	6.2	4	12.5	16.0	-	-	-	1	3.2	3.8	7	4.8	5.7
Poultry	-	-	-	-	-	-	3	10.7	8.5	1	3.2	2.6	4	2.7	3.5
Insects	1	1.8	0.1	1	3.1	0.5	-	-	-	1	3.2	0.3	3	2.1	0.2
Reptiles	1	1.8	3.7	-	-	-	-	-	-	-	-	-	1	0.7	0.6
Unidentified	3	5.6	-	1	3.1	-	2	7.1	-	2	6.5	-	8	5.5	-
Subtotal (b)	**14**	**25.9**	**62.9**	**17**	**53.1**	**94.8**	**19**	**67.8**	**99.7**	**17**	**54.8**	**97.1**	**67**	**46.2**	**91.7**
Other															
Soil	-	-	-	1	3.1	-	2	7.1	-	-	-	-	3	2.1	-
Anthropogenic item	-	-	-	-	-	-	-	-	-	1	3.2	-	1	0.7	-
Subtotal (c)	**0**	**0**		**1**	**3.1**		**2**	**7.1**		**1**	**3.2**		**4**	**2.8**	
Grand total (a + b + c)	**54**			**32**			**28**			**31**			**145**		

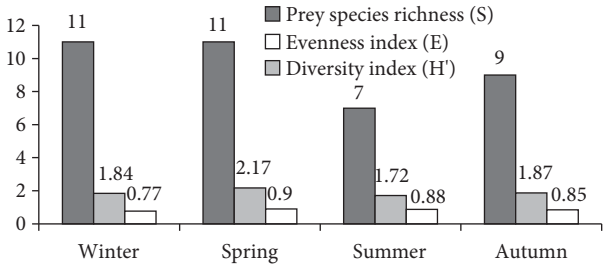

Figure 2. Seasonal diversity in the Asiatic jackal diet.

(t = 3.18, df = 3, P < 0.01). The proportion of plant numbers in the winter was also significantly higher than in summer (t = 1.833, df = 9, P ≤ 0.05) and autumn (t = 1.833, df = 9, P < 0.02). However, there was no significant difference between the proportion of plant numbers consumed in the winter and spring seasons. Numerically, the consumption of animal matter in winter was significantly lower than in spring (t = 2.011, df = 5, P < 0.05), summer (t = 1.89, df = 7, P ≤ 0.05), and autumn (t = 1.89, df = 7, P ≤ 0.05). The consumption of animal biomass was significantly higher in all seasons (t = 1.82, df = 3, P ≤ 0.01) and was dominated by goat, sheep, and cow carcasses.

Locality-related variation

a) Northern and southern Potohar

An analysis of the jackal scats collected from the subhumid northern part of Potohar revealed that the frequency of occurrence for plant food was 53.0% as compared to 44.0% for animal food. However, biomass consumption of plant food was just 9.1% compared to a 90.9% consumption of animal biomass (Table 2). Among the plants, biomass consumption was highest for fruits (8.6%), whereas mammals (80.6%) and birds (9.3%) dominated the animal prey items.

In southern Potohar, animals dominated the diet both in frequency of occurrence (51.1%) and in biomass consumption (93.1%). The jackals of southern Potohar also depended mainly on carcasses of domestic stock, small mammals, birds, and insects for their food, but somewhat more heavily than the northern population (Table 2). Medium-sized mammals did not feature in the diet of the jackals of southern Potohar. Instead, antelope carcasses were consumed there. However, the frequency of occurrence of food items in the northern and southern populations did not differ significantly. Prey diversity was slightly better in northern Potohar than in southern Potohar (Figure 3), but the evenness index showed the preference of Asiatic jackal for 1 or 2 prey items.

b) Protected and unprotected areas

In the protected areas, frequency of occurrence of plants was 63.3%, but their biomass share was only 16.7%. The rate of fruits was 48.9%, seeds were 11.0%, mammals were 18.9%, and birds were 5.6%. The biomass consumed was 42.7% mammal, 16.1% fruit, 8.9% bird, and 1.5% reptile.

In the unprotected areas, animals dominated the diet both in numbers (30.9%) and biomass (97.6%). Most of the biomass was contributed by mammals (88.1%) and poultry and wild birds (9.0%; Table 2). Numerically, fruits (23.6%) and seeds (7.3%) were the most frequently consumed plants in the diet; this was enriched through the consumption of some cultivated items such as watermelon, guava, and melon. The most preferred animal group was mammalian carcasses, which contributed 71.9% of the biomass in unprotected and 61.8% in protected regions; birds in unprotected areas and fruits in protected areas were the second most commonly consumed food items.

The proportion of plant food items in the jackal diet in protected areas was significantly greater than the proportion in unprotected areas (t = 1.812, df = 10, P ≤ 0.05). The opposite was true for animal food, which was more intensively consumed by jackals living in unprotected areas (t = 1.89, df = 7, P ≤ 0.05). The consumption of animal biomass was significantly greater than consumption of plant biomass in all 4 areas given in Table 2 (t = 1.82, df = 3, P ≤ 0.01). Higher prey diversity was recorded in protected than in unprotected areas (Figure 3); however, the evenness index was the same in the 2 areas and illustrated a preference in jackals for 1 or 2 prey items.

Table 2. Locality-related changes in the frequency of occurrence (N%) of food remnants in scats and biomass consumption (B%) in the Asiatic jackal diet in the northern and southern districts and protected and unprotected areas of the Potohar region; n = number of scats.

Prey items	Northern districts, Attock + Rawalpindi (n = 65)			Southern districts, Chakwal + Jhelum (n = 33)			Protected areas (n = 61)			Unprotected areas (n = 37)		
	N	N%	B%	N	N%	B%	N	N%	B%	N	N%	B%
Plant remains												
Ziziphus spp. (berries)	27	27.0	5.4	9	20.0	4.2	26	28.9	9.0	10	18.2	2.1
Olea cuspidata (jungali kao)	14	14.0	3.2	3	6.7	2.5	17	18.9	7.0	-	-	-
Grass	6	6.0	0.3	1	2.2	0.0	4	4.4	0.2	3	5.5	0.2
Triticum indicum (wheat)	2	2.0	0.0	3	6.7		4	4.4	0.0	1	1.8	0.0
Citrullus lanatus (watermelon)	1	1.0	0.0	1	2.2	0.0	1	1.1	0.0	1	1.8	0.0
Melia azedarach (dharaik)	1	1.0	0.2	-	-	-	1	1.1	0.2	-	-	-
Acacia nilotica (kikar)	-	-	-	1	2.2	0.1	1	1.1	0.1	-	-	-
Psidium guajava (guava)	1	1.0	0.0	-	-	-	-	-	-	1	1.8	0.0
Cucumis melo (melon)	1	1.0	0.0	-	-	-	-	-	-	1	1.8	0.0
Unidentified	-	-	-	3	6.7	0.1	3	3.3	0.1	-	-	
Subtotal (a)	**53**	**53.0**	**9.1**	**21**	**46.7**	**6.9**	**57**	**63.3**	**16.7**	**17**	**30.9**	**2.4**
Animal remains												
Small mammals	12	12.0	7.2	8	17.8	10.7	10	11.1	10.9	10	18.2	6.7
Medium-sized mammals (hare)	1	1.0	6.9	-	-	-	-	-	-	1	1.8	7.7
Antelope carcasses	-	-	-	1	2.2	3.0	-	-	-	1	1.8	1.8
Goat, sheep, cow carcasses	18	18.0	66.5	4	8.9	69.8	7	7.8	61.8	15	27.3	71.9
Wild birds	3	3.0	3.9	4	8.9	9.0	5	5.6	8.9	2	3.6	3.3
Poultry	4	4.0	5.4	-	-	-	-	-	-	4	7.3	5.7
Insects (exoskeleton)	1	1.0	0.0	2	4.4	0.6	2	2.2	0.2	1	1.8	0.2
Reptiles (snake)	1	1.0	1.0	-	-		1	1.1	1.5	-	-	-
Unidentified	4	4.0	-	4	8.9	-	5	5.6	-	3	5.5	-
Subtotal (b)	**44**	**44.0**	**90.9**	**23**	**51.1**	**93.1**	**30**	**33.3**	**83.3**	**37**	**67.3**	**97.6**
Other												
Soil	2	2.0	-	1	2.2	-	2	2.2		1	1.8	
Anthropogenic item	1	1.0	-	-	-	-	1	1.1		-	-	
Subtotal (c)	**3**	**3.0**		**1**	**2.2**		**3**	**3.3**		**1**	**1.8**	
Grand total (a + b + c)	**100**			**45**			**90**			**55**		

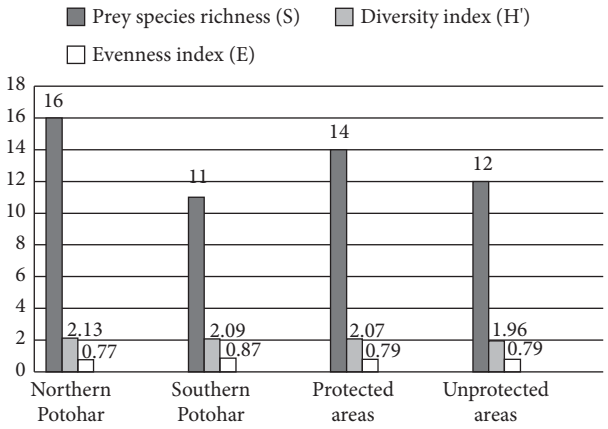

Figure 3. Locality-related diversity in the Asiatic Jackal diet.

Discussion

The Asiatic jackal in Pakistan is a generalist feeder, adapted to locally abundant food resources (Roberts, 1997). Such behavioral adaptation enables them to occupy various habitats and utilize a wide variety of food resources (Jhala and Mohelmen, 2004). The present study reveals that the Potohar jackal depends for its food mainly on the carcasses of domestic livestock, rodents, wild and poultry birds, fruits, and seeds of a few plants. The present study shows that the Asiatic jackal of Potohar is an omnivore, scavenger, and hunter like the black-backed jackal of South Africa (Bothma, 1971).

According to the findings of our study, the Asiatic jackal diet in Potohar consists of a wide variety of plant and animal foods. Of the plant foods, fruits of *Ziziphus*, wild olive, and seeds of grasses were consumed year round or during the greater part of the year. These 3 items were eaten in all 4 localities. However, the chief sources of the jackal diet were the carcasses of domestic stock, small mammals (chiefly rodents), poultry, and wild birds. Mammals have been reported as the main components of jackal diets (Roberts, 1997; Kaunda and Skinner, 2003; Radovic and Kovacic, 2010).

Whether the bird and poultry biomass consumed by the jackals in our study area came from live or dead birds is not known. It should be mentioned here that there are many poultry farms scattered throughout Potohar. The possibility that most of the poultry biomass came from dead poultry cannot be ruled out. The same may not be true for village poultry, which unlike farm-raised poultry is left free to forage. Jackals have often been observed capturing village poultry. Furthermore, in our study area there are a number of ground-nesting birds including partridges; they and their chicks may fall prey to the jackal. It has been reported that the proportion of birds consumed by the Asiatic jackal varies from very high in protected areas in India (Mukherjee et al., 2004) and protected wetlands in Greece (Lanszki et al., 2009) to very low in a well-managed hunting reserve in Hungary (Lanszki et al., 2006). Khan and Beg (1986) reported a diet of 16% bird in jackals from the cultivated areas of central Punjab in Pakistan, while in the present study birds (wild and poultry) contributed about 7.5% to the jackal diet with a biomass share of 9.2%.

Rodents and hares are definitely hunted by the jackals. Khan and Beg (1986) reported an 81% frequency of occurrence of rodents in the scats of jackal inhabiting the cultivated areas of central Punjab. Since these are areas practicing intensive agriculture, they represent a landscape that is ecologically different from the Potohar area. It is likely that the cultivated areas of central Punjab are more populated with rodents; hence, the rate of jackal–rodent encounters is higher there. A higher frequency of small mammals in the jackal diet has been reported from some localities in India and Hungary (Mukherjee et al., 2004; Lanszki et al., 2006; Giannatos et al., 2010). The diet composition of predators like the jackal is dependent on a number of factors such as habitat, season, availability, encounter rate of food, and the vulnerability of prey items. The results of the present study also show that the Asiatic jackal is an opportunistic feeder in the Potohar region.

In the present study, the overall frequency of occurrence and biomass of insects was estimated to be 2.1% and 1.2%, respectively. Only those insects that were capable of attracting the attention of the jackal and had hard exoskeletons would appear in the scats of this predator (Giannatos et al., 2010). Jackals are known to feed on insect larvae as well, but their remnants do not appear in the scat (Kaunda and Skinner, 2003).

This study also demonstrates that the jackal in Potohar is in conflict with man. Here it eats watermelon, melon, guava, and wheat grains; however, its share of these agricultural crops is

negligibly small. Its role in containing the rodent pest populations in agricultural crop areas cannot be ignored. Furthermore, this canid is a useful scavenger, especially following the depletion of vulture populations in Pakistan.

Acknowledgments

We are thankful to the Higher Education Commission of Pakistan for partial funding of this study. The cooperation of the Punjab Wildlife Department is also gratefully acknowledged.

References

Anwar, M.B., Jackson, R., Nadeem, M.S., Janečka, J.E., Hussain, S., Beg, M.A., Muhammad, G. and Qayyum, M. 2011. Food habits of snow leopard *Panthera uncia* (Schreber, 1775) in Baltistan, Northern Pakistan. Eur. J. Wildl. Res. 57(5): 1077–1083.

Anwar, M.B., Nadeem, M.S., Beg, M.A., Kayani, A.R. and Muhammad, G. 2012a. A photographic key for the identification of mammalian hairs of prey species in snow leopard (*Panthera uncia*) habitats of Gilgit–Baltistan Province of Pakistan. Pak. J. Zool. 44(3): 737–743.

Anwar, M.B., Nadeem, M.S., Shah, S.I., Kayani, A.R. and Mushtaq, M. 2012b. A note on the diet of Indian wolf (*Canis lupus*) in Baltistan, Pakistan. Pak. J. Zool. 44(2): 588–591.

Borkowski, J., Zalewski, A. and Manor, R. 2011. Diet composition of golden jackals in Israel. Ann. Zool. Fennici 48: 108–118.

Bothma, J. du P. 1971. Food of *Canis mesomelas* in South Africa. Zoologica Africana 6: 195–203.

Breuer, T. 2005. Diet choice of large carnivores in northern Cameroon. Afri. J. Ecol. 43: 97–106.

Carvalho, J.C. and Gomes, P. 2004. Feeding resource partitioning among four sympatric carnivores in the Peneda-Geres National Park (Portugal). J. Zool. 263: 275–283.

Giannatos, G., Karypidox, A., Legakis, A. and Polymeni, R. 2010. Golden jackal (*Canis aureus*) diet in Southern Greece. Mamm. Bio. 75(3): 227–232.

Goldenberg, M., Goldenberg, F., Funk, S.M., Henschel, J. and Millesi, E. 2010. Diet composition of black-backed jackals *Canis mesomelas* in the Namib Desert. Folia Zool. 59(2): 93–101.

Goszczynski, J. 1974. Studies on the food of foxes. Acta Theriol. 19: 1–18.

Jackson, R.M. 1996. Home range, movements and habitat use of snow leopard (*Uncia Uncia*) in Nepal, PhD dissertation, University of London (External Programme), London, UK, 233 pp.

Jędrzejewska, B. and Jędrzejewski, W. 1998. Predation in Vertebrate Communities: The Bialowieza Primeval Forest as a Case Study. Springer Verlag, Berlin.

Jędrzejewski, W. and Jędrzejewska, B. 1992. Foraging and diet of the red fox *Vulpes vulpes* in relation to variable food resources in Bialowieza National Park, Poland. Ecography 15: 212–220.

Jhala, Y.V. and Mohelmen, P.D. 2004. Golden jackal (*Canis aureus* Linnaeus, 1758). In: Foxes, Wolves, Jackals and Dogs. Status Survey and Conservation Action Plan. IUCN/SSC Canid Specialist Group, Gland, Switzerland and Cambridge, UK, pp. 156–161.

Kaunda, S.K.K. and Skinner, J.D. 2003. Black-backed diet at Mokolodi Nature Reserve, Botswana. Afri. J. Eco. 41: 39–46.

Khan, A.A. and Beg, M.A. 1986. Food of some mammalian predators in the cultivated areas of Punjab. Pak. J. Zool. 18(1): 71–79.

Lanszki, J., Giannatos, G., Heltai, M. and Legakis, A. 2009. Diet composition of golden jackal during cub-rearing season in Mediterranean marshland in Greece. Mamm. Bio. 74(1): 72–75.

Lanszki, J. and Heltai, M. 2002. Feeding habits of golden jackal and red fox in south-western Hungary during winter and spring. Mamm. Biol. 67: 129–136.

Lanszki, J., Heltai, M. and Szabo, L. 2006. Feeding habit and trophic niche overlap between sympatric golden jackal (*Canis aureus*) and red fox (*Vulpes vulpes*) in the Pannonian ecoregion (Hungary). Canadian J. Zool. 84(11): 1647–1656.

Magurran, A.E. 1988. Ecological Diversity and its Measurements. Croom Helm Ltd., London.

Mahmood, T., Hussain, I. and Nadeem, M.S. 2011. Population estimate, habitat preference and the diet of small Indian mongoose (*Herpestes javanicus*) in Potohar Plateau, Pakistan. Pak. J. Zool. 43(1): 103–111.

Mukherjee, S., Goyal, S.P., Johnsingh, A.J.T. and Leite-Pitman, M.R.P. 2004. The importance of rodents in the diet of jungle cat (*Felis chaus*), caracal (*Caracal caracal*) and golden jackal (*Canis aureus*) in Sariska Tiger Reserves, Rajasthan, India. J. Zool. Lond. 262(4): 405–411.

Nadeem, M.S., Imran, S.M.K., Mahmood, T., Kayani, A.R. and Shah, S.I. 2012. A comparative study of the diets of barn owl (*Tyto alba*) and spotted owlet (*Athene brama*) inhabiting Ahmadpur East, Southern Punjab, Pakistan. Animal Biology, 62(1): 13–28.

Oli, M.K. 1993. A key for the identification of hair of mammals of a snow leopard (*Panthera uncia*) habitat in Nepal. J. Zool. Lond. 231: 71–93.

Punjab Barani Commission, 1976. Report of the Punjab Barani Commission. Government of the Punjab, Lahore.

Radovic, A. and Kovacic, D. 2010. Diet composition of the golden jackal (*Canis aureus*) on the Peljesac Peninsula, Dalmatia, Croatia. Periodicum Biologorum 112(2): 219–224.

Roberts, T.J. 1997. The Mammals of Pakistan. Oxford University Press, Karachi, pp. 137–143.

Wilson, D.E. and Reeder, D.M. 2005. Mammal Species of the World. Johns Hopkins University Press, Baltimore.