

Food Habits of Punjab Urial, *Ovis vignei punjabiensis* Lydekker, 1913, in Chumbi Surla Wildlife Sanctuary, Chakwal, Pakistan

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Abstract: The study reports data on the composition of the annual diet of Punjab urial (*Ovis vignei punjabiensis*) from Chumbi Surla Wildlife Sanctuary, Chakwal, Pakistan. The recorded vegetation was characteristic of mixed scrub forest. It comprised of 47 plant species (eight trees and shrubby trees, nine shrubs, 19 grasses and 11 herbs). The animal was observed browsing on *Acacia modesta* and *Olea ferruginea* and grazing on *Sorghum halepense* and *Cynodon dactylon* almost all year round. Leaves of *Zizyphus nummularia* were ingested in winter and during the monsoon seasons. Analysis of 130 seasonally collected fecal pellet groups revealed occurrence of 13 plant species (five trees and shrubby trees, three shrubs and five grasses and herbs). Leaf parts of *A. modesta* and *O. ferruginea* appeared in all the annual fecal samples while remains of *Acacia nilotica* and *Z. nummularia* were recorded only from winter and summer seasons. Selectively favourite diet during summer was of *Zizyphus jujuba* leaves. Three shrubs, i.e. *Dodonea viscosa*, *Maytenus royleana* and *Adhatoda zeylanica*, supplemented the diet with small seasonal fluctuations. Spring and monsoon samples were dominated by *C. dactylon* and *S. halepense* along with records of other grasses (*Eleusine indica*, *Poa annua*, *Eleusine* sp.). In conclusion, the Punjab urial prefers graminoids (*C. dactylon* and *S. halepense*) during spring and monsoon seasons, and shifts towards trees and small shrubs (*O. ferruginea*, *A. modesta* and *Z. nummularia*) in winter and summer. Conservation of the Punjab urial demands better protection and propagation of indigenous plant species providing significant contribution to its diet.

Keywords: Wild sheep, Punjab urial, *Ovis vignei punjabiensis*, diet, Salt Range

Introduction

The Punjab urial (*Ovis vignei punjabiensis* Lydekker, 1913) is endemic for Northern Punjab, Pakistan. It has a restricted distribution confined to scrub forests located at 250-1500 m a. s. l. in the area between Jhelum and Indus Rivers (SCHALLER, MIRZA 1974, FRISINA *et al.* 2001). Historically four ranges i.e. Margalla Hills Range, Kala Chitta Range, Khairimurat Range and Salt Range were reported to host the Punjab urial populations. However, over the years at least in two of these ranges (Margalla Hills and Khair-i-Murat) no evidences of this wild sheep were found (AWAN *et al.* 2004).

So far considerable efforts have been made to assess the populations of the Punjab urial in its dis-

tribution range (ALEEM 1977, SCHALLER 1977, MIRZA *et al.* 1980, CHAUDHRY *et al.* 1988, IUCN 1997, AWAN *et al.* 2004, AZAM *et al.* 2008). SCHALLER (1977) was the first who quantified and depicted the world population of Punjab urial. He concluded that it might not exceed 2,000 animals. MIRZA *et al.* (1980) estimated 2,157 numbers of this subspecies in its entire geographical range. AWAN *et al.* (2004) reported 860 individuals at 16 isolated habitats within Salt range and Kala Chitta range of Pothwar. They estimated that an area of 1,265 km² in Salt-range supported about 80% of the reported individuals. A latter report (AZAM *et al.* 2008) revealed occurrence of about 220 animals in Chumbi Surla Wildlife Sanctuary, Chakwal.

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The Punjab urial was designated “endangered” conservation status at global scale (IUCN 2003) as well as in Pakistan (SHEIKH, MOLUR 2005). It is listed in Appendix II of the Convention on International Trade in Endangered Species and is protected under the Punjab Wildlife Protection and Conservation Act of 1974. To protect this species, one national park, five wildlife sanctuaries and two game reserves have been established in its distribution range. However, this protective system has not been able to increase the urial population or stop the declining trends. The main reasons of decline in numbers of this species is poaching, trophy value in sport hunting, the capture of newborn lambs for keeping as pets, habitat destruction and fragmentation due to expansion and intensification of agriculture, forestry and mining (AWAN *et al.* 2006a). Moreover, the construction of M-2 motorway between Islamabad and Lahore created a substantial barrier to seasonal migrations and local dispersal of this ungulate (AWAN 2006).

Knowledge on the diet of a wildlife species is of primary importance for its management (MARTINEZ 2001). In order to conserve an endangered wild ungulate like Punjab urial, it is essential to study its habitat requirements and, therefore, to understand its feeding habit and forage preferences (JOHNSON, SMITH 1980). For instance, sufficient information was generated on the diet of North American mountain sheep (HANSEN 1971, FRISINA 1974, PITT, WIKEEM 1978, JOHNSON, SMITH 1980) and to some extent on Indian Trans-Himalaya species of Bharal (*Pseudois nayaur* Hodgson, 1833) by MISHRA *et al.* (2004) and Himalayan ibex (*Capra ibex sibirica* Pallas, 1776) by MANJREKAR (1998). The Punjab urial, being an endemic species, has received less attention, particularly with respect to feeding and foraging in its native distribution ranges in Pakistan. The available studies described feeding habits and food preference of Punjab urial using visual observations either under natural conditions (ALEEM 1977, SCHALLER 1977) or in captivity (MIRZA *et al.* 1980). A study on its annual diet composition based on direct observation and fecal analysis (AWAN *et al.* 2006b) gave a good account of its food habits. However, this investigation was carried out in a privately owned Kala Bagh Game Reserve in Salt Range, presumably better managed to provide food and shelter than any protected area managed by public sector organisations. The present study is aimed to investigate food habits of Punjab urial in Chumbi Surla Wildlife Sanctuary (CSWS), Chakwal (public sector managed entity) and to explore its preference for different plant species with respect to their prevalence in the habitat.

Materials and Methods

Study Area

The study was conducted in Chumbi Surla Wildlife Sanctuary (32° 40' 12.15" N, 72° 19' 48.02" E), district Chakwal. The sanctuary spreads over about 22,640 ha area including 6,070 ha of state forests (CHAUDHARY *et al.* 2001). It is characterised by rock based area dominated by sandstone and patches of red sandy clay. The average altitude ranges between 460-1050 m a. s. l, with temperatures between 10-40°C and average annual rainfall 4994 mm. The forest supports scrub biome having dry subtropical evergreen vegetation (http://en.wikipedia.org/wiki/Chumbi_Surla_Wildlife_Sanctuary, downloaded on 12 Aug. 2013). *Chrysopogon serrulatus* Trin. dominated all the plant communities, whereas trees/large shrubs consisted of *Acacia modesta* Wall., *Dodonaea viscosa* Jacq., *Justicia adhatoda* L., *Olea ferruginea* Royle, *Maytenus royleanus* (Wall. ex Lawson) and *Ziziphus nummularia* (Burm. f.) Wight & Arn. Among under-shrubs/herbs, the following species were: *Lespedeza floribunda* Bunge, *Pupalia lappacea* (L.) Juss. and *Diclyptera bupleuroides* Nees in Wall.. The grasses included *Dactyloctenium scindicum* Boiss., *Cymbopogon jwarancusa* (Jones) Schult, *Sporobolus ioclados* (Nees ex Trin.) Nees, *Digitaria sanguinalis* (L.) Scop. and *Dichanthium foveolatum* (Del.) Roberty (Chaudhary *et al.* 2001)

Methods

Food sources and feeding patterns of the Punjab urial were studied from December 2010 to July 2011 by direct field observation and analysis of the content of fecal pellets.

Field observation

Foraging and feeding of the Punjab urial was studied on predetermined line transects of about 2000 m in length and 500 m in width using a field binocular and spotting scope (BUNHAM *et al.* 1980, SUMAN, SHYAMA, 2009, VARMAN, SUKUMAR 1995). Approximately three-four hours were spent for observation of the feeding and foraging animals during early morning and late evening hours (Table 1). However, the observation duration and the width of the selected transects depended on visibility-range due to seasonal changes in density and cover of the vegetations. The vegetation that the animals fed upon was confirmed on-spot through following the signs of browsing or grazing, followed by on-site identification of the plants. Samples of any unidentifiable vegetation were preserved in herbarium sheet for

later identification in the laboratory by expert plant taxonomists. Time of feeding, atmospheric temperature and weather conditions were recorded.

Fecal pellet collection and analysis

During field observations, fresh fecal pellets were collected from each transect line from isolated locations. In total, 130 fecal pellet group were collected from the seven line transects surveyed during this period (Table 1). Each fecal sample was packed in plastic bag labelled with necessary field information. The fecal samples were either processed immediately after arrival in the laboratory or otherwise stored in freezer for later examination.

Simultaneously with the collection of fecal pellets, plants potentially contributing to the diet of Punjab urial were collected as reference material. The vegetation material was identified on the basis of direct observation on the foraging animals and knowledge of local staff and residents. Two specimens of each plant were collected: one for the reference record (for herbarium) and identification, and the other for the preparation of reference slides. The collected plant species included five trees and large shrubs (*Acacia modesta*, *Acacia nilotica* L., *Olea ferruginea*, *Zizyphus jujuba* Mill., *Zizyphus nummularia*), three shrubs (*Adhatoda zeylanica* L., *Dodonea viscosa*, *Maytenus royleana*), five grasses (*Sorghum halepense* (Linn.) Pers., *Cynodon dactylon* (L.) Pers., *Eleusine indica* (L.) Gaertn., *Poa annua* L., *Eleusine* sp.) and two cultivated crops (*Eruca sativa* Mill., *Brassica campestris* L.).

The fecal analysis was carried using micro-histological technique (BAUMGARTNER, MARTIN 1939, SPARKS, MALECHEK 1968) which is the most commonly used method for determining the botanical composition of the diet of herbivores (HOLECHEK *et al.* 1982, ALIPAYO *et al.* 1992). From each fecal pellet group, 15

pellets were randomly drawn for processing to prepare micro-histological slides to identify remains of foods plants. The same procedure was followed for preparation of micro-histological slides of different edible parts of vegetation/ plants collected for reference materials. The slides of each part of reference plants were studied in detail by recording the specific cell characteristics, i.e. shape, size, fibres, trichomes, pores, stomata structures. Photomicrographs of these slides were taken by connecting Digital Camera/Electronic Eyepiece (DCE-2) with Compound Microscope (XSZ-701AN/XSZ-107AN). Then, the characteristics of reference plants were used as key features for comparison and identification of the materials from the slides prepared of each fecal sample.

Four slides prepared from each processed fecal pellet group were studied by taking five microscopic fields on each slide at magnification of 400X. Relative frequency (RF) of the remains of a plant species in a fecal sample was determined by dividing the total number of fragments identified for a given plant species by all the plant fragments in the fecal sample, multiplied by 100 (JNAWALI 1995). Diet selection value (DSV) was estimated by dividing the relative density of a particular plant species found in the fecal samples by the importance value index (IVI) of a plant species in the urial habitat (JNAWALI 1995; ASHRAF *et al.* 2014).

Vegetation analysis

Concurrently with the field observations and collection of fecal pellets, vegetation analysis of each selected transect was carried out through sampling the vegetation of three different strata: trees, shrubs and grasses/herbs. We sampled the vegetations by randomly selecting quadrates of variable size; 1 x 1 m for grasses and herbs, 4 x 4 m for shrubs and 10 x 10 m for trees (OOSTING 1956). In total 120 quad-

Table 1. Seasonal collection of fecal pellets of Punjab Urial from Chumbi Surla Wildlife Sanctuary, Chakwal, Pakistan

Transect No.	Location	Month/ Year	Season	Ordinates & elevation	No. of fecal samples
1	Dhoke Sehla	Dec., 2010	Winter	N: 32, 47.714 Altitude: 697 m	04
2	Sobedaran Wali Mori, Aunchi Thopri, Malakand Wala Chah	Jan-Feb., 2011	Winter	N: 32, 42.975 E: 72, 49.362; Altitude: 665 m	16
3	Sanran Wala Kore, Matha	March, 2011	Spring	N: 32, 47.553 E: 72, 47.468 Altitude: 718 m	20
4	Kaila	April, 2011	Spring	N: 32, 47.466 E: 72, 47.090 Altitude: 724 m	30
5	Matha, Kaila	May, 2011	Summer	N: 32, 47.619 E: 72, 47.585 Altitude: 720 m	20
6	Sanghwalian Wali Charh, Aukhian	June, 2011	Summer	N: 32, 47.597 E: 72, 47.513 Altitude: 720 m	20
7	Sanghwalian Wali Charh, Aukhian	July, 2011	Monsoon	N: 32, 47.304 E: 72, 47.700 Altitude: 776 m	20

rates (40 quadrates for each vegetation class and 10 quadrates per season) were taken between 450-1060 m a.s.l.. We calculated Importance Value Index (IVI) of plant species within its group by taking relative values of its density, frequency and cover (Table 3).

Results

Field observation on foraging and feeding of Punjab urial (Table 2) revealed that the animal was feeding on seasonally available vegetation comprising of trees, shrubs, grasses and cultivated crops. We observed it browsing on *Acacia modesta* and *Olea ferruginea* almost all year around. The seasonal records showed it fed on *Acacia nilotica* in winter and summer months, *Zizyphus nummularia* in winter and monsoon, and on *Zizyphus Jujuba* only during the winter season. The urial was observed browsing on three species of shrubs, among which *Dodonea viscosa* (during all the seasons except for summer), *Maytenus royleana* (in winter and spring) and *Adhatoda zeylanica* (in spring and summer). This wild sheep was recorded grazing on five species of grasses. *Sorghum halepense* and *Cynodon dactylon* were part of its diet over the entire study period, whereas grazing on *Eleusine indica*, *Poa annua* and *Eleusine* species was recorded in spring and summer. The animal also foraged on two cultivated oilseed crops (*Eruica sativa* and *Brassica campe-*

tris) during their cropping period in winter.

In total, 130 fecal pellet groups were collected and analysed to determine diet composition of Punjab urial inhabiting Chumbi Surla Wildlife Sanctuary, Pakistan (Table 3). The analysis identified remains of 15 plant species (including 13 wild and two cultivated taxa). The yearly menu of this wild sheep showed occurrence of leaves of 14 species and stem epidermis of one species (i.e. *Adhatoda zeylanica*), indicating a high subsistence of the animal on plant leaves. Out of nine prevailing trees and large shrubs, the animal browsed only on five (55.6%) species. Prevalence of *Acacia modesta* and *Olea ferruginea* in all the seasonal samples was supported by our field records (Table 2) of feeding and foraging. A seasonal dichotomy did exist for two tree species, *Acacia nilotica* and *Zizyphus nummularia*, showing their prevalence only in winter and summer. Feeding on leaves of *Zizyphus Jujuba* was evident only in the summer, but with the highest diet selection value of 10.5 against its lowest IVI value (1.1) recorded among the trees. Against comparatively higher occurrence of *A. modesta* in the habitat, the urial showed least preference toward this tree, which otherwise remained a consistent source of food for this ungulate (Table 3).

Three of the nine shrubs (33.3%) appeared in the diet of Punjab urial. *Dodonea viscosa* was almost uniformly distributed in the seasonal samples.

Table 2. Field observation of Punjab Urial feeding and foraging in Chumbi Surla Wildlife Sanctuary, Chakwal, Pakistan

Plant Species	Plant part eaten	Season			
		Winter	Spring	Summer	Monsoon
Trees and large shrubs					
<i>Acacia modesta</i>	leaves	+	+	+	+
<i>Acacia modesta</i>	flowers	-	+	-	-
<i>Olea ferruginea</i>	leaves	+	+	+	+
<i>Acacia nilotica</i>	leaves	+	-	+	-
<i>Zizyphus nummularia</i>	leaves	+	-	+	-
<i>Zizyphus Jujuba</i>	leaves	+	-	-	-
Shrubs					
<i>Dodonea viscosa</i>	leaves	+	+	-	+
<i>Maytenus royleana</i>	leaves	+	+	-	-
<i>Adhatoda zeylanica</i>	leaves	-	+	+	-
Grasses and Herbs					
<i>Sorghum hellepense</i>	leaves	+	+	+	+
<i>Cynodon dactylon</i>	leaves	+	+	+	+
<i>Eleusine indica</i>	leaves	-	+	-	+
<i>Poa annua</i>	leaves	-	+	-	+
<i>Eleusine</i> sp.	leaves	-	+	-	+
Cultivated crops					
<i>Eruica sativa</i>	leaves	+	-	-	-
<i>Brassica compestris</i>	leaves	+	-	-	-

Table 3. Occurrence of plant parts identified in seasonally collected faecal samples of Punjab Urial in Chumbi Surla Wildlife Sanctuary, Chakwal, Pakistan

Plant species	Proportion (%) of positive feces (PF) for a plant species, relative frequency (RF, %) of a plant remains in feces, diet selection value (DSV) for a plant species and importance value index (IVI) of plant species in the Punjab Urial habitat												IVI
	Winter (20 samples)			Spring (50 samples)			Summer (40 samples)			Monsoon (20 samples)			
	PF	RF	DSV	PF	RF	DSV	PF	RF	DSV	PF	RF	DSV	
Trees and large shrubs (leaves)													
<i>Acacia modesta</i>	35	28.3	0.4	40	14.5	0.2	40	20.3	0.3	20	14.7	0.2	70.6
<i>Olea ferruginea</i>	25	13.0	3.2	34	8.4	2.1	35	14.4	3.5	30	7.9	1.9	4.1
<i>Acacia nylotica</i>	20	9.4	3.5	-	-	-	18	6.9	2.6	-	-	-	2.7
<i>Zizyphus nummularia</i>	25	4.7	0.9	-	-	-	38	13.0	2.4	-	-	-	5.5
<i>Zizyphus Jujuba</i>	-	-	-	-	-	-	30	11.6	10.5	-	-	-	1.1
Total	105	55.4	8.0	74	22.9	2.3	161	66.2	19.3	50	22.6	2.1	
Shrubs (leaves)													
<i>Dodonea viscosa</i>	45	5.9	0.2	14	6.8	0.2	28	8.5	0.3	20	5.9	0.2	32.0
<i>Maytenus royleana</i>	30	16.5	0.4	18	9.1	0.2	25	13.6	0.3	-	-	-	42.8
<i>Adhatoda zeylanica</i> (+ stem)	-	-	-	28	5.8	0.1	25	6.9	0.1	-	-	-	56.3
Total	75	22.4	0.6	60	21.7	0.5	78	29	0.7	20	5.9	0.2	
Grasses (leaves)													
<i>Sorghum hellepense</i>	-	-	-	30	14.1	1.1	10	3.7	0.3	30	19.2	1.5	13.2
<i>Cynodon dactylon</i>	15	3.5	0.1	34	20.5	0.5	-	-	-	45	24.4	0.6	43.0
<i>Eleusine indica</i>	-	-	-	22	9.9	1.2	-	-	-	25	6.7	0.8	8.3
<i>Poa annua</i>	-	-	-	20	3.7	3.4	-	-	-	20	6.6	6.0	1.1
<i>Eleusine sp.</i>	-	-	-	8	2.4	2.2	-	-	-	10	4.8	4.4	1.1
Total	15	3.5	0.1	86	72.5	8.9	10	3.7	0.3	100	80.3	14.3	
Cultivated crops (leaves)													
<i>Eruica sativa</i>	20	9.4											
<i>Brassica compestris</i>	15	5.9											
Unidentified	10	3.3	-	10	4.8	-	8	4.8	-	20	9.8	-	-

Maytenus royleana was consumed during three out of four seasons, showing absence in monsoon samples. This shrub also did not show any seasonal dominance in the diet. The third shrub, *Adhatoda zeylanica* was ingested during spring and summer showing relatively lowest DSV as compared to its highest IVI (Table 3).

The fecal analysis showed presence of five grasses. All of the recorded species were present essentially in the spring and monsoon samples, while *Cynodon dactylon* was also found in winter and *Sorghum halepense* in monsoon samples. *Cynodon dactylon* dominated in the habitat but, nevertheless, showed relatively lower prevalence in the diet. On the contrary *Poa annua* and *Eleusine sp.* showed higher DSV against their lower occurrence (IVI) in the studied habitat (Table 3).

The results for the total DSV values demonstrated that this wild sheep relied of leaves of trees and large shrubs in winter and summer, whereas it fed upon grasses during spring and monsoon seasons.

The flora in the habitat of Punjab urial in Chumbi

Surla Wildlife Sanctuary was surveyed to determine Importance Value Index (IVI) of each plant species based on the estimates of the relative values of density, frequency and cover. A detailed record of plant species with their ranks of dominance in IVI is given in Table 4. In total 47 plant species were counted which included eight trees, nine shrubs, 19 grasses and 11 herbs. Of the 47 wild floral species recorded, remains of only 13 (27.7%) were found in the fecal samples: five out of eight trees (62.5%), three of the nine shrubs (33.3%) and five of the 28 grasses/herbs (17.9%) appeared in the fecal remains. Seasonal diversity showed occurrence of seven (14.9%) species in winter, 11 (23.4%) species in spring, nine (19.1%) species in summer and eight (17.0% species in monsoon. Tree leaves dominated the diet in winter (57.1%) and summer (55.6%) while grasses were equating and dominating during the spring (50%) and monsoon (62.5%) seasons. These findings demonstrated that the urial was dominantly browser in winter and summer, and shifted to grazing during spring and monsoon seasons.

Table 4. Floral assessment in the habitat of Punjab Urial in Chumbi Surla Wildlife Sanctuary, Chakwal, Pakistan

S. No.	Plant Species	Relative Density	Relative Frequency	Relative Cover	Importance Value Index
Trees and large shrubs					
1	<i>Acacia modesta</i> *	55.3	4.8	10.6	70.6
2	<i>Capparis aphylla</i>	0.7	15.2	2.1	18.1
3	<i>Zizyphus nummularia</i> *	0.2	4.7	0.6	5.5
4	<i>Prosopis glandulosa</i>	0.1	2.5	1.9	4.5
5	<i>Olea ferruginea</i> *	0.1	3.8	0.2	4.1
6	<i>Acacia nilotica</i> *	0.1	1.1	1.6	2.7
7	<i>Grewia optiva</i>	0.1	1.0	0.02	1.1
8	<i>Zizyphus Jujuba</i> *	0.1	1.0	0.02	1.1
Shrubs					
9	<i>Adhatoda zeylanica</i> *	10.7	35.5	10.2	56.3
10	<i>Maytenus royleana</i> *	2.5	35.9	4.5	42.8
11	<i>Sageretia theezans</i>	4.4	25.7	5.2	35.3
12	<i>Dodonea viscosa</i> *	2.5	25.0	4.5	32.0
13	<i>Lantana camara</i>	1.5	20.4	0.5	22.4
14	<i>Grewia tenax</i>	0.5	5.4	0.8	6.7
15	<i>Otostegia limbata</i>	0.4	4.6	0.5	5.5
16	<i>Fagonia indica</i>	0.05	2.1	0.03	2.2
17	<i>Capparis spinosa</i>	0.1	1.1	0.03	1.1
Grasses/Herbs					
18	<i>Cynodon dactylon</i> *	13.5	27.4	2.1	43.0
19	<i>Saccharum bengalense</i>	7.6	12.3	4.6	24.4
20	<i>Eulaliopsis binata</i>	3.4	12.3	2.5	18.3
21	<i>Sorghum hellepense</i> *	3.0	6.9	3.4	13.2
22	<i>Eragrostis cynosuroides</i>	1.7	8.7	1.0	11.3
23	<i>Eleusine indica</i> *	1.4	6.5	0.2	8.1
24	<i>Ischaemum rugosum</i>	1.1	3.4	1.4	5.9
25	<i>Paspalidium flavidum</i>	1.9	3.7	0.3	5.9
26	<i>Andropogon contortus</i>	0.8	3.3	0.2	4.3
27	<i>Cymbopogon sessilis</i>	0.7	2.8	0.1	3.7
28	<i>Paspalum floridanum</i>	0.7	1.0	0.1	1.9
29	<i>Imperata cylindrical</i>	0.1	1.0	0.2	1.3
30	<i>Desmostachya bipinata</i>	0.1	1.1	0.1	1.2
31	<i>Echinochloa crus-galli</i>	0.04	1.1	0.05	1.2
32	<i>Cenchrus pennisetiformis</i>	0.1	1.1	0.02	1.1
33	<i>Dichanthium annulatum</i>	0.1	1.1	0.02	1.1
34	<i>Polypogon monspeliensis</i>	0.03	1.1	0.02	1.1
35	<i>Eleusine sp.*</i>	0.02	1.1	0.02	1.1
36	<i>Poa annua</i> *	0.02	1.1	0.02	1.0
37	<i>Pergularia tomentosa</i>	0.2	2.9	0.1	3.1
38	<i>Suaeda fruticosa</i>	0.3	2.3	0.1	2.8
39	<i>Sonchus arvensis</i>	0.2	2.1	0.04	2.4
40	<i>Verbena spp.</i>	0.1	2.1	0.05	2.3
41	<i>Rhynchosia minima</i>	0.03	1.1	0.4	1.5
42	<i>Torilis leptophylla</i>	0.3	1.0	0.04	1.3
43	<i>Tephrosia uniflora</i>	0.1	1.1	0.02	1.2
44	<i>Dicliptera roxburghii</i>	0.04	1.1	0.04	1.2
45	<i>Psammogeton biternatum</i>	0.1	1.0	0.02	1.1
46	<i>Solanum incanum</i>	0.03	1.1	0.02	1.1
47	<i>Tribulus terrestris</i>	0.02	1.1	0.02	1.1

* Plant species identified in the fecal samples of Punjab Urial

Discussion

Records of 47 floral species within foraging ranges of the Punjab urial in Chumbi Surla Wildlife Sanctuary (CSWS) provided evidence of adequate floral diversity to cater food and shelter needed by

the wild sheep in this protected area. A study by CHAUDHRY *et al.* (2001) covering all the directional and peripheral aspects of CSWS, reported the occurrence of 116 plant species, designating the habitat



Fig. 1. Fecal pellets of Punjab urial from Chumbi Surla Wildlife Sanctuary, Chakwal, Pakistan

highly suitable for the Punjab urial. Another report by AHMAD *et al.* (2008) in Kufri (Soon Valley), an area nearby CSWS, demonstrated the occurrence of 24 plant species including nine leguminous, 11 non-leguminous and four species of grasses and sedges. Earlier ROBERTS (1991) reported 16 dominant plant species representing the major flora of Salt Range area (including CSWS) of Pothwar.

Our study revealed that *Acacia modesta* and *Olea ferruginea* were regular part of urial's diet around the year with seasonal variation in relation to foliage, flowers and fruit/seeds, as well as availability of alternate forage i.e. shrubs and grasses. ALEEM (1977) reported the urial fed on low hanging branches of *Olea ferruginea*, *Acacia modesta* and *Zizyphus nummularia* in a similar habitat of Chak Jabbi area in Kala Chitta Range, Pothwar, Pakistan. SCHALLER (1977) also reported browsing as a preferred mode of feeding of Punjab urial. Likewise, CHAUDHRY *et al.* (2001) emphasised on improvement of useful trees and large shrubs like *Olea ferruginea*, *Dodonaea viscosa*, *Maytenus royleanus* and *Zizyphus nummularia* with regard to shelter, nesting and food for Punjab urial in CSWS. Furthermore, AYAZ *et al.* (2012) observed the urial fed on grasses and *Acacia modesta*, *Olea ferruginea* and *Zizyphus nummularia* in protected areas of Kohat, Pakistan. However, forbs and browse provided important sources of nutrients, especially protein, during at critical times of the year when grasses were low in nutritional value and digestibility (WAGNER, PEEK 2006).

The urial was observed grazing on *Cynodon dactylon* and *Sorghum halepense* over the entire period of our study. The outcome of fecal analysis, however, was not able to report the presence of *Sorghum halepense* in winter samples and *Cynodon dactylon* in the summer samples. AWAN *et al.* (2006b) reported

67% share of Graminoids (dominant were *Cynodon dactylon*, *Digitaria* spp. and *Eleusine compressa*) in the diet of Punjab urial inhabiting the salt range of Pothwar. Another ungulate belonging to this genus, the Rocky mountain bighorn sheep (*Ovis canadensis canadensis*) had also Graminoids dominated its diet, particularly during spring when protein contents and digestibility of grasses were at peak levels. Consequently, the consumption of forbs and browse declined in spring. Nevertheless, they provided important sources of nutrients, especially protein, at critical times of the year when grasses were low in nutritional value and digestibility (WAGNER, PEEK 2006). Similarly, a population of Moufflon sheep (*Ovis musimon*) showed preference (80%) in selection of its forage towards monocotyledonous herbs (GARCIA-GONZALEA, CUARTAS 1989).

Out of 47 wild plant species recorded, we found remains of only 13 (27.7%) in fecal samples of Punjab urial. Such behaviour is evident in wild and domestic Himalayan ungulates (AWASTHI *et al.* 2003) indicating selection of only 13 (9.3%) species out of the existing 140 palatable plant species. The authors suggested further research was needed to support their findings. Kalabagh game reserve, a privately protected habitat designated for conservation of Punjab urial in the Salt Range of Pakistan was reported to provide 131 plant species out which 22 species (17%) were present in the fecal matter of this ungulate (AWAN *et al.* 2006b).

The population of Punjab urial in CSWS showed diverse food choices mainly related to seasonal changes in vegetation growth. These findings support the results of PFISTER *et al.* (1988) who reported that the wild sheep had diversified food choices regardless of their similar digestive systems and nutritional requirements (BAROLOME *et al.* 1998). The preferences were presumably related to difference in floral diversity, composition, their succession stages and variation in the local climatic factors.

We can conclude that Punjab urial prefers Graminoids (*Cynodon dactylon* and *Sorghum halepense*) during the spring and monsoon seasons while shifts its food preference to trees and small shrubs (*Olea ferruginea*, *Acacia modesta* and *Zizyphus nummularia*) in winter and summer. The dominant indigenous floral species contributing in the diet of Punjab urial in CSWS should be protected and propagated. Introduction of exotic plant species should be strongly discouraged before thoroughly studies on their impact on local flora and fauna are conducted. Management of CSWS should involve the local communities and ensure their support for protection of the urial habitat.

References

- AHMAD K., Z.I. KHAN, M. ASHRAF, M. HUSSAIN, M. IBRAHIM, E.E. VALEEM 2008. Status of plant diversity at Kufri (Soone Valley) Punjab, Pakistan and prevailing threats therein. – *Pakistan Journal of Botany*, **40**: 993-997.
- ALEEM A. 1977. Punjab Urial in Chak Jabbi area Kala Chitta Range. – *Pakistan Journal of Forestry*, **27**: 130-138.
- ALIPAYO D., R. VALDEZ, J. L. HOLECZEK, M. CARDENAS 1992. Evaluation of microhistological analysis for determining ruminant diet botanical composition. – *Journal of Range Management*, **45**: 148-152.
- ASHRAF N., M. ANWAR, I. HUSSAIN, M. A. NAWAZ 2014. Competition for food between the markhor and domestic goat in Chitral, Pakistan. – *Turkish Journal of Zoology*, **38**: 191-198.
- AWAN G. A. 2006. Conservation of Punjab Urial (*Ovis vignei punjabiensis*) through long-term monitoring of marked individuals. A report to the Rufford Maurice Laing Foundation, London, UK, 22 p.
- AWAN G. A., T. AHMAD, A. SALMAN 2004. On the distribution of Punjab Urial (*Ovis vignei punjabiensis*). – *Records Zoological Survey of Pakistan*, **15**: 1-6.
- AWAN G. A., M. F. BIANCHET, T. AHMAD 2006a. Poaching, recruitment and conservation of Punjab Urial *Ovis vignei punjabiensis*. – *Wildlife Biology*, **12**: 443-449.
- AWAN G. A., M. FESTA-BIANCHET, M. R. FRISINA 2006b. Diet of Punjab Urial (*Ovis vignei punjabiensis*) in the Salt Range, Pakistan, and potential competition with domestic sheep and goats. – *Mammalia*, **70**: 261-268.
- AWASTHI A., K. S. UNIYAL, G. S. RAWAT, S. SATHYAKUMAR 2003. Food plants and feeding habits of Himalayan ungulates. – *Current Science*, **85**: 719-723.
- AYAZ S., MUHIBULLAH, A. A. ANJUM, M. JAMIL, M. A. KHAN, M. F. QAMAR 2012. Behaviour and biology of *Ovis Orientalis* (Urial) in Kotal wildlife park and Borraka wildlife sanctuary in Kohat. – *The Journal of Animal and Plant Sciences*, **22**: 29-31.
- AZAM M. M., A. Q. NAZAR, N. ABBAS 2008. Some observations on the population status of Punjab Urial (*Ovis vignei punjabiensis*) in district Chakwal, Punjab. *Records Zoological Survey of Pakistan*, **18**: 01-03.
- BARTOLOME J., J. FRANCH, J. PLAIXATS, N.G. SELIGMAN 1998. Diet selection by sheep and goats on Mediterranean heathwoodland range. – *Journal of Range Management*, **51**: 383-391.
- BAUMGARTNER L. L., A.C. MARTIN 1939. Plant histology as an aid in squirrel food habit studies. – *Journal of Wildlife Management*, **3**: 266-268.
- BUMHAM K. P., D. R. ANDERSON, J. L. LAAKE 1980. Estimation of density from Line Transect sampling of Biological populations. – *Wildlife Monographs*, **72**: 1-202.
- CHAUDHRY A. A., M. HAMEED, R. AHMAD, A. HUSSAIN 2001. Phytosociological studies in Chhumbi Surla wildlife sanctuary, Chakwal, Pakistan II. Phytocoecology. – *International Journal of Agriculture and Biology*, **3**: 369-374.
- CHAUDHRY A. A., U. KHALID, S. A. CHAUDHRY 1988. Urial population in the Punjab. Proceeding 8th Pakistan Congress of Zoology, **8**: 201-204.
- FRISINA M. R., M. WOODFORD, G. A. AWAN 2001. Status of the Punjab Urial (*Ovis vignei punjabiensis*) population in the Kalabagh, Salt Range of Punjab Province, Pakistan. United States Fish and Wildlife Service, Division of International Conservation and WWF-Pakistan, **8** p.
- FRISINA M. R. 1974. Ecology of bighorn sheep in the Sun River area of Montana during fall and spring. Master thesis, Montana State University, Montana.
- GARCIA-GONZALEA R., P. CUARTAS 1989. A comparison of the diets of the wild goat (*Capra pyrenaica*), domestic goat (*Capra hircus*), Mouflon (*Ovis musimon*) and domestic sheep (*Ovis aries*) in the Cazorla mountain range. – *Acta Biologica Montana*, **IX**: 123-132.
- HANSEN R. M. 1971. Estimating plant composition of wild sheep diets. In: Proceedings Trans North American Wild Sheep Conference, **1**: 108-113.
- HOLECZEK J. L., M. VAVRA, R. D. PIEPER 1982. Botanical composition determination of range herbivore diets. – *Journal of Range Management*, **35**: 309-315.
- IUCN 1997. Rapid surveys of short-listed protected areas. Summary Report, IUCN Pakistan.
- IUCN 2003. Red Data Book for Mammals. IUCN. Gland, Switzerland.
- JNAWALI S. R. 1995. Population ecology of greater one-horned rhinoceros (*Rhinoceros unicornis*) with particular emphasis on habitat preference, food ecology and ranging behavior of a reintroduction population in Royal Bardia National Park in lowland Nepal. PhD thesis, Agricultural University of Norway.
- JOHNSON B. K., D. R. SMITH 1980. Food habits and forage preferences of bighorn sheep in alpine and subalpine communities. In: Proceeding Biennial Symposium Northern Wild Sheep and Goat Council, **2**: 1-17.
- MANJREKAR N. 1998. Feeding ecology of Ibex (*Capra ibex sibirica*) in Pin Valley National Park, Himachal Pradesh. PhD Thesis. Saurashtra university, Rajkot, India, 123 p.
- MARTINEZ T. M. 2001. The feeding strategy of Spanish ibex (*Capra pyrenaica*) in the northern Sierra de Gredos (central Spain). – *Folia Zoologica*, **50**: 257-270.
- MIRZA Z. B., M. ASLAM, M. ASGHAR, A. Q. MEHAL 1980. Distribution, status, habitat and food of the Urial in the Punjab. – *Journal of Bombay Natural History Society*, **76**: 423-430.
- MISHRA C., S. E. VAN WIJEREN, P. KETNER, I. M. A. HEITKÖNIG, H. H. T. PRINS 2004. Competition between domestic livestock and wild bharal *Pseudois nayaur* in the Indian Trans-Himalaya. – *Journal of Applied Ecology*, **41**: 344-354.
- OOSTING H. J. 1956. The study of plant communities: an introduction to plant ecology. Second Edition. W. H. Freeman and Co., San Francisco. 440 p.
- PFISTER J. A., J. C. MALACHEK, D. B. BALPH 1988. Foraging behavior of goats and sheep in the Caatinga of Brazil. – *Journal of Applied Ecology*, **25**: 379-388.
- PITT M. D., B. M. WIKHEEM 1978. Diet preference of California bighorn sheep on native rangeland in south-central British Columbia. Proceeding Biennial Symposium Northern Wild Sheep and Goat Council, **1**: 331-341.
- ROBERTS T. J. 1991. The birds of Pakistan. Volume 1. Oxford University Press, Karachi, 598 p.
- SCHALLER G. B. 1977. Mountain Monarchs-Wild Sheep and Goats of the Himalaya. University of Chicago Press, Chicago. USA, 425 p.
- SCHALLER G. B., Z. B. MIRZA 1974. On the behaviour of Punjab Urial (*Ovis orientalis punjabiensis*). The behaviour of ungulates and its relation to management. Morges, Switzerland, 306-312.
- SHEIKH K. M., S. MOLUR (Eds.) 2005. Status and Red list of Pakistan's Mammals, based on conservation assessment and management plan for mammals. IUCN, Pakistan, 344 p.
- SPARKS D. R., J. C. MALECZEK 1968. Estimating percentage dry weight in diets using a microscope technique. – *Journal of Range Management*, **21**: 264-265.
- SUMAN D. G., S. K. SHYAMA 2009. Studies on the food and feeding habits of Gaur (*Bos gaurus*) in two protected areas of Goa. – *Journal of Threatened Taxa*, **1**: 128-130.
- VARMAN K. S., R. SUKUMAR 1995. The line transect method for estimating densities of large mammals in a tropical deciduous forest: An evaluation of models and field experiments. – *Journal of Bioscience*, **20**: 273-287.
- WAGNER G.D., J.M. PEEK 2006. Bighorn sheep diet selection and forage quality in central Idaho. – *Northwest Science*, **80**: 246-258.

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