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Food habits of Nilgai (*Boselaphus tragocamelus*) as determined by Pellet Analysis in a human dominated landscape, Western Gujarat, India.

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Abstract

We examined the food habits of the Nilgai (*Boselaphus tragocamelus*) from May 2012 to September 2013 in a human dominated central Saurashtra landscape using microhistological technique of pellet samples. A total of 112 pellet samples were collected over three seasons- summer, monsoon and winter and analyzed for percent frequency of occurrence of different plant species. Contribution to the diet by monocots and dicots showed seasonal differences (ANOVA, F= 6.45, df=15, p=0.011) and the Nilgai was found to be a mix feeder through all the seasons in the study area.

Keywords: dicot, monocot, microhistology, Nilgai, Saurashtra

INTRODUCTION

Different methods of studying plant selection by herbivores, such as direct observation (Lamprey, 1963), pasture analysis before and after grazing (Stoddard, 1952) and examination of digestive tract contents (Norris, 1943), which have proved useful in some circumstances, each have limitations under other conditions (Tribe, 1950). The methods are difficult or impossible to apply to the study of preferences shown by wild animals where the pasture contains many closely intermingled and often heavily grazed plant species, where several animal species are often found feeding together, and where animals may not be collected (Stewart, 1967). These limitations were exemplified in our study area as direct observations could not be made, the animals were wary of the observer's presence and hence we adopted the technique of microhistology of faecal samples to examine diet of the Nilgai (*Boselaphus tragocamelus*). Studies on food habits using the microhistological technique of identifying diet constituents have appeared in the literature since Baumgartner and Martin (1939) first described the technique.

A number of studies have been carried out to examine diets of wild ungulates using microhistology all over the world; few examples being wildebeest (*Connochaetes taurinus*), hartebeest (*Alcelaphus buselaphus*), topi (*Damaliscus korrigum*), gazelles (*Gazella granti* and *G. thomsonii*), eland (*Taurotagus oryx*) and zebra (*Equus burchelli)* in Southern Kenya (Stewart and Stewart, 1970), Bushbuck (*Tragelaphus scriptus*) (MacLeod *et al.*, 1996), Pronghorn antelopes (*Antilocapra americana*) (Smith and Shandruk, 1979), mule deer (*Odocoileush emionus*) and white-tailed deer (*O. virginianus*) in U.S.A. (Anthony and Smith, 1974), Gaur or Indian Bison (*Bos gaurus*) in India (Gad and Shyama, 2011), Himalayan Serow (*Capricornis thar*) in Nepal (Giri *et al.,* 2011), Greater one-horned rhinoceros (*Rhinoceros unicornis*) in Nepal (Jnawali, 1986; Pradhan *et al.* 2008), Kiang in the Indian Trans-himalaya (Hussain *et al.,* 2010), Swamp deer (*Rucervus duvaucelii duvaucelii*) in India (Tewari and Rawat, 2013), Alpine musk deer (*Moschus chrysogaster*) in Kedarnath Wildlife Sanctuary (India) (Green, 1987; Syed and Ilyas, 2012) and Hangul deer (*Cervus elaphus hanglu*) in Dachigam, India (Shah *et al.,* 2009).

STUDY SPECIES AND STUDY AREA

The Nilgai are endemic to peninsular India and are the largest antelopes in Asia. They occur in human habitations and crop fields outside protected areas. They are found in a variety of habitats from level ground to undulating hills, in thin bush with scattered trees to cultivated plains, but not in dense forests and steep hills (Blanford, 1888; Prater, 1971). They are absent from the true arid zone where woody cover is inadequate to meet their requirements (Sankar *et al*., 2004). Gradual degradation of dense forests into open scrub and thickets, increasingly bordered by agricultural fields, has offered favourable habitat conditions for the increase of Nilgai numbers and they hence are seen often in human or agricultural landscapes (Sankar *et al*., 2004).

The Saurashtra peninsula forms a rocky tableland dominantly composed of Deccan lava. It is flanked by the Gulf of Kutch and coastal plains in the North, Arabian Sea towards the West and South, demarcated by the Gulf of Khambhat on the South East and alluvial plains to its East. It comprises of seven states namely Surendranagar, Rajkot, Jamnagar, Porbandar, Junagadh, Amreli and Bhavnagar covering 47,000 km^2

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representing 24% of the state of Gujarat (Jadav, 2010) (Figure 1). It is bound between the latitudes 20°50' and 23° 5' and longitudes 69° 20' and 72° 10'. Biogeographically, the whole area falls under the province 4B-Semi arid Gujarat Rajputana (Rodgers *et al*., 2002). The major habitat of Saurashtra is represented by an open thorny scrub forest with graminoid ground cover, commonly referred to as tropical scrubland savanna which gradually changes to a dry savanna in the process of continuous degradation and is locally called *Vidi*. The *vidis* historically were protected and maintained by the earstwhile princely states as private game reserves, community grasslands or pastures by local authorities and then transferred to and maintained by the state forest department since 1959-60 (Jadav, 2010). Central Saurashtra is a human dominated landscape predominated by the Rajkot district. The region experiences a semi arid climate with a mean annual temperature as 26-27°C and the temperature ranges from 46°C to 5°C. The relative humidity is 65-70 percent and an annual mean rainfall of 120 mm. It has three distinct seasons- summer (March to June), monsoon (July to October) and winter (November to February). The types of forest include scrubland, open and moderately open forests. The forest cover in the region is shown in Figure 2. The major vegetation of the *vidis* in Central Saurashtra includes grasses like *Sehima nerosum, Dicanthium annulatum, Andropogon pumilius, Apluda mutica, Arisitda adscensionis, Cenchrus ciliaris, Cymbopogon martinii, Heteropogon contortus, Cynodon dactylon, Iseilema laxum* and *Chrysopogon fulvus* with scattered growth of mostly thorny species of trees like *Acacia nilotica*, *A. senegal, A. leucophloea, Balanites aegyptica* and *Zizyphus nummularia.* The exotic Mesquite (*Prosopis juliflora*) has not invaded the *vidis* in this part thus keeping the grassland ecosystem intact with its indigenous vegetation community. The *vidis* act as refuges for the Nilgai populations in the area. We conducted our sampling in 10 *vidis* located over six *tehsils* (Lodhika, Padadhari, Rajkot, Gondal, Jamkandorna and Jasdan) of Rajkot range namely Khirasara (22°13.662'- 22°11.585'N, 70°39.352'-70°39.835'E) Khambhala-Ishvariya (22°18.600'-22°18.840'N, 70°41.745'-70°40.996'E), Hirasar (22°24.709'- 22°24.328'N, 71°00.756'- 70°59.695'E), Bhandariya (21°48.230'-21°47.304'N, 70°41.844'-70°42.848'E), Vanathali (21°59.006'-21°59.835'N,70°37.456'-70°35.660'E) Rampar (21°56.342'-21°57.155'N, 70°30.051'-70°30.219'E), Meghavad (21°58.495'-21°58.784'N, 70°31.332'-70°31.041'E), Nani Kanesara (22°07.434'-22°06.981'N, 71°08.065'-71°08.239'E), Umath (22°06.485'-22°05.176'N, 71°20.797'-71°22.467'E) and Modhuka-Chadika (22°07.651'-22°07.285'N, 71°24.967'-71°25.044'E).

Fig.1 Map of Saurashtra peninsula showing the study area, Rajkot, Gujarat.

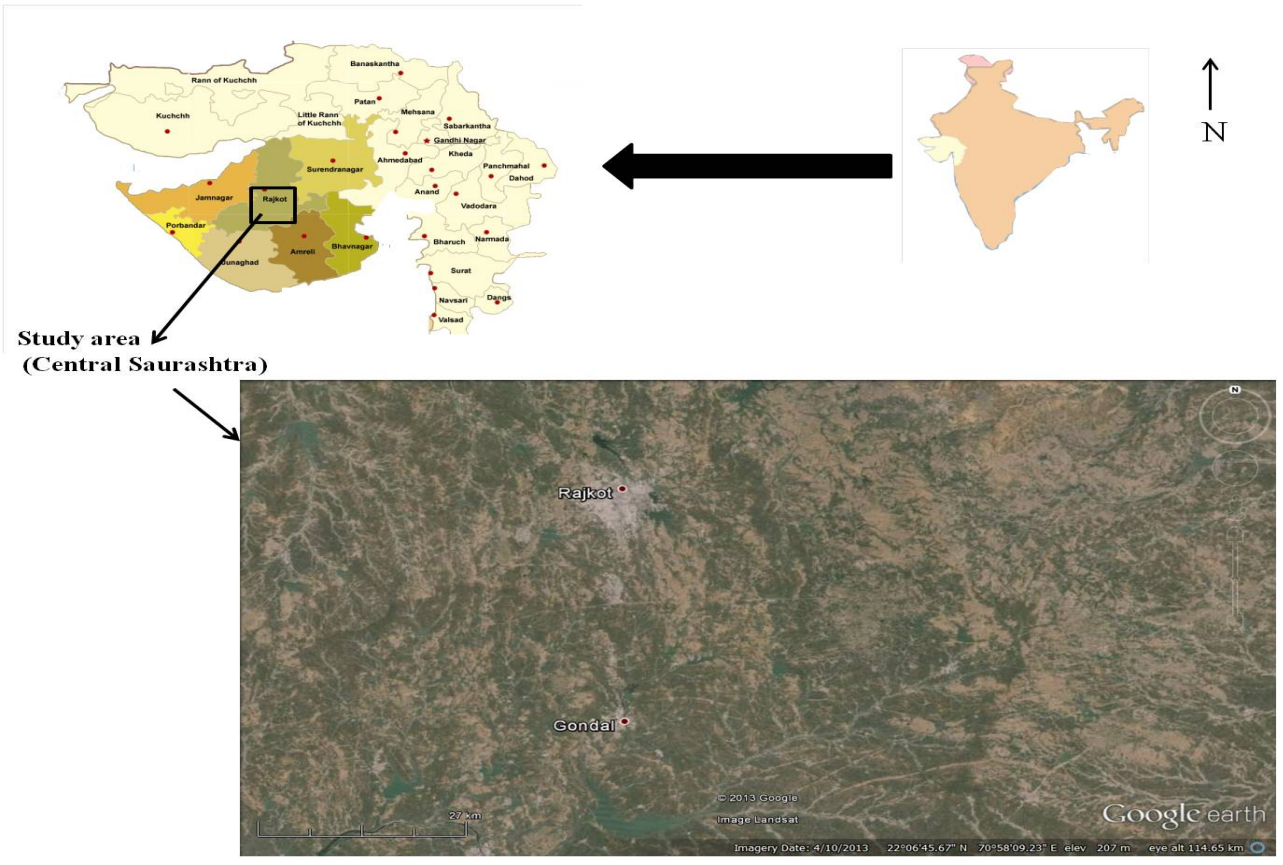
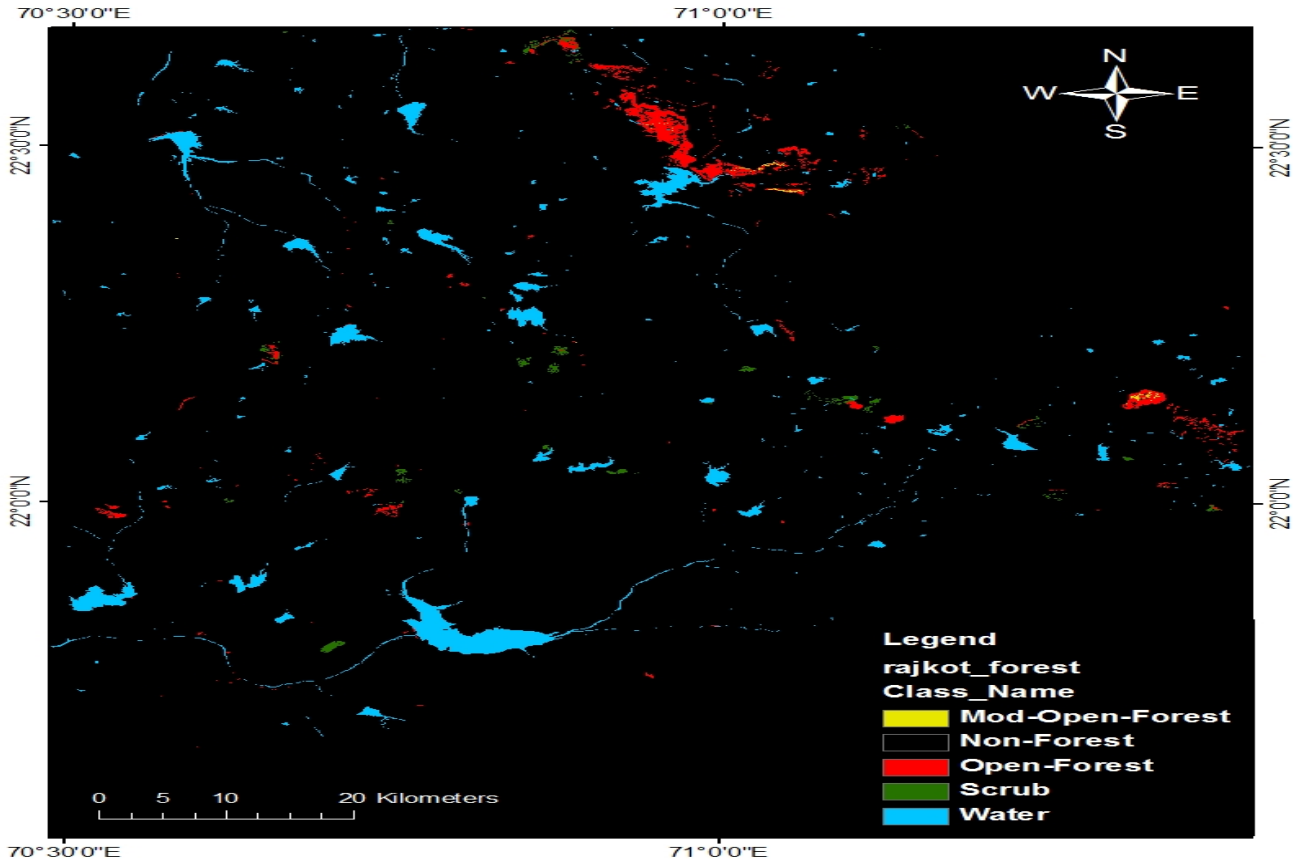


Fig.2 Forest cover and types in Rajkot district. Both open and scrub forests constitute *vidis*.



Source: GIS cell, Wildlife Institute of India, Dehra Dun

METHOD

Unlike some of the previous studies on the species (Dinerstein, 1979, 1980; Sankar and Vijayan, 1991; Khan, 1993; Sankar, 1994) direct observations to study the diet and feeding habits was difficult in the study area, hence the indirect method of faecal analysis was adopted. Fresh pellet samples of Nilgai were collected from different study sites systematically by collecting fresh samples encountered on permanent foot transects (n=28) and opportunistically through all the three seasons from May 2012 to September 2013. A total of 112 samples (37 in summer, 36 in monsoon and 39 in winter) were collected and sun dried initially and stored in paper bags. All probable food species were collected from the study sites in different seasons for the purpose of identifying the plant fragments in the pellet samples. The plants were collected and stored in paper bags, sun and oven dried at 60° C for further analyzing their nitrogen content by Kjeldahl method and percentage crude protein was estimated by multiplying a constant factor of 6.25 to the percent nitrogen values obtained (Chaturvedi and Sankar, 2006). The reference slides were prepared by oven drying the plant species and ground in a micro-Wiley mill with a 1 mm screen to reduce all the fragments to a uniform size. The fragments were then bleached in Hydrogen Peroxide, washed, mounted in DPX as a medium and were examined to identify distinguishing features under 10X and 40X (if required).

The pellet samples were also run through the same procedure to make slides. Four replicates for each sample were prepared. The observations were carried out by sampling in a systematic random manner for each slide prepared under 10X and 40X (if required) with 10 microscope fields for each slide.

To determine the diet composition, the relative frequency of each plant species was calculated using the following formula:

Rf %= (n1+n2+……. / N)*100

Where Rf %= Relative percentage frequency

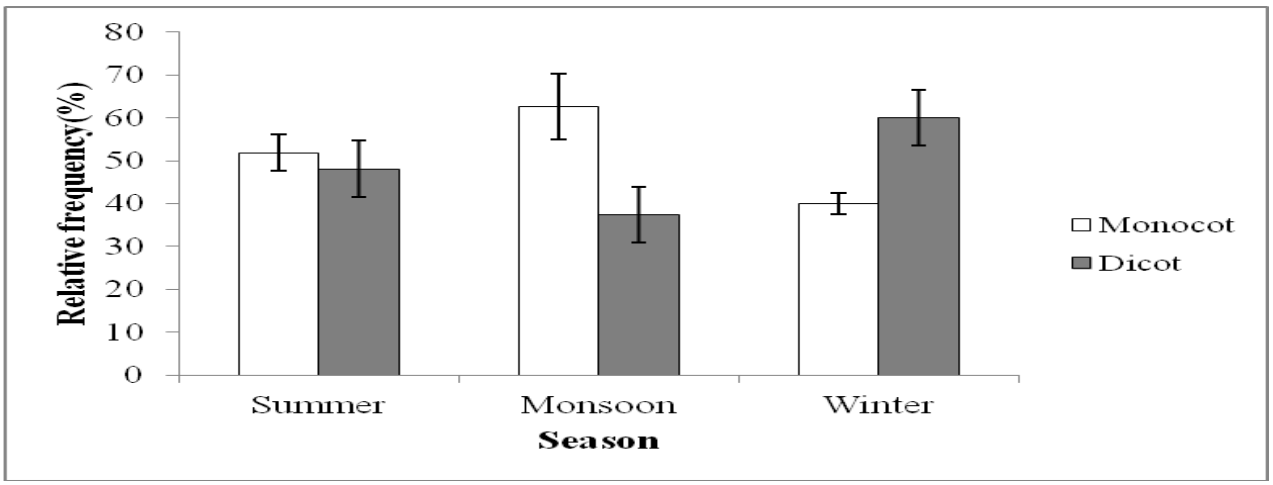
n= Total number of fragments identified for a given food species and

N= Grand total number of fragment counts made in the sample

RESULTS

A total of 7400 plant fragments were observed and classified as monocots and dicots. The monocot and dicot fragments were further identified to each species whenever possible. Many fragments could not be

Fig.3. Proportional consumption of monocots and dicots in the diet of Nilgai (May 2012 to September 2013)



identified to their species level because of lack of peculiar features unique to each species. Considering homogeneity of vegetation structure in the sites from which the samples were collected, the data was clubbed and averaged for different sites and compared for seasonal variations in the diet intake.

The intake of monocots and dicots varied significantly between seasons (one way ANOVA, F= 6.45, df=15, p=0.011) The monocots and dicots were eaten almost in the same proportion in summer, with greater utilization of monocots during monsoon and towards dicots during winter. (Figure 3). The grass:browse ratios for different seasons are given in Table 1. Amongst the monocots, fragments of *Sehima nervosum*, *Chrysopogon fulvus, Cymbopogon martinii* and Maize could be identified. Amongst these, *Sehima nervosum* contributed the most (4.21% in summer, 2.32% in monsoon and 2% in winter) to the relative frequency though the majority remained unidentified (Table 2).

Table 1. Grass: Browse ratios in different seasons as observed in pellets of Nilgai (May 2012 to September 2013)

Season	Avg. ratios	SE
Summer	100:99.07	19.42
Monsoon	100:66.47	18.56
Winter	100:157.05	19.24

Leaves and fruits of *Acacia nilotica, A. senegal, B. aegyptiaca, Zizyphus nummularia, Arachis hypogea* and flowers of *Gossypium herbacium* amongst dicots could be identified whenever they occurred in the slides.

Both species of *Acacia, Belanaites* and *Zizyphus* played an important role in the diet of the Nilgai in various seasons. The summer diet of Nilgai was contributed by pods of *A. nilotica* (4.05%), fruits of *B. aegyptiaca* (4.90%) and fruits and leaves of *Zizyphus nummularia* (11.54%

Table 2. Percentage contribution of different species of monocots in diet of Nilgai during three seasons (May 2012 to September 2013)

Species	Summer (%)	Monsoon (%)	Winter (%)
Sehima nervosum	4.21	2.32	2.009
Chrysopogon fulvus	0	0.26	0
Cymbopogon martinii	0.16	0.16	0
Zea mays	0	0.11	0
Uncategorized	95.62	97.13	97.99

Table 3. Percentage contribution of dicots in the diet of Nilgai during three seasons (May 2012 to September 2013)

Species	Part	Summer (%)	Monsoon (%)	Winter (%)
Acacia nilotica	Pod	4.05	0	0.38
Acacia nilotica	Leaf	0	1.64	0
Acacia senegal	Pod	0.13	0	0.51
Acacia senegal	Leaf	0.26	0	0
Zizyphus nummularia	Leaf	12.59	0	0
Zizyphus nummularia	Fruit	11.54	0	15.09
Belanaites aegyptiaca	Fruit	4.90	0	0
Belanaites aegyptiaca	Leaf	0.2	0	0
Gossypium herbacium	Flower	NA	1.62	0.07
Arachis hypogea	Pod	NA	0.61	0
Arachis hypogea	Leaf	NA	0	0.25
Uncategorized	NA	66.53	96.13	83.70

and 12.59% respectively) contributed to some extent. Higher amount of monocots were eaten in monsoon (62.61%) but leaves of *A. nilotica* contributed to the dicot intake in comparatively higher proportion (1.64%). Fruits of *Zizyphus nummularia* showed higher contribution in winter (15.09%). Details of all the eaten species in terms of percentage contribution is given in Table 3.

The highest crude protein content was found in *A. senegal* leaves (23.01%). The most frequently occurring plant species had crude protein levels of 14.33% (*Zizyphus* leaves), 6.24% to 7.60% (*Zizyphus* fruits), 9.66% (*A. nilotica* pods), 2.47% (*B. aegyptiaca* fruits) and 6.42% to 13.52% (*Sehima nervosum*). The crude protein content of each identified plant species in the diet of Nilgai in terms of percentage is given in Table 4.

DISCUSSION

From the results, it is evident that the Nilgai are mix feeders in the study area. During summer, very limited food resources are available and no crops usually are grown, thus making the Nilgai dependent on the natural vegetation. Grass in the *vidis* is harvested from mid to late winter, thus limiting the amount of grass available in summer. Nilgai were found to feed on monocots and dicots in equal proportions though, which indicates that the animal survived on whatever small strands of grass occurred in the grasslands at that time (CP for *Sehima nervosum*=6.42%). Moreover, among the dicots, the results indicated leaves and fruits of *Zizyphus nummularia* (CP=14.33% and 6.24% respectively) were consumed in higher proportions and to some extent the pods of *Acacia nilotica* (CP= 9.66%). The fruiting in case of *Zizyphus* was observed during winter and hence the Nilgai feed on the dried fruits in summer and leaves that remain on the plant. Sankar (1994) reported the crude protein of *Zizyphus mauritiana* leaves and fruits to vary between 6% to 10% and 5% to 10% respectively.

Table 4. Estimated Crude Protein contents of the eaten food plants of Nilgai between May 2012 to September 2013

Plant species and part	Season in which consumed	CP (%)
Sehima nervosum	S,M,W	6.42(S)-13.52(M)
Chrysopogon fulvus	M	6.89
Cymbopogon martinii	S, M	6.77
Zea mays	M	15.60
Acacia nilotica pod	S, W	9.66
Acacia nilotica leaf	M	14.01
Acacia senegal pod	S, W	11.90
Acacia senegal leaf	S	23.01
Zizyphus nummularia fruit	S, W	6.24(S)-7.60(W)
Zizyphus nummularia leaf	S	14.33
Belanaites aegyptiaca fruit	S	2.47
Belanaites aegyptiaca leaf	S	9.95
Gossypium herbacium flower	M	17.07
Arachis hypogea pod	W	14.95
Arachis hypogea leaf	M, W	15.98

CP- Crude Protein; S-Summer; M-Monsoon; W-Winter

Grasses are available in bounty during monsoon and the Nilgai seemed to maximize this opportunity and there was a clear indication as the proportion of monocots showed relatively very high as compared to the dicots. The most frequently occurring identifiable grass species in the pellet of Nilgai was *Sehima nervosum* with a crude protein value of 13.52% in monsoon. Most of the crops reach their prime in late monsoon and winter. Moreover the grass starts getting harvested in mid-winter. There was an increase in the uptake of dicots during winter with high frequency of *Zizyphus nummularia* fruits (CP=7.60%) as this is the season when they are fleshy. The uncategorized dicots may also be constituted by some crops.

Only a few grass species could be distinguished depending on their cell structures. *Sehima nervosum* occurred most frequently in the diet of Nilgai. The *vidis* in Central Saurashtra are valued for this grass species and is also the dominant graminoid in these *vidis.* It was found to contribute to the diet of Nilgai in relatively higher proportions. All the tree species except *A. leucophloea* found in the *vidis* were utilized as food species and *Zizyphus nummularia* played an important part of the diet in winter and summer. Pods and leaves of two species of *Acacia* and fruits of *Belanaites aegyptiaca* in accordance with the phenology of the plants were also consumed. The Nilgai are known to be a pest species raiding crops which barring cereal food crops are dicots. Small proportions of Groundnut (0.61%) and Cotton (1.62%) were observed in the monsoon pellet samples and these species were high in crude protein content as well (CP=14.95% and 17.07% respectively). These are the two main cash crops of the region and farmers suffer to a great extent due to crop loss in these areas. However, crop plants could not be distinguished in the faecal samples due to lack of identification for dicots and also might have been underrepresented due to higher digestibility.

Other studies on Nilgai food habits showed that they are browsers (Berwick, 1974; Mirza and Khan, 1975; Dinerstein, 1979, 1980) or mixed feeders (Haque, 1990; Sankar, 1994). In southern Texas, they are grazers (Sheffield *et al.*, 1983).

The crude protein content of the identified plant species in the diet of Nilgai fell in the range between 2.47% to 23.01%. Nilgai can thrive upon variable proportions of grass, herbs, and browse, subject only to a minimum requirement of protein, which must not be below eight per cent of their intake (Sankar *et al.*, 2004). The crude protein content in the plant species occurring more frequently in the pellets of Nilgai had a crude protein content of more than eight percent except *Zizyphus nummularia* fruits (7.60%) but this too did not deviate much from the threshold value of eight percent as proposed by Sankar *et al.* (2004). According to Rodgers (1988), the large size of Nilgai means they can exist on much poorer quality food items, making them coarser browsers. Grass formed an important component of Nilgai diet during and soon after monsoon, in winter and summer, they fed on parts of *Zizyphus mauritiana, Butea monosperma, Acacia nilotica, A. catechu*, *A. leucophloea* and *Anogeissus pendula,* along with grass and browse in Sariska (Sankar, 1994).

Butea monosperma and Zizyphus mauritiana contributed in higher proportion amongst the tree species and *Apluda mutica* and *Themeda quadrivalvis* dominated the grass proportion in Gir (Khan 1993). Sankar and Vijayan (1991) reported that Nilgai fed on grasses like *Scirpus tuberosus, Cynodon dactylon, Desmostachya bipinnata*, dry pods of *Prosopis chillensis* and *Acacia nilotica* were eaten in summer and in monsoon and post monsoon, they mainly fed on herbs and grasses in Keoladeo National Park (KNP), Bharatpur. Fallen leaves and fruits of *Zizyphus jujuba* were eaten from December to February in KNP.

Nilgai in the current study were found to feed on pods of *Acacia nilotica* in summer and their diet was dominated by grass in monsoon while fruits of *Zizyphus nummularia* were seen frequently in the winter diet. Keoladeo falls under the same biogeographic province as Saurashtra and results of our study share similarity with the previous study by Sankar and Vijayan (1991).

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REFERENCES

Anthony, R.G. and Smith, N.S. 1974. Comparison of Rumen and Fecal Analysis to Describe Deer Diets. *J.Wildlife.Manage.*, Vol. 38 (3): 535-540.

Baumgartner, L. L. & Martin, A. C. 1939. Plant histology as an aid in squirrel food-habit studies. *J.Wildlife. Manage.*, 3: 266-268.

Berwick, S.H. 1974. The community of wild ruminants in the Gir forest ecosystems, India. Ph.D. Dissertation, Yale University, New Haven, U.S.A.

Blanford, W.T. 1888. *The Fauna of British India, including Ceylon and Burma. Mammalia.* Taylor and Francis. London. England.

Chaturvedi, R.K., and K. Sankar. 2006. *Laboratory manual for the physico-chemical analysis of Soil, Water and Plant*. Wildlife Institute of India, Dehra Dun, India.

Dinerstein, E. 1979. An ecological survey of the Royal Karnali-Bardia Wildlife Reserve, Nepal. Part II; Habitat/animal interaction. *Biol.Conserv.,* 16: 265–300.

Dinerstein, E. 1980. An ecological survey of the Royal Karnali-Bardia Wildlife Reserve, Nepal. Part III; Ungulates. *Biol.Conserv.,* 16: 5-38.

Gad, S. D. and Shyama, S. K. 2011. Diet Composition and Quality in Indian Bison (*Bos gaurus*) based on Fecal Analysis. *Zool.Sci.* 28(4):264-267

Giri, S., Aryal, A., Koirala, R.K., Adhikari, B. and Raubenheimer, D. 2011. Feeding Ecology and Distribution of Himalayan Serow (*Capricornis thar*) in Annapurna Conservation Area, Nepal. *World.J.Zool.,* 6 (1): 80-85

Green, M.J.B. 1987. Diet Composition and Quality in Himalayan Musk Deer Based on Fecal Analysis. *J.Wildlife.Manage.,* 51(4): 880-892.

Haque, N. 1990. Study on the ecology of wild ungulates of Keoladeo National Park, Bharatpur. Ph.D. Thesis, Aligarh Muslim University, Aligarh, India.

Hussain, A., Qureshi, Q. and Rawat, G.S. 2010. Tibetan wild ass (*Equus kiang*) - livestock interactions in the Changthang Wildlife Sanctuary, Ladakh, India. *Galemys,* 22 (nº especial): 395-405.

Jadav, R.D. 2010. Ecological Status and Importance of Grasslands *(Vidis)* in Conservation of Avian Fauna in Saurashtra. Ph.D. thesis, Saurashtra University, Rajkot, India.

Jnawali, S.R., 1986. Diet analysis of greater one –horned rhinoceros (*Rhinoceros unicornis*) by fecal analysis; M. Sc. Thesis, Tribhuvan University, Kathmandu, Nepal.

Khan, J.A. 1993. Ungulate-habitat relationships in Gir forest ecosystem and its management implications. Ph.D. Thesis, Aligarh Muslim University, Aligarh, India.

Lamprey, H. F. 1963. Ecological separation of the large mammal species in the Tarangire Game Reserve, Tanganyika. *Afr.J.Ecol.,* 1: 63-92.

MacLeod, S.B., Kerley G.I.H. and Gaylard, A. 1996. Habitat and diet of bush buck *Tragelaphus scriptus* in the Woody Cape Nature Reserve: observations from

faecal analysis. *S.Afr.J.Wildl.Res.*, Vol. 26 (1): 19-25.

Mirza, Z.B. and Khan, M.A. 1975. Study of distribution, habitat and food of nilgai *(Boselaphus tragocamelus* in Punjab). *Pak.J.Zool.,* 7: 209-214.

Norris, J. J. 1943. Botanical analyses of stomach contents as a method of determining forage consumption of range sheep. *Ecology*, 24: 244-51.

Pradhan, N.M.B., Wegge, P., Moe, S.R & Shrestha, A.K. 2008. Feeding ecology of two endangered sympatric megaherbivores: Asian elephant *Elephas maximus* and greater one-horned rhinoceros *Rhinoceros unicornis* in lowland Nepal. - *Wildlife Biol.*, 14: 147-154.

Prater, S.H. 1971. *The Book of Indian Animals.* Bombay Natural History Society, Bombay.

Rodgers, W.A. 1988. The Wild Grazing Ungulates of India: An Ecological Review. *In*: Singh, P. and P.S. Pathak (Eds.) *Rangeland Symposium.* Rangeland Management Society of India, IGFRI, Jhansi, Nov. 9-12, 1987. P. 404-419.

Rodgers, W.A., Panwar, H.S., and Mathur, V.B. 2002. *Executive summary*. In: *Wildlife protected networks in India. A review.* Wildlife Institute of India, Dehra Dun, India.

Sankar, K. 1994. The ecology of three large sympatric herbivores (chital, sambar and nilgai) with special reference for reserve management in Sariska Tiger Reserve, Rajasthan. Ph.D. thesis, University of Rajasthan, Jaipur, India.

Sankar, K. and Vijayan, V.S. 1991. Notes on the food habits of Nilgai *Boselaphus tragocamelus*. *J.Bombay.Nat.Hist.Soc.*, 89 (1): 115.

Sankar, K., Johnsingh, A.J.T., and Acharya, B. 2004. Blue bull or Nilgai (*Boselaphus tragocamelus* Pallas, 1766) *In*: K. Sankar and S.P. Goyal (Eds.) *Ungulates of India.* ENVIS Bulletin: Wildlife and Protected Areas, Vol. 07, No. 1. Wildlife Institute of India, Dehradun, India. P. 29-40.

Shah, G.M., U. Jan, B.A. Bhat and F.A. Ahangar. 2009. Diets of Hangul Deer *Cervus elaphus hanglu* (Cetartiodactyla: Cervidae) in Dachigam National Park, Kashmir, India. *J.Threatened Taxa*, 1(7): 398-400.

Sheffield, W.J., Fall, B.A., and Brown, B.A. 1983. The Nilgal Antelope. The Caesar Kleberg Program in Wildlife Ecology and Department of Wildlife and Fisheries Sciences. The Texas A&M University, U.S.A.

Smith, A.D. and Shandruk, L.J. 1979. Comparison of Fecal, Rumen and Utilization Methods for Ascertaining Pronghorn Diets. *J.Range Manag.*, 32 (4): 275-279.

Stewart, D. R. M. and Stewart, J. 1970. Food preference data by faecal analysis for African Plains ungulates. *Zoologica Africana*, Vol. 5 (1): 115-129.

Stewart, D.R.M. 1967. Analysis of Plant Epidermis in Faeces: A Technique for Studying the Food Preferences of Grazing Herbivores. *J.Appl.Ecol.*, 4 (1): 83-111.

Stoddard, L. A. 1952. Problems in estimating grazing capacity of ranges. *Proc. 6th international Grassland Congress.* P. 1367-1373.

Syed, Z. and Ilyas, O. 2012. Status, distribution and aspects of ecology of Alpine Musk Deer (*Moschus chrysogaster*) in Uttrakhand Himalayas, India *In:* S. Gonzalez and W. McShea (Eds.) *Deer Specialist Group News NO 24.* P. 4-12.

Tewari, R. and Rawat, G.S. 2013. Studies on the Food and Feeding Habits of Swamp Deer (*Rucervus duvaucelii duvaucelii*) in Jhilmil Jheel Conservation Reserve, Haridwar, Uttarakhand, India. *ISRN Zoology* Vol. 2013. http: / / dx.doi.org / 10.1155 / 2013 / 278213

Tribe, D. E. 1950. The behaviour of the grazing animal: a critical review of present knowledge. *Grass. Forage Sci.*, 5: 209-224.