Journal of Threatened Taxa | www.threatenedtaxa.org | 26 June 2015 | 7(8): 7422–7427

ISSN 0974-7907 (Online)
ISSN 0974-7893 (Print)

OPEN ACCESS

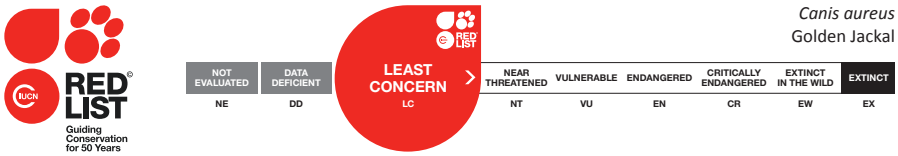
# Diet composition of Golden Jackals *Canis aureus* (Mammalia: Carnivora: Canidae) in Van Vihar National Park, India, a small enclosed area

**S. Prerna [1], Advait Edgaonkar [2] & Yogesh Dubey [3]**

[1] Wildlife Institute of India, Chandrabani, Dehradun, Uttarakhand 248001, India
[2,3] Indian Institute of Forest Management, Nehru Nagar, Bhopal, Madhya Pradesh 462003, India
[1] prernawildlife@gmail.com (corresponding author), [2] advaite@iifm.ac.in, [3] ydubey@iifm.ac.in

**Abstract:** Food habits of Golden Jackals were estimated by an analysis of 200 scats in Van Vihar National Park, India, a small park of 4.45km$^2$ with a very high density of jackals and ungulates. A total of 10 items including fruits (40.74%), vegetative matter (24.38%), Chital (21.61%), Nilgai (9.57%), rodent (1.54%), birds (1.23%), Sambar (0.62%) and Wild Pig (0.31%) were consumed. We estimated relative biomass consumption for the top potential ungulate prey and found that for every 100kg of potential prey killed by jackals, 89.4kg came from Chital and 10.6kg came from Nilgai calves. The impact that predation can have on the ungulate population in an enclosed area is discussed.

**Keywords:** Biomass, Chital, diet, jackal, ungulates.




*Canis aureus*
Golden Jackal

**DOI:** http://dx.doi.org/10.11609/JoTT.o4091.7422-7

**Editor:** József Lanszki, University of West Hungary, Sopron, Hungary. **Date of publication:** 26 June 2015 (online & print)

**Manuscript details:** Ms # o4091 | Received 07 July 2014 | Final received 28 April 2015 | Finally accepted 03 June 2015

**Citation:** Prerna, S., A. Edgaonkar & Y. Dubey (2015). Diet composition of Golden Jackals *Canis aureus* (Mammalia: Carnivora: Canidae) in Van Vihar National Park, India, a small enclosed area. *Journal of Threatened Taxa* 7(8): 7422–7427; http://dx.doi.org/10.11609/JoTT.o4091.7422-7



**Funding:** Self funded by first author, in kind funding by IIFM and WII.

**Competing interests:** The authors declare no competing interests.

**Author Details:** S. Prerna is a researcher at Wildlife Institute of India. Prerna has worked in All India tiger monitoring project 2013-15 and has worked for 5 years on captive bear rehabilitation. This work was for her MPhil thesis at IIFM, Bhopal. Apart from carnivores, Prerna is interested in animal behavior and conservation. Advait Edgaonkar is an Assistant Professor at Indian Institute of Forest Management, Bhopal. He has a PhD in Wildlife Ecology and Conservation. He is interested in carnivore ecology and is presently estimating the population of domestic dogs in Bhopal City. Yogesh Dubey is an Associate Professor at IIFM,Bhopal. He has a PhD in wildlife science. He is interested in biodiversity impact assessment studies and Protected area management.

**Author Contribution:** SP - study design, analysis, field work, lab work, writing; AE - study design, analysis; YD - study design, logistics

**Acknowledgements:** We acknowledge the Madhya Pradesh Forest Department, Indian Institute of Forest Management and Wildlife Institute of India for the permissions and support. We thank Dr.K. Sankar, Dr. Y.V. Jhala, Q. Qureshi and V. Thakur for technical support and advice.

iifm प्रगते मूलं प्रकृतिः

भारतीय वन्यजीव संस्थान
Wildlife Institute of India

## INTRODUCTION

Golden Jackals *Canis aureus* are omnivorous and opportunistic foragers, and their diet varies according to season and habitat (Schaller 1967; Jhala & Moehlman 2004; Mukherjee et al. 2004; Gupta 2011; Chourasia et al. 2012). Their diet consists of a range of prey species, fruits and vegetable matter and is very flexible depending on the local availability of different food items. Golden Jackals are included in CITES Appendix III and Schedule III of the Wildlife (Protection) Act 1972 of India (Jhala & Moehlman 2008). Van Vihar National Park (VVNP) is an enclosed area of about 4.45km², out of which only 3.5km² is available for free ranging animals; the rest consists of several large enclosures which house captive animals. Prerna (2013), estimated a high density of Golden Jackals (17±3.8 km$^{-2}$) and of ungulates like Chital *Axis axis* (118±18.8 km$^{-2}$), Sambar *Rusa unicolor* (34.1±6.9 km$^{-2}$), Nilgai *Boselaphus tragocamelus* (13.1±2.8 km$^{-2}$), Blackbuck *Antilope cervicapra* (6.6±1.5 km$^{2}$) and Wild Pig *Sus scrofa* (3.7±0.8 km$^{-2}$) by using line transect based distance sampling.

In this managed park, with introduced Golden Jackals, the impact of predation on the potential prey base is an important consideration for effective management. To demonstrate that a predator has had an impact on the prey; one requires additional information on the demography of the prey populations; other non-predation related mortality sources in the dynamics of the prey populations; and how the predator selects for species, gender, age or condition (Hunter 1998). To address this, most importantly one requires annual potential prey densities and a record of what the jackals prey upon.

Here, we estimate the food habits of jackals (Image 1), which are the only free ranging carnivore of VVNP, by scat analysis, and we quantify the relative biomass consumption of various potential (ungulate) prey species.

Scat analysis is the most common indirect method for studying feeding ecology of carnivores (Wachter et al. 2012) because it is non-invasive and cost effective. One can determine the range of prey species consumed by the carnivore, the frequency with which each prey species occurs in scats and the proportion each prey species contributes to the diet. Scat analyses helps in studying predator-prey relationships, the impact on prey population, niche breadth and inter specific competition (Ruhe et al. 2008). Various studies have suggested that the calculation of percentage of occurrence of prey species alone in scat analysis will over-represent


**Image 1. Golden Jackal *Canis aureus***

the biomass consumed of relatively smaller prey in comparison with larger prey (Mech 1970; Floyd et al. 1978; Ackerman et al. 1984; Weaver 1993; Jethva & Jhala 2004). The larger area to volume ratio of smaller prey with higher digestibility will be over represented compared to the larger prey. This can be corrected by using a correction factor derived from a positive linear relationship between the body mass (kg) of prey and mass of prey consumed per collectable scat (Mech 1970; Floyd et al. 1978; Ackerman et al. 1984; Weaver 1993; Jethva & Jhala 2004).

## MATERIALS AND METHODS

### Study Area

Van Vihar National Park (23.2300$^{0}$N & 77.3664$^{0}$E) is situated at the foot of the Shyamla Hills, which is one of the several hills constituting the geography of the city of Bhopal, the capital of Madhya Pradesh in central India. It is on the fringe of the Upper Lake, which is a Ramsar Site. It has also been developed and managed as a modern zoological park. VVNP is situated in the centre of the city. There is a concrete wall topped by barbed wire fencing along its northern and eastern boundary. The western boundary is a 5km stretch of lake fenced off with a wire mesh. The areas abutting VVNP are the residential localities of Shyamla Hills and Prempura Village, and the campuses of the Regional Institute of Education and Indira Gandhi Rashtriya Manav Sangrahalaya, an anthropological museum. The scraps of leftover food from the housed carnivores like Tigers *Panthera tigris*, Lions *Panthera leo persica* and Leopards

*Panthera pardus* are often dumped within VVNP (S. Prerna pers. obs.) and are likely scavenged by the jackals. The natural areas are tropical dry deciduous forest, comprising of species such as *Acacia catechu, A. nilotica, Adina cordifolia, Aegle marmelos, Anogeissus latifolia, Anona squamosal, Butea monosperma, Cassia fistula, Diospyros melanoxylon, Holorrhena antidysentrica, Phoenix* spp., *Tamarindus indica, Wrightia tinctoria* and *Zizyphus mauritiana.*

### Method

A minimum sample size of 80 scats per season has been recommended to understand the food habits of Golden Jackal (Gupta 2011). Therefore, two hundred scats of Golden Jackals were collected opportunistically. These scats were sun dried, carefully washed, soaked in water and rinsed through a sieve. All remains such as hair, feather, fruit seeds, bones, claws, jaws, vegetable matter (grass, leaves) and artificial materials (paper, plastic, cloth, thread, pebbles, etc.) were separated and sun dried for further preparation of slides for microscopic observation. For a reliable estimate of the jackal's diet, standard protocols were followed including examination of a minimum of at least 20 prey hairs per scat (Mukherjee et al. 1994; Jethva & Jhala 2003). Hair were treated with xylene in order to view the medulla structure clearly and then mounted on slides using a permanent mounting medium (Bahuguna et al. 2010). Identification of prey species from the medulla characteristics of their guard hair was done under a magnification of 150x and 600x using reference slides which were also prepared for the prey species found in VVNP. The percent occurrence was calculated as simple proportion of the number of scats including the specific component to the total number of scats analyzed. This was bootstrapped 9999 times to get mean and confidence intervals, using IBM SPSS Statistics Version 20.0. Relative percent occurrence was calculated as a percentage of the number of occurrences of one food item to the total number of occurrences of all food items (Breuer 2005). For computing relative biomass consumption from prey occurrence, a regression equation derived for the Indian Wolf *Canis lupus pallipes* (Jethva & Jhala 2004) was used, where Y is biomass eaten per collectable scat in kg and X is prey weight in kg.

$$Y = 0.0148 (X) + 0.135$$

To apply the biomass conversion equation, we converted frequency of occurrence into Whole Scat Equivalents (WSE). WSE was computed by adding up proportions of different food items found within scats. Biomass contribution of a prey species was calculated as Y * WSE of that prey species. Relative biomass was computed to estimate the contribution of each potential prey species in the total collectable scats containing that species. The average weight of an adult female Chital and Nilgai calf were assumed to be 35kg (Davis & Schmidly 1997) and 6kg (Leslie 2011) respectively.

## RESULTS

From 200 scats of Golden Jackals, after excluding the presence of bones, jaws and artificial items like paper, polythene and pebbles, 37% of scats had remains of one food item, 27% had three, 24% had two, 8% had four, 2.5% had five and 1.5% of scats had no remains of any food items.

Ten food items were identified from the scats (Table 1). Tendu Fruit (*Diospyros melanoxylon*) constituted a major food in the diet of Golden Jackal, followed by vegetative matter like grass, leaves, etc. Animal matter comprised 34.6% of the diet and belonged to six taxa (Table 1).

Fifty-eight scats had presence of bones, out of which three scats had presence of only bones and no other indigestible material to identify the potential prey species. Artificial materials found in the scats were paper, plastic, polythene, cloth, thread, aluminum foil and pebbles. Jaws of rodents (2.5%) were also found but species identification was not carried out.

Chital and Nilgai were the most important

**Table 1. Diet Composition of Golden Jackals in Van Vihar National Park (Bootstrapped mean percent occurrence ± 95%CI)**

| Food Item | Count of Occurrence | Percent Occurrence (n=200) Mean±CI | Relative Percent Occurrence (n=324) | Whole Scat Equivalents |
|---|---|---|---|---|
| Chital | 70 | 35±7 | 21.61 | 40.33 |
| Nilgai | 31 | 15.5±5 | 9.57 | 14.08 |
| Sambar | 2 | 1±1 | 0.62 | 2 |
| Blackbuck | 0 | 0±0 | 0 | 0 |
| Wild pig | 1 | 0.5±1 | 0.31 | 1 |
| Rodent | 5 | 2.5(1–4)* | 1.54 | 5.5 |
| Bird | 4 | 2(1–4)* | 1.23 | 1.75 |
| Tendu fruit | 97 | 48.5±7 | 29.94 | 73.08 |
| Ber fruit | 26 | 13(9–18)* | 8.02 | 12.25 |
| Bael fruit | 9 | 4.5±3 | 2.78 | 4.67 |
| Vegetative Matter | 79 | 39.5(6–7)* | 24.38 | 42.33 |

*Asymmetric 95% Confidence Interval

Table 2. Relative biomass of the major jackal prey as calculated by the regression equation of Jethva & Jhala (2004).

| Potential prey species | Average weight of the prey species (X) in kg | Y=0.0148 (prey weight(X)) + 0.135 | Whole scat equivalent | Biomass contribution (in Kg) | Relative biomass |
|---|---|---|---|---|---|
| Chital (Female) | 35 | 0.65 | 40.33 | 26.22 | 89.43 |
| Nilgai (calf) | 6 | 0.22 | 14.08 | 3.09 | 10.57 |

components of the jackal's potential mammalian prey. In the case of Nilgai, only calves can be preyed upon by jackals, since adult Nilgai are too large (120–240 kg; Leslie 2011) to be subdued by even a group of jackals. Although carrion of adult Nilgai can be scavenged, it was considered unlikely that adult mortality due to natural causes took place within the short study period of three months, particularly in the absence of any large carnivore. Under these assumptions, we estimated the relative biomass contribution of Nilgai calves only. Presence of other ungulates (Sambar, Blackbuck and Wild Pig), rodents and birds was negligible and therefore not included for the calculation of relative biomass. Chital biomass per collectable scat was found to be 650g and Nilgai calf biomass per collectable scat was 220g. Therefore 200 scats represent 45.7kg of Chital and 6.9kg of Nilgai. This implies that for every female Chital preyed on by jackals, we can expect 0.2 Nilgai calves to be killed, and for every 100kg of potential prey killed by jackals in VVNP, 89.4kg is estimated to come from Chital and 10.6 kg from Nilgai calves (Table 2).

## DISCUSSION

The study confirms the opportunistic behavior of the Golden Jackal and its ability to adapt to various conditions in the field. Fruits were the most important component of the jackal's diet at VVNP. This was followed, in order of frequency, by vegetative matter, Chital and Nilgai. Frugivory is a common feature in certain mesocarnivores, occurring with a frequency of more than 25% in the diet of most mesocarnivores in Mediterranean Europe (Rosalino & Santos-Reis 2009) and may provide protection against starvation when animal prey is scarce. In Asia also, fruit eating (*Zizyphus*) species has been found in many studies (Sankar 1998; Gupta 2006). The fruits consumed were Bael *Aegle marmelos*, Ber *Ziziphus mauritiana* and Tendu *Diospyros melanoxylon*. The second important component in the diet of Golden Jackals was found to be vegetative matter, also found by Chourasia et al. (2012). Grass eating by dogs is a normal and common behavior and it should not be associated with illness or a dietary deficiency (Bjone et al. 2007) Wild canids and felids in nature are known to eat grass and plants - plant material has been found in 2% to 74% of scats and stomach content samples of wolves and cougars (cited in Hart 2008).

Another important component in the diet of Golden Jackals was Chital, which has also been reported by previous studies by Mukherjee 1989; Chourasia et al. 2012). During two months of field work, a Chital fawn was sighted only once as opposed to 732 sightings of adult females, perhaps they are easily preyed upon by the jackals; this suggests that there are not many chital fawns in VVNP. Predation on fawns has also been reported by Klare et al. (2011); Majumder et al. (2011), in their studies elsewhere. In other studies, Chital female to fawn ratio has been 1:0.3 on average (Sankar & Acharya 2004). The presence of Nilgai hair in the scat means that they are likely hunting Nilgai calf in VVNP, since adults are too big a prey for jackals. Hunting of Nilgai calves by jackals has been seen in Bhal and Kutch areas of India (Y.V. Jhala 2013, pers comm.).

The proportion of birds was negligible in the diet of jackals. The birds available to them are mostly Peafowl *Pavo cristatus* and Grey Francolin *Francolinus pondicerianus*. The density of these birds was not estimated in this study, though they were commonly seen. The proportion of rodents was negligible in comparison with various previous studies (Jaeger et al. 1996; Mukherjee et al. 2004; Gupta 2011; Majumder et al. 2011; Chourasia et al. 2012; Markovi & Lanszki 2012). The density of rodents was also not estimated, so it is not possible to say whether the lack of rodents in the diet was because prey scarcity. This may be because of higher density of ungulates that are easier to kill in the park. No Blackbuck was identified in the diet, though they were numerous adult and sub adult Blackbucks in the park, perhaps the antelope were too fast to be caught. There were no black buck fawns sighted in this study period. Jackals were found scavenging on the garbage dumped (waste meat and bones) from the animal enclosures. Garbage has been described before as an alternate source of food for jackals (McShane & Grettenberger 1984). Presence of a very small percentage of Sambar in the scat analysis indicated either jackal scavenged on dead Sambar or there was

predation on Sambar fawn. Only one scat had Wild Pig hair.

Scat analysis is the most practical method of estimating diet for carnivores. The bias associated with this method is that the remains of one individual prey item can be found in multiple scats and one scat may have multiple prey items. Frequency occurrence of prey from scats tends to overestimate the contribution of smaller prey item as they have relatively larger surface-area to volume ratio and consequently more indigestible matter. Additionally shape and size of scats alone is not always a reliable discriminator for species identity in the case of carnivores (Chame 2003). Scats of Golden Jackal and Jungle Cat are morphometrically indistinguishable (Vanak & Mukherjee 2008) and some of the scats could be potentially misidentified with jungle cat scats (Jaeger et al. 2007). However, the number of jungle cats in VVNP is very low—only one was sighted in the study compared to 110 sightings of jackals—so this bias was felt to be negligible. There are no free-ranging dogs in VVNP, so there was no possibility of mistaken identity with domestic dogs.

VVNP is a very small park with a high density of wild ungulates as well as jackals (Prerna 2013). In VVNP, ungulates are fed Berseem *Trifolium alexandrinum* or Jowar Fodder *Sorghum bicolor* during summer. It may be speculated that the ungulates are maintained at high densities by supplementary feeding (S. Prerna pers. obs.), and the jackals are unable to move out because of the boundary walls and water body enclosing the area. In such a case the jackals, subsidized by meat from the enclosures and seasonally abundant fruit, have wiped out the Chital fawns. Predators can regulate and even limit their prey population where prey populations are enclosed in small reserves (Smuts 1978; Sinclair 1995; Harrington et al. 1999; Peel & Montagu 1999; Power 2002). The impact that predation can have on the prey is an important consideration for effective management and conservation. In the absence of management measures to reduce the jackal population, it seems possible that chital recruitment has declined to zero because of predation. Before carrying out such measures, we recommend further studies to estimate the carrying capacity of the park for jackals over the long term, incorporating the fruits and rodent components of their diet into the analysis, so that the number of jackals to be maintained in the park can be determined.

## REFERENCES


**Ackerman, B.B., F.G. Lindzey & T.P. Hemker (1984).** Cougar food habits in southern Utah. *Journal of Wildlife Management* 48: 147–155; http://dx.doi.org/ 10.2307/3808462

**Bahuguna, A., V. Sahajpal, S.P. Goyal, S.K. Mukherjee & V. Thakur (2010).** *Species Identification from Guard Hair of Selected Indian Mammals: A Reference Guide*. Wildlife Institute of India, Dehradun, India.

**Bjone, S.J., W.Y. Brown & I.R. Price (2007).** Grass eating patterns in the domestic dog *Canis familiaris*. *Recent Advances in Animal Nutrition Australia* 16: 45–49.

**Breuer, T. (2005).** Diet choice of large carnivores in northern Cameroon. *African Journal of Ecology* 43: 97–106; http://dx.doi.org/10.1111/j.1365-2028.2005.00562.x

**Chame, M (2003).** Terrestrial mammal feces: a morphometric summary and description. *Memórias do Instituto Oswaldo Cruz* 98: 71–94; http://dx.doi.org/10.1590/S0074-02762003000900014

**Chourasia, P., K. Mondal, K. Sankar & Q. Qureshi (2012).** Food Habits of Golden Jackal (*Canis aureus*) and Striped Hyena (*Hyaena hyaena*) in Sariska Tiger Reserve, Western India. *World Journal of Zoology* 7(2): 106–112; http://dx.doi.org/10.5829/idosi.wjz.2012.7.2.63139

**Davis, W. & D. Schmidly (1997).** *The mammals of Texas* (Online ed.). Lubbock, Tex.: Texas Tech University.

**Floyd, T.J., L.D. Mech & P.A. Jordan (1978).** Relating wolf scats content to prey consumed. *Journal of Wildlife Management* 42: 528–532; http://dx.doi.org/10.2307/3800814

**Gupta, S. (2006).** Prey abundance and feeding habits of jackal (*Canis aureus*) in Keoladeo National Park, Bharatpur, Rajasthan. M.Sc Dissertation. Department of Wildlife Sc. Aligarh Muslim University, Aligarh, 72pp.

**Gupta, S. (2011),** Ecology of medium and small sized carnivores in Sariska Tiger Reserve, Rajasthan, India. PhD Thesis. Saurashtra University.

**Hart, B.L. (2008).** CVC 2008 Highlights: Why do dogs and cats eat grass? Retrieved December 13, 2014, from http://veterinarymedicine.dvm360.com/cvc-2008-highlights-why-do-dogs-and-cats-eat-grass?rel=canonical

**Harrington, R., N. Owen-Smith, T.C. Viljoen, H.C. Briggs, D.R. Mason & P. Funston (1999).** Establishing the causes of the roan antelope decline in the Kruger National Park, South Africa. *Biological Conservation* 90: 69–78; http://dx.doi.org/10.1016/S0006-3207(98)00120-7

**Hunter, L.T.B (1998).** The behavioural ecology of reintroduced lions and cheetahs in the Phinda Resource Reserve, Kwazulu-Natal, South Africa. PhD Thesis.University of Pretoria, Pretoria.

**Jaeger, M.M., R.K. Pandit & E. Haque (1996).** Seasonal differences in territorial behavior by golden jackals in Bangladesh: Howling versus confrontation. *Journal of Mammalogy* 77: 768–775; http://dx.doi.org/10.2307/1382682

**Jaeger, M.M., E. Haque P. Sultana & R. Bruggers (2007).** Daytime cover, diet and space-use of Golden Jackals (Canis aureus) in agro-ecosystems of Bangladesh. *Mammalia* 71: 1–10; http://dx.doi.org/10.1515%2fMAMM.2007.016

**Jethva, B.D. & Y.V. Jhala (2003).** Sample size considerations for food habits studies of wolves from scats. *Mammalia* 67: 589–591; http://dx.doi.org/10.1515/mamm-2003-0415

**Jethva, B.D. & Y.V. Jhala (2004).**Computing biomass consumption from prey occurrences in Indian wolf scats. *Zoo Biology* 23: 513–520; http://dx.doi.org/10.1002/zoo.20030

**Jhala, Y.V. & P.D. Moehlman (2004).** Golden Jackal *Canis aureus* et al Sub-Saharan Africa (Ethiopian). In: Sillero-Zubiri, C., M. Hoffmann, & D.W. Macdonald (eds). *Canids: Foxes, Wolves, Jackals and Dogs. Status Survey and Conservation Action Plan*. IUCN/SSC Canid Specialist Group. Gland, Switzerland and Cambridge, UK, x+430pp.

**Jhala, Y. & P.D. Moehlman (2008).** *Canis aureus.* The IUCN Red List of Threatened Species.Version 2014.3.<www.iucnredlist.org>. Downloaded on 03 December 2014.

**Klare, U., J.F. Kamler & W. Macdonald (2011)**. A comparison and critique of different scat-analysis methods for determining carnivore diet. *Mammal Review* 41(4): 294–312; http://dx.doi.org/10.1111/j.1365-2907.2011.00183.x

**Leslie, D.M., Jr. (2011).** Nilgai (*Boselaphus tragocamelus*), pp. 591–592. In: Wilson, D.E. & R.A. Mittermeier (eds). *Handbook of the Mammals of the World - Volume 2*. Hoofed Mammals. Lynx Edicions, Barcelona.

**Majumder, A., K. Sankar, Q. Qureshi & S. Basu (2011).**Food habits and temporal activity patterns of the Golden Jackal *Canis aureus* and the Jungle Cat *Felis chaus* in Pench Tiger Reserve, Madhya Pradesh, India. *Journal of Threatened Taxa* 3(11): 2221–2225; http://dx.doi.org/10.11609/JoTT.o2713.2221-5

**Markovi, G. & J. Lanszki (2012).** Diet composition of the Golden Jackal, *Canis aureus* in an agricultural environment. *Folia Zoologica* 61(1): 44–48.

**McShane, T.O. & J.F. Grettenberger (1984).**Food of the Golden Jackal (*Canis aureus*) in Central Niger. *African Journal of Ecology* 22: 49–53; http://dx.doi.org/10.1111/j.1365-2028.1984.tb00673.x

**Mech, L.D. (1970).** *The Wolf: The Ecology and Behavior of An Endangered Species*. Natural History Press, Doubleday Publishing Co., NY, USA.

**Mukherjee, S (1989).** Ecological Separation of Four Sympatric Carnivores in Keoladeo National Park. MSc Dissertation. Saurashtra University, Rajkot, 64pp.

**Mukherjee, S., S.P. Goyal & R. Chellam (1994).** Standardisation of scat analysis techniques for leopards (*Panthera pardus*) in Gir National Park, Western India. *Mammalia* 58: 139–143; http://dx.doi.org/10.1515/mamm.1994.58.1.139

**Mukherjee, S., S.P. Goyal & R. Chellam (1994).** Refined technique for the analysis of Asiatic Lion (*Panthera leo persica*) scats. *Acta Theriologica* 39(4): 425–430.

**Mukherjee, S., S.P. Goyal, A.J.T. Johnsingh & M.R.P.L. Pitman (2004).** The importance of rodents in the diet of Jungle Cat (*Felis chaus*), Caracal (*Caracal caracal*) and Golden Jackal (*Canis aureus*) in Sariska Tiger Reserve, Rajasthan, India. *Journal of Zoology* 262: 405–411; http://dx.doi.org/10.1017/S0952836903004783

**Peel, M.J.S. & G.P. Montagu (1999).** Modelling predator-prey interactions on a Northern Province game ranch. *South African Journal of Wildlife Research* 29(2): 31–34.

**Prerna, S. (2013).** Population Estimation, Feeding Ecology and Management Strategies for Golden Jackals (*Canis aureus*) in Van Vihar National Park Bhopal, Madhya Pradesh India. M.Phil Dissertation. IIFM, Saurashtra University, Gujarat.

**Power, R.J. (2002).** Prey selection of lions *Panthera leo* in a small, enclosed reserve. *Koedoe* 45: 67–75; http://dx.doi.org/10.4102/koedoe.v45i2.32

**Rosalino, L.M. & M. Santos-Reis (2009).** Fruit consumption by carnivores in Mediterranean Europe. *Mammal Review* 39(1): 67–78; http://dx.doi.org/10.1111/j.1365-2907.2008.00134.x

**Rühe, F., M. Ksinsik & C. Kiffner (2008).**Conversion factors in carnivore scat analysis: sources of bias. *Wildlife Biology* 14(4): 500–506; http://dx.doi.org/10.2981/0909-6396-14.4.500

**Sankar, K. (1998).** Some observations on food habits of Jackals (*Canis aureus*) in Keolaeo National Park, Bharatpur, as shown by scat analysis. *Journal of Bombay Natural History Society* 85: 185–186.

**Sankar, K. & B. Acharya (2004).** Spotted Deer Or Chital *(Axis axis* Erxleben), pp. 171–180. In: Sankar, K. & S.P. Goyal (eds.). Ungulates of India. ENVIS Bulletin: Wildlife and Protected Areas, Vol. 07, No. 1. Wildlife Institute of India, Deheradun, India, 448pp.

**Schaller, G.B. (1967).** *The Deer and The Tiger: A Study of Wildlife in India*. Chicago: University of Chicago Press, 370pp.

**Sinclair, A.R.E. (1995).** Population consequences of predation-sensitive foraging: the Serengeti example. *Ecology* 76: 882–891.

**Smuts, G.L. (1978).** Interrelations between predators, prey and their environment. *Bio Science* 28: 316–320; http://dx.doi.org/10.2307/1307372

**Vanak, A.T. & S. Mukherjee (2008).** Identification of scat of Indian Fox, Jungle Cat and Golden Jackal based on morphometrics. *Journal of the Bombay Natural History Society* 105: 212.

**Wachter, B., A.S. Blanc, J. Melzheimer, O.P. Höner, M. Jago & H. Hofer (2012).** An Advanced method to assess the diet of free-ranging large carnivores based on scats. *PLoS ONE* 7(6): e38066; http://dx.doi.org/10.1371/journal.pone.0038066

**Weaver, J.C. (1993).** Refining the equation for interpreting prey occurrence in the Grey Wolfs scats. *Journal of Wildlife Management* 57: 783–786; http://dx.doi.org/10.2307/3809278