Food preferences of the Golden Jackal *Canis aureus* in the Gir National Park and Sanctuary, Gujarat, India

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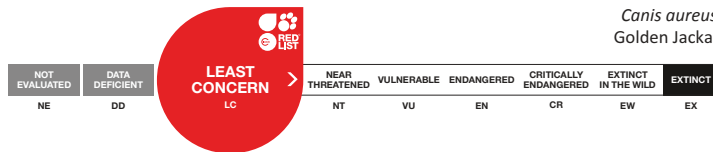[1] msalam01@gmail.com (corresponding author), [2] secretarywsi@gmail.com, [3] chegeherman@gmail.com,
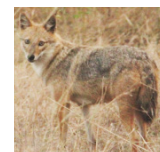[4] dcfwildlife@gmail.com, [5] cf.wl.jun@gmail.com

Abstract: The feeding habits of the Golden Jackal *Canis aureus* were investigated by analysis of its scat contents (n=81), collected between October 2007 and June 2008 in Gir National Park and Sanctuary, Gujarat, India. Jackal dietary habits reflected the availability of a wide variety of food items and the differential vulnerability of prey. Potential animal and plant foods available to jackal varied because of their seasonal variability. About 32.69% scats were found to have only one prey item, whereas 48.08% of scats represented two prey items. Overall, it was found that the large mammalian prey was the most important food item which was significantly supplemented by vegetative material particularly *Zizyphus* spp. Amongst mammalian prey, the percentage frequency of occurrence (percentage±SE) of Chital *Axis axis* was 25.93±2.84, Buffalo *Bubalus arnee bubalis* was 27.16±2.98 followed by Indian Hare *Rufus nigricollis* 19.75±2.15 and Sambar *Rusa unicolor* 11.11±1.19 while the least was found for Langur *Semnopithecus entellus* 2.47±0.21 and Bluebull *Boselaphus tragocamelus* 2.47±0.21. Although, there is substantial availability of wild prey kills, the results suggest the presence of domestic mammals and human waste matter in the scats which could be assumed as a fortification of the Jackal's dietary spectrum, substantiating the scavenging tendency of the jackal to forage near human settlements.

Keywords: *Canis aureus*, food habit, Golden Jackal, Gir National Park and Sanctuary, scat analysis.

Canis aureus
Golden Jackal

The Golden Jackal *Canis aureus*, a medium-sized predator and omnivore, is one of the most widely distributed canid species, occurring in many areas of central, eastern, and southern Europe, northern Africa, and parts of Asia with a range extending from the Arabian Peninsula into western Europe and east into Turkey, the Middle East, Central Asia, the entire Indian subcontinent south to Sri Lanka, and east to Myanmar, Thailand, and parts of Indo-China (Prater 1980; Sillero-Zubiri et al. 2004; Jhala & Moehlman 2008; Katuwal & Dahal 2013). During the past about half century, its populations in many parts of its geographical range have undergone significant changes in distribution and abundance, including drastic declines (Jhala & Moehlman 2008). Over most of its distribution, the jackal is fairly common, although it is thought to be declining in many areas due to poaching, habitat loss and modification. In south-eastern Europe, the preferred habitat of the jackal consists of a mosaic of small cultivations and dense scrub as well as lowland or wetlands with adequate vegetation covers (Macdonald 1984; Giannatos 2004; Katuwal & Dahal 2013). With increasing anthropogenic pressures it is facing threats and has started disappearing from many places of its global distribution range. The causes of decline seem to be related to the limited habitat availability due to changes in human agro-pastoral activities, which resulted mainly in reduced day-cover availability and possibly reduced food base as well. Other than forest areas of different habitats and mountainous areas, agricultural habitats are also being occupied by jackal in high numbers (Russev 2010). The species is included in the Convention on International Trade in Endangered Species (CITES) Appendix III, listed as a species of 'Least Concern' as per the International Union for Conservation of Nature (IUCN) Red List of Threatened Species. It is a schedule III species in The Wildlife (Protection) Act, 1972 of India, receiving legal protection (Jhala & Moehlman 2008).

The jackal is an opportunistic canid species, showing high flexibility in hunting strategies according to actual food availability (Lamprecht 1978; Macdonald 1983; Demeter & Spassov 1993). Its diet pattern varies across a wide distribution whereas its food spectrum ranges from plants, arthropods and reptiles to birds, lagomorphs and rodents; it also preys upon young domestic or wild ungulates, and is also considered a scavenger (Demeter & Spassov 1993; Yom-Tov et al. 1995; Jhala & Moehlman 2008). It is a very valuable animal in the tropical ecosystem; acting in many ways in balancing the eco-cycles and keeping the environment clean (Prater 1980). In India, it is widely distributed and also marks its presence in many protected areas, but the information available on this species is scanty.

The Gir National Park and Sanctuary (GNPS) is one such protected area which supports a very high density of large predators including the Asiatic Lion *Panthera leo persica* and the Common Leopard *Panthera pardus* along with a healthy population of herbivores and livestock (Khan et al. 1996; Singh & Kamboj 1996; Singh & Gibson 2011; Meena & Kumar 2012). We assumed that large carnivores provide ample opportunity to jackal to feed in terms of providing kills and thus, supporting this species, even in the presence of a large scavenger/competitor in the form of Striped Hyena *Hyena hyena* (Alam 2011; Alam et al. 2014). Therefore, we investigated the feeding habits of jackal by analysing faecal scat samples. Since, no quantitative information is available on the food spectrum and feeding habits of this species in the Gir ecosystem, this study presents the first ever record of jackal feeding habits in a typical dry-deciduous forest area of the GNPS.

MATERIALS AND METHODS
Study Area
The study was carried out in the GNPS, located in the Gujarat province of India (Fig. 1). GNPS ($20^040'$–$21^050'$N & $70^050'$–$71^015'$E) lies around 40km away from the Arabian Sea coast in the Kathiawar or Saurashtra peninsula of Gujarat State. It stretches over a length of about 70km from west to east and about 40km from north to south. The maximum and the minimum temperature is 45^0C in summer and 7^0C in winter. The rainfall pattern is erratic and uneven, with the maximum and minimum annual rainfall being 1866mm and 199mm, respectively averaging to 980mm. There are 45 small temporary settlements of 'Maldhari' graziers locally known as 'Ness'.

GNPS is well known for the only wild population of the Asiatic Lion. The total area of GNPS is 1412.13km² of which the National Park comprises 258.71km² surrounded by 1153.41km² of sanctuary. It also supports a rich biodiversity, viz.: 606 recorded flowering plant species, 39 mammal species, 37 reptiles, 300 species of birds and more than 2000 species of insects (Alam 2010, 2011; Meena & Kumar 2012). According to Champion & Seth (1968), the GNPS falls under the type 5A/Cla, i.e., very dry teak forest. The area comprises low hills of volcanic origin with an altitudinal range of 83–524 m.

Methods
It is difficult to determine each prey item contributing to the diet of a carnivore species by direct
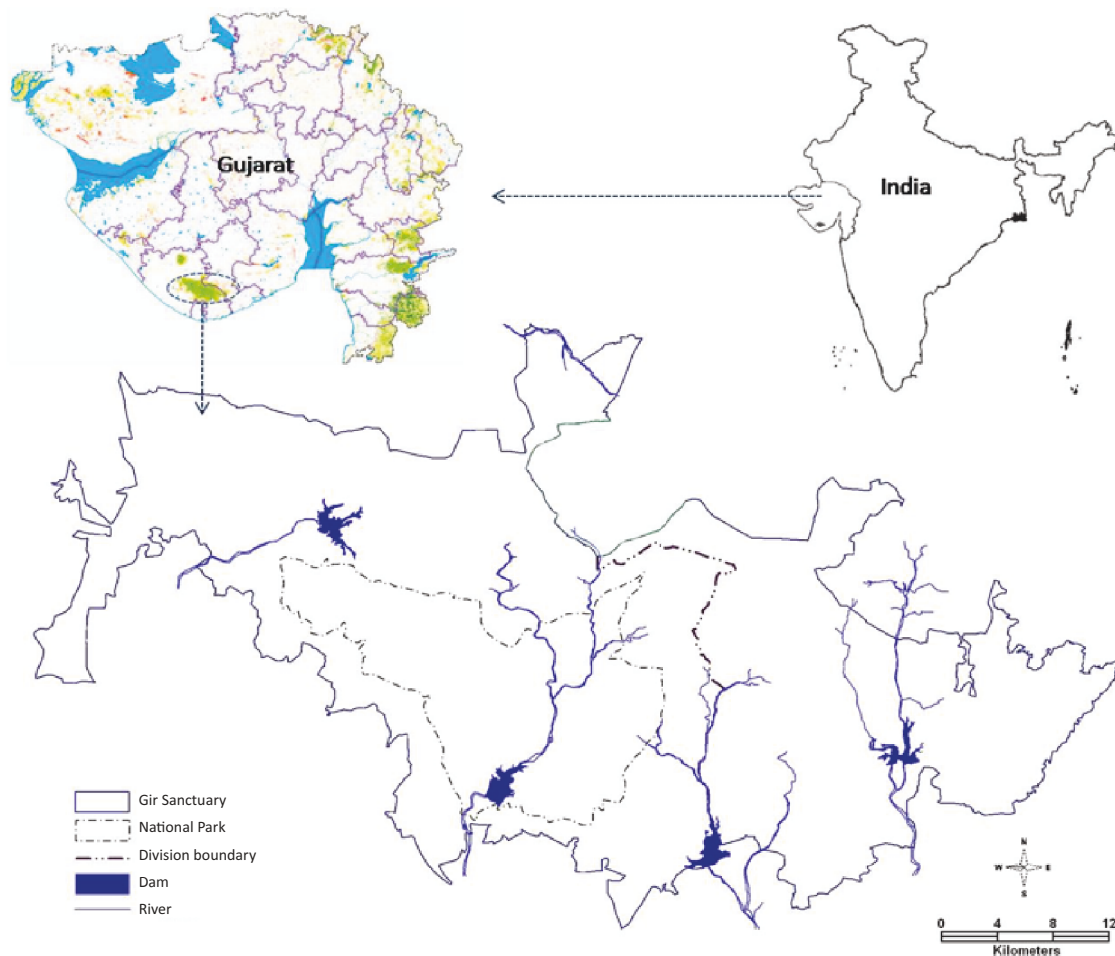
Figure 1. Location map of Gir National Park and Sanctuary, Gujarat, India

observations in the field. Scat analysis is, thus widely used for studying food habits of carnivores because of its non-invasive nature and easy collection and analysis (Korschgen 1980; Ackerman et al. 1984). Therefore the scat analysis method was used to determine the food habits of jackals in the GNPS.

Jackal scats are very easy to identify in the field (Majumder et al. 2011) and we found no ambiguity and confusion in differentiating jackal scats from that of the Indian Fox *Vulpes bengalensis* which is generally found in the fringe areas of the sanctuary. Scats were collected near identified active dens of jackals and stored in zipped polythene bags with ancillary information like place, habitat, GPS coordinates and date of the collection. The scats were collected between October 2007 and June 2008 in GNPS. Each scat was crushed very carefully avoiding any mix-up and indigestible prey remains such as hairs, bones, claws, hooves, teeth, feathers and other materials were used for identification of prey species (Lockic 1959; Korschgen 1980; Mukherjee et al.

1994; Jethva & Jhala 2003). The hairs were the most important factor used to determine the prey species in the scats. Hairs were collected randomly from each scat and treated with xylol and subsequently with xylene. From each scat, 20 hairs were taken randomly for microscopic examination using a compound stereoscopic microscope (Olympus CH 20i) under 40X magnification. The microscopic examination of hairs and their characteristics such as medullary and cuticular patterns were observed and compared with reference slides. The reference slides of all possible prey species found in the study area were prepared. The reference slides of hair samples were collected from the field as well as from Sakkarbag Zoo.

The percentage occurrence of a mammalian prey item was calculated as the number of times a specific prey item was found to occur in scat and expressed as a percentage of all prey occurrences (Floyed et al. 1978; Weaver & Fritts 1979; Ackerman et al. 1984). The frequency of occurrence of prey species in the scats was

computed as the number of occurrence of each prey type divided by the total number of scat analyzed and expressed as a percentage (Leoplod & Karusman 1986; Corbett 1989; Reynold & Aebischer 1991; Jethva & Jhala 2004). The standard error (SE) was estimated from the percentage occurrence of each mammalian prey species and 95% confidence interval was obtained by multiplying the SE by 1.96 (Fowler et al. 2006). Diet content other than mammalian prey was also calculated as the number of times a specific item was found to occur in scat and expressed as a percentage of occurrences of all items other than mammalian prey. Data was visualized as bar plots using the statistical program R (R Development Core Team 2008).

RESULTS

Table 1 shows the occurrence of the number of prey items in the scat of the jackal in this study. The species seems to prefer one to two prey items at 80.77%, followed by three and four prey items at 17.31% and 1.92%, respectively. Figure 2 shows the overall scat content of the jackal in GNPS. A relatively large percent showed an occurrence of plant materials (*Zizyphus* spp. and *Caparis* spp.). The remains of mammalian prey items seen in the scats of jackal included those of Chital *Axis axis*, Sambar *Rusa unicolor*, Buffalo *Bubalus* sp., Indian Hare *Rufus nigricollis*, Cow *Bos indicus*,
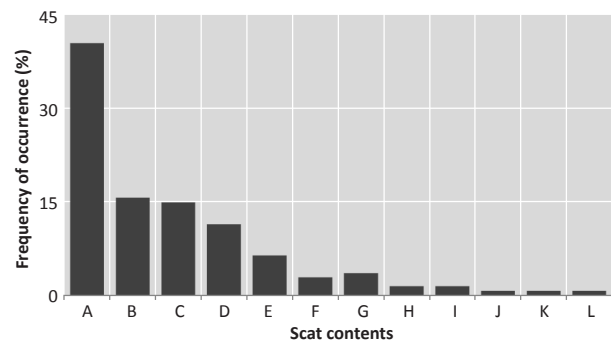
Table 1. Occurrence of number of prey in the scats of the jackal in Gir National Park and Sanctuary, India.

Prey Items	Percentage of Scats
One	32.69
Two	48.08
Three	17.31
Four	1.92

Table 2. Mammalian prey items detected in the diet of Golden Jackal in Gir National Park and Sanctuary, India.

Prey	Percentage Occurrence	Standard Error	± Confidence level (95%)
Buffalo	27.16	2.98	5.84
Chital	25.93	2.84	5.57
Sambar	11.11	1.19	2.32
Hare	19.75	2.15	4.22
Rodent	6.17	0.63	1.24
Cattle	4.94	0.49	0.97
Langur	2.47	0.21	0.42
Bluebull	2.47	0.21	0.42

Figure 2. Overall visualization of the scat content of the Golden Jackal in Gir National Park and Sancturay,India.
[A - Plant material (*Zizyphus* spp. and *Caparis* spp.); B - Buffalo; C - Chital; D - Indian Hare; E - Sambar; F - Rodents; G - Cow; H - Hanuman Langur; I - Bluebull; J - Peafowl; K - Plastic; L - Rubber]
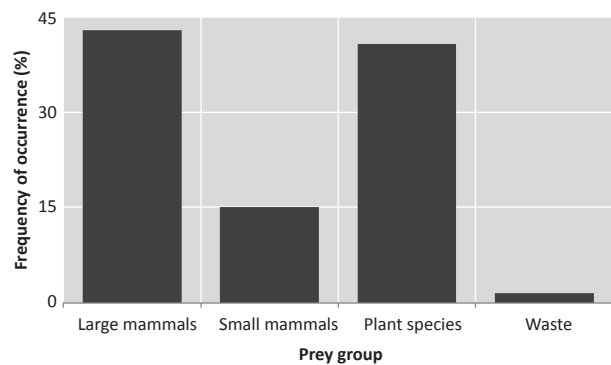

Figure 3. Prey group frequency of occurences in the scat of the Golden Jackal in Gir National Park and Sancturay, India.
[Large mammals (buffalo, cow, chital, sambar, langur and bluebull); Small mammals (hares and rodents); Plant species (*Zizyphus* and *Caparis*); Waste (plastic and rubber)].

rodents, Hanuman Langur *Semnopithecus entellus* and Bluebull *Boselaphus tragocamelus* (Table 2). Chital, Buffalo and hare seem to be preferred mammalian prey species covering around 72.84% of the jackal diet. The contribution of wild and domestic mammalian prey in the diet of jackals in GNPS was observed as 67.9% and 32.1%, respectively.

Large mammals were the preferred prey group of the jackal, observed from the scat analysis (Fig. 3). Plant material has a relatively high frequency of occurrence compared to other food groups showing the relative importance of the plant material in the diet of the jackal in GNPS. The occurrence of plant material is not detected in all the scats of the jackal despite being a relatively important food source. This may have been due to the temporal availability of fruits in GNPS.

DISCUSSION

Scat analysis has been used in a wide variety of canid species to infer dietary composition (Schaller 1967; Jethva & Jhala 2004; Giannatos et al. 2005; Habib 2007; Szabó et al. 2010; Majumder et al. 2011). The dietary composition of jackal has been studied based on the frequency of occurrence and percentage weight of different food items in scats (Giannatos et al. 2005; Szabó et al. 2010; Majumder et al. 2011) as well as direct observations and stomach content analysis (Stoyanov 2012). All these methods have shortcomings. The percent occurrence of a particular food item in scats may differ from actual consumption. Different plant species also vary in their seed size and pulp-seed size ratio, which affects the percent weight. These methods, however, can provide useful insights into the dietary preferences of omnivore species such as the jackal.

Jackal feeds on a variety of food items including plant material like other canids (Jethva & Jhala 2004; Habib 2007). They are opportunistic omnivores and their diets may vary seasonally and geographically (Giannatos 2004; Jhala & Moehlman 2008; Majumder et al. 2011; Stoyanov 2012). In previous studies, it was also found that jackal consumed both animal and plant matter, with variation probably related to food availability (Sillero-Zubiri et al. 2004; Lanszki & Heltai 2010; Majumder et al. 2011). This also confirms the variety of food items including mammals, birds, plant materials (fruits) and human food waste in the diet of jackal.

GNPS being a dry and semi-arid tropical area, the summer starts a little early, and dry fruits left intact in trees are shed owing to a change in wind speed. These fallen dry fruits especially *Zizyphus* spp. which is high in nutritional value become available to any herbivore species as well as omnivores such as jackal. Similarly, other studies on jackal (Sankar 1988; Balasubramaniam & Bole 1993; Mukherjee et al. 2004; Aiyadurai & Jhala 2006; Majumder et al. 2011) also reported the same finding along with studies on other omnivores that found the occurrence of plant matter (Gopal 1991). The jackals remain active during the day, which allows them to search for food in larger areas and scavenge on carcasses of large mammals such as chital, sambar, bluebull, hare and langur. Jackals are group hunting canids (Lanszki & Heltai 2010). The observed hairs of Chital and Indian Hare in the jackal diet might also be a result of predation on chital fawn and hares. Jackals carrying hares and remains of chital fawn in daylight were observed several times during the field work in the GNPS (Image 1–3). On several occasions, groups of jackals were found chasing chital fawns. There

Image 1. Golden Jackal carring remains of Chital fawn in Gir National Park and Sanctuary, India

Image 2. Golden Jackals in Gir National Park and Sanctuary

Image 3. Golden Jackals in tropical dry deciduous forest of Gir National Park and Sanctuary, Gujarat, India

are many 'Maldhari Nesses' distributed throughout the Gir Sanctuary, and the observed occurrence of livestock remains in jackal scats during the study period were possibly due to scavenging on the carcasses of livestock from these 'Nesses' and possibly also from the

surrounding villages.

In GNPS, both animal and plant matter contribute to the diets of jackal. The considerable presence of plant matter in the diet of the jackal confirmed that plants might play an important role in fulfilling their nutritional requirements. The low content of birds in the scats was in accordance with the evidence of low bird consumption outside the nesting season found in most studies (Demeter & Spassov 1993). The content of rodents found in jackal scats in this study confirmed the significance of rodents as a prey item throughout the year. Utilization of small mammals by jackal was also reported in numerous studies in Asia (Demeter & Spassov 1993; Mukherjee et al. 2004; Jaeger et al. 2007), Africa (Lamprecht 1978) and European agricultural area (Lanszki et al. 2006; Lanszki & Heltai 2010), and this food type is clearly preferred by the jackal (Lanszki & Heltai 2010). The presence of domestic mammals in the scat remains also reveals the tendency of jackal to frequent human settlements and nesses in search of food reflecting dependency of these animals on human leftovers.

In conclusion, the primary food of jackal consisted of large animals (carcass of large animals are scavenged) to medium size to small animals (small animals are hunted), as well as plant material (mainly fruits) in the GNPS. A long term ecological study is required on this meso-carnivore to examine the implications of the diet profiles of different carnivore species and temporal activity for understanding resource partitioning patterns and sympatricity among them in GNPS.

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