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## **REVIEW ON CURRENT WORLDWIDE STATUS, DISTRIBUTION, ECOLOGY AND DIETARY HABITS OF GOLDEN JACKAL, *CANIS AUREUS***

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**Abstract:** The golden jackal is a medium-sized predator and omnivore, with a range covering the southern parts of the Palearctic, South Asia and northeastern Africa. The entire jackal population is now confined to a few clusters grouped into 7 sub-areas with criteria such as connectivity and isolation. 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. This review summarizes the basic aspects of golden jackal distribution, ecology and dietary habits, analyses the main threats and problems of jackal management. The jackals seem to do well in moderately modified agro-systems with non-invasive human activities. Barriers for jackal expansion and population recovery seems to be the mountains with extensive high forests or unbroken scrub, heavy snowy winters and irregular food supply, large intensively cultivated areas without cover, urbanization and established wolf populations. Agro pastoral changes during the past 25-30 years has resulted in habitat and human use changes, which have largely contributed to the massive jackal population declines. Following a short introduction on phylogeny, classification, and evolutionary ecology of the Canidae, this review provides the latest information on the distribution, biology and conservation status of *Canid aureus* species, organized by geographical region.

**Keywords:** *Canis aureus*, Conservation, Ecology, Golden Jackal, Population.

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## **INTRODUCTION**

### **Family Canidae**

Among the living families within the Order Carnivora, the Canidae is the most ancient. The family arose in the late Eocene, when no other living families of carnivorans had yet emerged (two arctic families, Miacidae and Viverravidae, have a much older history but none survive to the present time). This is a large group of mostly predatory mammals characterized by their common possession of a pair of carnassial teeth (upper fourth premolar and lower first molar) that are modified to maximize efficiency for shearing skins, tendons and muscles in their prey. The Canidae consists of approximately 36 extant species

categorized into five genera (Van Gelder 1978; Nowak 1991; IUCN/SSC Canid Specialist Group, 2004). The members of the family Canidae are called canids, characterized by an inflated entotympanic bulla (bony chamber enclosing the middle ear region) that is divided by a partial septum along entotympanic and ectotympanic suture. Other characteristic features of canids are loss of carotid artery that is situated between the entotympanic and petrosal for most of its course and contained within the rostral entotympanic anteriorly (Wang and Tedford, 1994). These basicranial characteristics have remained more or less stable throughout the history of canids, allowing easy identification in the fossil record

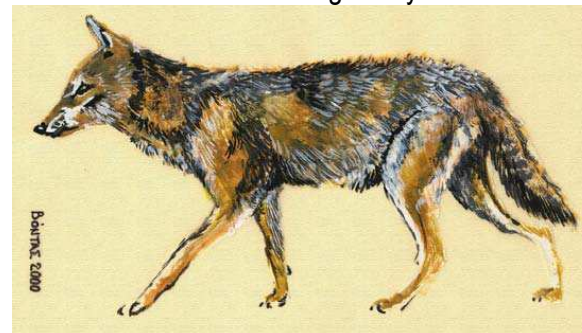
when structures are preserved. The contemporary Canidae is the most wide spread family that occurs throughout the world from Arctic to tropical forests (Sheldon 1992) with at least one species present in every continent except Antarctica. A quick perusal of the ranges of all canid species (Macdonald and Sillero-Zubiri 2004) indicated that over the last century, the geographical range of seven species have increased, eight have decreased and nine have remained stable.

Many canids have distributions that span over a whole continent. Red foxes (*Vulpes vulpes*) and grey wolves (*Canis lupus*) have the most extensive natural range of any land mammal (with the exception of humans and perhaps some commensal rodents). Red foxes are the only canid present in five continents, recorded in a total of 83 countries. Grey wolves occur naturally in North America, Europe and Asia, their range spanning over 62 countries. Two species are present on three continents, namely the golden jackal (*Canis aureus*) and arctic fox (*Alopex lagopus*). And two other, the red fox (*Vulpes vulpes*) and dingo (*Canis lupus dingo*), have reached Australia and Oceania with assistance from mankind (Macdonald and Sillero-Zubiri 2004). At least 155 of the 192 countries across the globe have (81%), canids including Sudan with the highest number of species (10 species), followed by USA (9 species) and Ethiopia (8 species). The countries that don't host any canid species are island states (e.g., Caribbean island, Madagascar, Malta and most Australian islands). Africa, Asia and South America support the greatest diversity with more than 10 canid species each. Red foxes are sympatric with 14 other canids (from three geographic regions), golden jackal with 13 (from two regions) and Grey wolves with 11 (from three regions) (Macdonald and Sillero-Zubiri 2004). There are five canid species endemic to a single country. Not surprisingly, most are also threatened (Red wolf, *Canis lupus rufus*; Ethiopian wolf, *Canis simensis*;

Darwin's fox, *Lycalopex fulvipes*; Island fox, *Urocyon littoralis*; and Hoary fox, *Pseudolopex vetulus*), with the Sechuran fox (*Pseudolopex sechurae*) a near-endemic to Peru. Of the two continents with the highest species diversity, South America harbors nine species (out of 11 species present confined entirely to south of Panama, while Africa has eight endemic (of 13 species present). Out of 12 canid species found in Asia, only two are restricted in the continent (Macdonald and Sillero-Zubiri 2004)

### Golden Jackal

Jackal, as a group amongst canids is a widespread species of the family Canidae. There are four species of jackals, golden jackal (*Canis aureus*), black (Silver)-backed jackal (*Canis mesomelas*), side-striped jackal (*Canis adustus*) and the fourth which is very rare called simien jackal or Ethiopian wolf (*Canis simiensis*). The golden jackal means 'golden dog' is largest of the jackals and presumed to be a true member of the dog family.



**Figure 1. A medium sized Canid, Golden Jackal with variable pelt colours (Drawing by M Vontas)**

There are 13 species of golden jackal being recognized (Wozencraft, 2005) (Table1) so far, however, recently, a new subspecies of golden jackal was described from the Gaza strip, Palaestine and named *Canis aureus palaestina* Khalaf (Khalaf 2008). Usually there are three jackal subspecies living in the area around Palaestine: the Syrian golden jackal, *Canis aureus syriacus*, the Egyptian golden jackal, *Canis aureus lupaster*, and the Arabian golden jackal, *Canis aureus hardranauticus*. The Palaestinian golden jackal subspecies is morphologically and geographically distinct

from these three species by its distinctive coloration on the fur and the moderate size. The size of the Palaestinain jackal is moderate if compared with the larger Egyptian jackal and the smaller Arabian jackal. It is a small race of the Golden or Asiatic jackal, *Canis aureus*. It is smaller than a wolf, larger than a fox and can be distinguished by its relatively smaller, rufous ears and shorter black-tipped tail. The dorsal colour is usually variable black, yellowish-grey or brown-yellowish tinged with rufous, greyer on the back, which is grizzled with varying amounts of black. A dark band runs along the back from the nose to the top of the tail. This mane becomes wider on the back, extending into the lateral surfaces. There are two dark bands across the lower throat and upper breast. There is also a reddish phase. The under parts are almost white or yellowish-brown. The winter coat is longer and greyer. The tail is relatively short, usually with a black tip. Now the Egyptian jackal (*Canis aureus lupaster*) present in the North Africa is also considered a subspecies of grey wolf (*Canis lupus*) in comparison to golden jackal. The evidences were explained by Nassef 2003 and Rueness *et al.*, 2011.

### Distribution

Distribution of these jackals, namely side-striped, black-backed and simien jackal is limited to Africa, as side-striped jackal is native to Central and southern Africa (Wozencraft 2005) and black-backed jackal inhabits two areas of the African continent. One region includes the southernmost tip of the continent including South Africa, Namibia, Botswana and Zimbabwe; other is along the Eastern coastline including Kenya, Somalia and Ethiopia. Simien jackal is endemic to Ethiopia, where it is one of several species of mammals restricted to Afro-alpine grassland and health lands (Yalden and Largen 1992), whereas, the golden jackal is widely spread in North Africa and North-East Africa, occurring from Senegal on the west coast of Africa to Egypt in the East. In the northern region it is found in Morocco, Algeria

and Libya, while in South it expands to Nigeria, Chad and Tanzania. They have expanded their range from the Arabian Peninsula into Western Europe to Austria and Bulgaria (Genov and Wassiley 1989; Shledon 1992) and eastwards into Turkey, Syria, Iraq, Iran, Central Asia, the entire Indian subcontinent, then East and South to Sri Lanka, Myanmar, Thailand and parts of Indo-China region (Jhala and Moehlman 2008). The worldwide distribution of the golden jackal is shown in Figure 2. Golden jackal, a typical representative of the genus *Canis* (Clutton-Brock 1976), is generally 70 to 105centimeters (28-42inches) in length, with a tail length of about 25centimeters (10inches). Its standing height is approximately 38 to 50centimeters (16-20inches) at the shoulder. Average weight is 7 to 15kilograms (15-33 pounds), with males tending to be 15% heavier than the females (Ivory 1999; Moehlman and Hofer 1997). Basic coat color of golden jackal is golden but varies from pale creamy yellow to a dark tawny hue on a seasonal basis. The pelage on the back is often a mixture of black, brown and white hair. Jackals inhabiting rocky, mountainous terrain may have a greyer coat shade (Sheldon 1992). The belly and under parts are a lighter pale ginger to cream. Unique lighter marking on the throat and chest make it possible to differentiate individuals in a population (Macdonald 1979a; Moehlman 1983). Melanistic and piebald forms are sometimes reported (Jerdon 1874; Muller-Using 1975). The tail is bushy with a tan to black tip. Legs are relatively long and feet slender with small pads. Scent glands are present on the face, anus and genital regions. Females have 4-8 mammae (Macdonald 1992). The skull of the golden jackal is more similar to that of the coyote (*Canis latrans*) and the grey wolf (*Canis lupas*) than that of the black-backed, side-striped and simien jackal (Clutton-Brock *et al.*, 1976). The dental formula reported for golden jackal is  $3/3-1/1-4/4-2/3 = 42$ .

**Table 1. Subspecies of Golden Jackal**

<b>Subspecies</b>	<b>Binomial Authority</b>	<b>Description</b>	<b>Range</b>
<i>Canis a. algirensis</i> (Algerian jackal)	Wagner, 1841	Sports large, fox-like ears and a lupine face, golden fur with a slight reddish tint, white stain on the throat.	Algeria, Morocco and Tunisia
<i>Canis a. anthus</i> (Senegalese jackal)	Cuvier, 1820	Known as the small Black jackal, it is darker than other subspecies.	Senegal
<i>Canis a. aureus</i> (Common jackal)	Linnaeus, 1758	Generic subspecies.	Live among central range of golden jackal
<i>Canis a. bea</i> (Serengeti jackal)	Heller, 1914	This golden jackal lives in Serengeti National Park, included to be a subspecies.	Kenya, Northern Tanzania
<i>Canis a. cruesemanni</i> (Siamese jackal)	Matschie, 1900	-	Thailand, Myanmar to east India
<i>Canis a. ecsedensis</i>	Kretzoi, 1947	-	-
<i>Canis a. indicus</i> (Indian jackal)	Hodgson, 1833	-	India, Nepal
<i>Canis a. lupaster</i> (Egyptian jackal )	Hemprich and Ehrenberg, 1833	A subspecies with long legs, ears, dirty yellow fur. Recently, genetically proven a subspecies of wolf and named <i>Canis lupus lupaster</i>	Egypt locally
<i>Canis a. moreotica</i> (European jackal)	Geoffroy Saint-Hilaire, 1835	It is among the largest of the golden jackal subspecies, in Hungary and Austria it is known as the Hungarian reed wolf.	Southern and Southern-central Europe, especially Greece
<i>Canis a. naria</i> (Sri Lankan jackal)	Wroughton, 1916	-	Southern India, Sri Lanka
<i>Canis a. riparias</i>	Hemprich and Ehrenberg, 1832	-	Coast of Ethiopia and Eritrea
<i>Canis a. soudanicus</i> (Variegated jackal)	Thomas, 1903	-	Sudan and Morocco
<i>Canis a. syriacus</i> (Syrian jackal)	Hemprich and Ehrenberg, 1833	Closely related to <i>Canis a. lupaster</i> , but is smaller and more richly colored	Israel, Western Jordan



**Figure 2. Red shaded areas showing the worldwide distribution of golden jackal ([www.iucnredlist.org](http://www.iucnredlist.org))**

The black-backed jackal (*Canis mesomelas*) is distinguished from other members of the genus *Canis* by a dark saddle extending from neck to tail in bold contrast to the rufous head, flanks and legs (Estes 1991; Stains 1974; Van de Merwe 1953). Its head resembles that of a dog with a pointed muzzle and erect, large and pointed ears (Smithers 1983). General colour is reddish brown to tan, redder on flanks and legs. The Black-backed jackal is longer and taller than the golden jackal. Its skull size is similar to other jackals with usual length of 141-147mm (Van Valkenburgh 1994) and mean adult cranial volume of 56ml (Sheppy and Bernard 1984). It was also reported that skull of the black-backed jackal from East Africa is shorter in total length and wider and less variable in 16 other measures than from Southern Africa (Valkenburgh and Wayne 1994). Other species of jackal is side-striped jackal (*Canis adustus*). It is a medium sized canid with overall grey to buff-grey in colour. Its head is grey-buffy white while the ears are dark buffy. The back is grey, darker than the underside and the flanks are marked by the indistinct white stripes running from elbow to

hip with black lower margins. The boldness of marking varies greatly between individuals; those of juveniles are less and well defined than those of adults. The legs are often tinged rufous, and the predominantly black tail nearly always bears the distinctive white tip, which Kingdon (1977) suggests may be a "badge" of the species' nocturnal status. Its skull is similar to that of black-backed jackal, but flatter, with a longer and narrower rostrum and having a distinct sagittal crest and zygomatic arches of lighter build (Atkinson and Loveridge 2004). As a result of elongation of the rostrum, the third upper premolar lies almost in line with the others and not at an angle unlike black-backed jackal (Skinner and Smithers 1990). This jackal is reported to have three to seven subspecies from the continent (Allen 1939; Kingdon 1997). Fourth and very rare, the simien jackal or Ethiopian wolf (*Canis simiensis*) is the largest member of the genus in Africa and is distinguishable from other jackals by its larger size, relatively long legs, distinctive reddish coat and white under parts, throat, chest and tail marking (Gottelli and Sillero-Zubiri 1990, 1992). It has elongated skull with a slender

elongated nose (Gray 1868). The facial length is 58% of the total skull length. The skull is very flat in profile, with only a shallow angle between frontals and nasals. The teeth, especially the premolar, are small and widely spread. The sharply pointed canines are average 19mm long (14 to 22mm), and the carnassials (P4 and M1) are relatively small (Clutton-Brock *et al.*, 1976). With probably fewer than 500 individuals surviving (Gottelli and Silleo-Zubiri 1992), this distinctive carnivore is considered the rarest canid in the World and is classified by IUCN as endangered (Ginsberg and Macdonald 1990). More than half of the species' population lives in the Bale Mountains National Park. There is no fossil record of this canid yet.

The jackals in Europe are distributed in small and scattered populations, mainly along the mediterranean and Black Sea Coast of the Balkan Peninsula (Demeter and Spassov 1993; Krystufek *et al.*, 1997). The golden jackals are found in the Caucasus, Turkish Thrace, Greece, Bulgaria, Albania, along the eastern Adriatic Coast and in Romania. Serbia has recently been recolonized (Mitchell-Jones *et al.*, 1999). Over the first half of the 20<sup>th</sup> century, the population of the golden jackal declined dramatically due to habitat fragmentation and intensive hunting pressure. Population density decreased in core areas (Bulgaria, Serbia and Greece) as well as at the edges of its distribution range from where the golden jackal will be completely disappeared within the next 50 years (Krystufek *et al.*, 1997). Under intensive conservation, apart from Greece, where the species has been listed as vulnerable in the national red list (Giannatos *et al.*, 2005), the golden jackal has expanded its European distribution range, most notably in Bulgaria, where there was a 33-fold increase in the area inhabited by jackals between the 1960s and the 1980s and which now supports the largest jackal population in Europe (Genov and Wassilev 1989; Krystufek and Tvrtkovic 1990; Krystufek *et al.*, 1997; Giannatos 2004; Humer *et al.*, 2007). During this period, stable

population was established in Romania (200 individuals) and in Hungary (1000 individuals) (Demeter 1984; Humer *et al.*, 2007). The stabilization and growth of the Balkan population resulted in the expansion of the species to central and Western Europe. The presence of golden jackal was first recorded in Italy in 1984 (Lapini and Perco 1988), in Slovenia in 1985 (Krystufek and Tvrtkovic 1990), in Austria in 1987 (Bauer and Suchentrunk 1995; Spitzenberger 2001), in Slovakia in 1989 (Hell and Bleho 1995; Hell and Rajskey 2000; Rajskey *et al.*, 2005) and in Germany in 1996 (Möckel 2000). Along the Dalmatian coast, a rapid expansion of the golden jackal took place in the 20<sup>th</sup> century and after 1980, Jackals have also established permanent territories in Istria (Krystufek and Tvrtkovic 1990). From the Pelješac Peninsula (Southern Dalmatia, Croatia), the presence of jackals was mentioned in the literature for the first time in the 19<sup>th</sup> century and they are known to be present here ever since (Krystufek and Tvrtkovic 1990). In a recent survey, jackals were present throughout the Peninsula (Krofel 2008), though the number of jackals on the Peninsula was somewhat decreased after temporary higher hunting pressure (D. Denac, pers. comm.). Rarely, records of vagrants are also reported from central Europe, e.g., Slovakia (T. Pataky pers. comm.), Austria (Bauer and Suchentrunk 1995), Italy (Lapini *et al.*, 1993) and Slovenia (Krystufek *et al.*, 1997). Recently, a female jackal was shot in Upper Savinja Valley, Northern Slovenia (Krofel *et al.*, 2008). According to the available information, it is not possible to reliably ascertain whether this was a territorial animal or a vagrant. However, since there were neither reports of other jackals observed in this region nor any vocalization heard before or after the killing, it seems more reasonable to conclude that it was a vagrant. The unusual aspect of this record is the location in Northern Slovenia, which is further away from areas of permanent jackal presence in Croatia than other known records of jackals during last decade in Slovenia (Krofel



*et al.*, 2008). The Asiatic or golden jackal, *Canis aureus* in Thailand has been found in some of the country's protected forests such as Khao Nang Wildlife Research Centre (Conforti 1996; Simchareon 1998), Thung Yai and Huai Kha Khaeng Wildlife Sanctuary in western Thailand (Robinson *et al.*, 1995). Jackal has also been reported as an imported mythic symbol in literature. The Egyptian god of embalming, Anubis, was portrayed as a jackal-headed man or as a jackal wearing ribbons and holding a flagellum, a symbol of protection, in the crook of its arm. Anubis' head is always shown as a black jackal or dog with long ears and pointed muzzle, even though real jackals are typically tan or light brown. To the Egyptians, black was the color of regeneration, death and the night. The reason for Anubis' animal model being canine is based on what the ancient Egyptians themselves observed of the creature- dogs and jackals often haunted the edges of the desert, especially near the cemeteries where the dead were buried. Infact, it is thought that the Egyptians began the practice of making elaborate graves and tombs to protect the dead from desecration by jackals. Like-wise, the Greek god Hermes and the Monster Cerberus are thought to derive their origins from the golden jackal. In India, jackals feature in ancient texts like the *Jatakas* and *Panchatatra* that abound with animal stories. The jackal normally is portrayed as an intelligent or wily creature in these stories. Some tribes here believe in the existence of a horn-like growth called *Shiyal-shingi* which appears on the heads of some jackals. The possession of this growth is considered a sign of good fortune. Coffee beans that have passed through the gut of a jackal are believed to have an added flavour, and these are collected and marketed in certain parts of Southern India (Jerdon 1874, A. J. & T. Johnsingh pers. Comm.). The jackal is also mentioned frequently in the Bible, where it is portrayed as a sinister creature, most notably in Pslam 63: 9-11 where it is stated that non-believers would become food for the jackals.

### **Societal Behaviour**

The social organization of golden jackals is extremely flexible depending on the availability and distribution of food resources (Macdonald 1979a; Moehlman 1983, 1986, 1989; Moehlman and Hofer 1997). Jackals have a monogamous pair as a social unit in their society, which defends its territory from other pairs. These territories are defended by vigorously chasing intruding rivals and making landmarks around the territory with urine and faeces. The territory may be large enough to hold some young adults who stay with their parents until they establish their own territory. Thus, the primary social unit of golden jackal is the pair bond between the mated male and female, which persists throughout life. They also howl together to show that there is a bond between them. They also use different howls to locate one another. They both take care of the young, but the male does even more. Of a total of 270 recorded jackal sightings in the Bhal and Kachchh areas of Gujarat, India, 35% consisted of two individuals, 14% of three, 20% of more than three and the rest of single individual (Jhala and Giles 1991). Moehlman and Hofer 1997 gave average group size as 2.5 in Serengeti, Tanzania, while average pack size in Velavadar National Park, India was 3.0 (n=7) (Jhala and Giles 1991). Affiliative behaviours like greeting ceremonies, grooming, and group vocalizations are common in jackal social interactions (Van Lawick and Van Lawick-Goodall, 1971; Golani and Keller 1975). Vocalization consists of a complex howl repertoire beginning with 2-3 simple, low-pitch howls and culminating in a high-pitched staccato of calls. Jackals are easily induced to howl and a single howl evokes responses from several jackals in the vicinity. Golden jackals often emit a warning call that is very different from that of their normal howling repertoire in the presence of large carnivores like tigers, hyaenas and wolves (Jerdon 1874). In India, howling is more frequent between December and April, a time when pair bonds are being established and breeding occurs, perhaps

suggesting a role in territory delineation and defense (Jaeger *et al.*, 1996).

Reproductive activity commences from February to March in India and Turkmenistan, and from October to March in Israel (Golani and Killer 1975; Ginsberg and Macdonald 1990). In Tanzania, mating typically occurs from October to December with pups being born from December to March (Moehlman 1983, 1986, 1989). The Golden jackal of the Serengeti court at the end of the dry season and produce pups during the rainy season. As with other canids, mating results in a copulatory tie that lasts for several minutes (Golani and Mendelsohn 1971; Golani and Keller 1975). Timing of births coincides with abundance of food supply; for example, the beginning of the monsoon season in northern and central India, and the calving of Thomson's gazelle in the Serengeti (Moehlman 1983; Ginsberg and Macdonald 1990). Females are typically monoestrus, but there is evidence in Tanzania of multiple litters. The gestation period (pregnancy) lasts for about nine weeks (63 days) (Sheldon 1992). Moehlman and Hofer (1997) gave mean litter size as 5.7 (range=1-8) in Tanzania, while in Bhal areas in India, average litter size was 3.6 (range=2-5; n=11) (Jhala unpubl.) Just before giving birth, the female digs a nursery den. There may be upto nine pups in a litter, but two to four is the usual number. Weight of a pup is about 200gm at birth. The newly-born pups are covered in soft fur but are blind and helpless for the first few days. Their eyes open after about ten days. For the first three weeks they feed on nothing but their mother's milk and she never leaves them alone. For another five weeks the pups continue to suckle, but also eat regurgitated food the parents swallow prey they have caught. At the age of three months, the den is no longer used and pups begin to follow the parents as they begin to learn the territory and hunting. At six months they are prepared to hunt alone. Even though pups have begun to gain independents, the parents still care for

and play with them. Pups attain maturity at eleven months.

Both male and female members of a pair have important roles in maintaining their territory and in raising the young when one parent dies, it is unlikely that the rest of the family will survive. However, in most jackal families, there are one or two adult members called "helpers". Helpers are jackals who stay with the parents for a year after reaching sexual maturity, without breeding, to help take care of the next litter. These helper associations are probably responsible for reports of large joint hunting. Within the family, helpers are subordinate to parents. Helpers strengthen the family in several ways. The presence of a single adult at the den provides considerable protection: adults both "rumble growl" and "predators bark" to warn the pups to take refuge, and a single adult can successfully drive off large predators. Helpers also bring food to a lactating mother and improve the provisioning of the pups directly by allowing the parents to spend more time foraging alone or hunting as a pair. Families with helpers may be able to defend and exploit a carcass more successfully than an individual would be able to. The female jackal initiates all den changes. Though the males are predominantly monogamous, females reserve their aggression for female intruders, preventing the sharing of the male and his parental investments. However, this "monogamy" might be behavioral but not sexual. In a fascinating study on a related canid species, the Ethiopian wolf, *Canis simiensis*, Claudio-Sillero-Zubiri and others found that while the male and female wolves would stay together and continue to care for the young (with their probably closed related pack member), 70% of the copulation were not between the bonded male and female pairs but with wolves from different packs, which might be preventing inbreeding of this particularly isolated species. Paternal care has never been reported as absent in any canid species. Male parental care, usually in the context of biparental investment in monogamous pairs, is



probably universal in canids. Kleiman and Malcolm (1981) reviewed literature up to 1979 and found reports of male care in 17 of 35 species. Paternal care has subsequently been reported in two more fox species, *Vulpes bengalensis* (Johnsingh 1978) *Vulpes macrotis*, now recognized as distinct from *Vulpes velox* in which male care was reported by Seton (1909). However, quantitative data on parental care in wolf, *Canis lupus* (Harrington and Mech 1982; Fentress and Ryon 1982), golden jackal, *Canis aureus* (Moehlman 1983), black-backed jackal, *Canis mesomelas* (Moehlman 1983), red fox, *Vulpes vulpes* (Macdonald 1979a), arctic fox, *Alopex lagopus* (Garrott and Eberhardt 1982), maned wolf, *Chrysocyon brachyurus* (Rasmussen and Tilson 1984) and African wild dog, *Lycon pictus* (Malcolm and Marten 1982) have been reported. In only cases of black-backed jackal, *Canis mesomelas* and bat-eared fox, *Otocyon megalotis* (Malcolm, personal observation, Nel 1978), males have been recorded spending more time at the den than females. In arctic foxes, there was no difference in the food brought to the four dens by males and females. However, in both golden and black-backed jackals, females were recorded regurgitating more frequently than males (Moehlman 1983). Moehlman (1986, 1989) synthesized data on canid behavioural ecology and hypothesized that adult sex ratio, dispersal, mating and neonate rearing systems are size related. In small canids (< 6 kg), the adult sex ratio in social groups is biased toward females, young males tend to emigrate, and females stay in their natal ranges as helpers until a breeding opportunity arises. Medium sized canids (6-13 kg) have an equal adult sex ratio and an equal emigration rate, and both sexes may be helpers. Large sized canids (> 13 kg), excluding the maned wolf, *Chrysocyon brachyurus*, exhibit an adult sex ratio skewed toward males, female emigration and male helpers.

### Dietary Habits

The diet of golden jackal is catholic, as they are opportunistic foragers. The diet consists of

54% animal food and 46% plant food (Ivory 1999). Like most predator, they use to scavenge rather than hunt since hunting is both energetically expensive and at times even dangerous. Hunting is usually carried out at night and normally they do not attack large animals but prefer small to medium sized prey such as rabbits, rodents, birds, insects, fish and monkeys (Jhala and Moehlman 2008, Kruuk 1972; Lamprecht 1978; Macdonald 1979b; Poche *et al.*, 1987; Demeter and Spassov 1993; Yom-Tov *et al.*, 1995; Lanszki and Heltai 2002; Lanszki *et al.*, 2006). Golden jackals have excellent sense of hearing which they put to good use in locating their prey hiding in grassland. It has been observed to hunt ungulates 4-5 times its body weight, though it more commonly targets young specimens. In the Serengeti, the golden jackal is a major predator of gazelle fawns (Ivory 1999), while in India, the golden jackal often kills black buck calves (Jhala and Moehlman 2008). Although it is common for Jackals to hunt alone, they do occasionally do so in small groups, usually consisting of 2-5 individuals. Working in pack greatly increases the chances of making a successful kill (Jhala and Moehlman 2008). The golden jackal is often seen scavenging. They are ever alert to scavenging opportunities provided by kills of larger predators such as leopard (*Panthera pardus*), lion (*Panthera leo persica*) and tiger (*Panthera tigris*). When they spot a large predator making a kill, the jackals rush in to eat any remaining meat. Groups of 5-18 jackals have been seen frequently large ungulating carcasses. If other scavengers such as hyaenas and vultures have also arrived, the jackals bury as much meat as they can. Jackals also reach for turtle nests along coastal beaches and feed on the eggs. Usually larger mammals such as water buffalo (*Bulbalus bulbalis*), sambar (*Cervus unicolor*), spotted deer (*Axis axis*), wild boar (*Sus scrofa*) are inaccessible to the jackals by their sheer size. But whenever these animals die or are killed, jackals are assured of a rich and plentiful

supply of food. So, why bother to go to all that trouble and run unnecessary risks, when nature offers such a windfall in the shape of a dead animal. Bad meat is not poisonous since harmless bacteria bring out decomposition. Nevertheless, jackals are much less dependent on carrion than is commonly supposed. Like dogs, they bury surplus food but return to it within a day to retrieve it using their sense of sight and smell. When animal food is not available, they use to feed on fruits and berries, as during the breeding season in India, the jackal feeds predominantly on fruits (Jhala and Moehlman 2008).

However, living in some parts of India and Bangladesh, the jackals can even subsist on garbage (Jhala and Moehlman 2008). They can also exploit man-introduced food sources such as small live stock and so could cause noticeable damage to poultry farms. There are literatures available for live-stock predation by golden jackal. In Israel, the farmers claim to lose an average of 1.5-1.9% of the calves born each year to golden jackal (*Canis aureus*) predation. The economic value of the total cattle losses in 1993 was estimated to be about US\$ 42,000 (Yom-Tov *et al.*, 1995). This high predation rate is actually caused by the farmers themselves, through the illegal dumping of domestic animal carcasses, a primary source of food for jackals, whose population has in turn thrived and augmented. As a matter of fact, in the decade 1978-1988, the number of jackals increased from a density of 0.2/km<sup>2</sup> to 2.5/km<sup>2</sup> and the current amount of meat dumped by farms is calculated to be enough to support a population density of 3.8/km<sup>2</sup> predators. However, the jackals were also considered a serious problem in Bulgaria, where 1053 attacks on small stock, mainly sheep and lambs were recorded between 1982 and 1987. Along with this, some damage to newborn deer in game farms was also reported (Giannatos *et al.*, 2005). This high predation rate is thought to be the consequence of a jackal population explosion due to the high availability of human produced food and/or

habitat manipulation (Yom-Tom *et al.*, 1995). This means that the conflict is expected to escalate if illegal waste dumping is not prohibited and the predator population is not controlled (Yom-Tov *et al.*, 1995) and also the preventive measures to avoid predation are lacking in both the cases. Genov and Vassilev 1991, reported that in Bulgaria most of the attacks on live-stock happened in the flocks of sheep that grazed unattended at night in pastures, while in Israel, the cattle grazed unattended all the year round in paddocks and gave birth in the field, so the opportunistic jackals would learn to exploit newborn calves, taking advantage of their high numbers (Yom-Tov *et al.*, 1995). However, even without preventing measures, the highest damage by jackals from Bulgaria is minimal when compared to the domestic losses by wolves (Giannatos *et al.*, 2005).

The feeding ecology of the golden jackal (*Canis aureus* Linnaeus. 1758) and its interspecific trophic relationship with the sympatric red fox (*Vulpes vulpes* Linnaeus. 1758) was investigated in an area of recent range expansion of the golden jackal in Hungary, Central Europe (Lanszki *et al.*, 2006). Diet composition was determined by scat analysis over 4 years. Compared with jackals, foxes consumed more small mammals (mean biomass consumed: jackal 77%, fox 68%) and to a lesser extent plant matter (6% and 18% respectively). Based on prey remains found in scats, small mammal specialization over a 2-year period and seasonal predation upon wild boar piglets (mainly by jackal), seasonal fruit eating (mainly by the fox), and scavenging on wild or domestic ungulates (both predators) were found. The trophic breadth of both species was very narrow and the fox proved to be more of a generalist. The food overlap index between the two canids was high (mean, 70%) and varied with the decreasing availability and consumption of small mammals. Alongwith the golden jackal, the red fox, *Vulpes vulpes* is a commonly occurring predator in Israel. Although the jackal is larger than a fox, their

dietary habits are identical and are therefore in direct competition with one another. Foxes generally ignore jackal scent or tracks in their territories, though they will avoid close physical proximity with jackals themselves. Studies have shown that in areas where jackals became very abundant, the population size of foxes decreased significantly, apparently because of competitive exclusion (Scheinin *et al.*, 2006). Borkowski *et al.*, 2011 studied the diet composition of golden jackal in central Israel. The result showed that the main food category was ungulates (39.4% frequency of occurrence), 80% of which were domestic animals-which were assumed mostly consumed as carrion. Other common food types included fruits (31.3%), birds (30%), small mammals (23.5%) and invertebrates (21.2%), while garbage was found in only 9.1% of the scats.

In India, golden jackals have been known to appropriate the dens of Bengal foxes (Jhala and Moehlman 2008). Conversely, jackals are shown to vacate areas inhabited by the larger grey wolf. Wolves are often actively intolerant of jackals in their established territories and have been known to approach jackal - calling stations at a quick trotting pace, presumably to chase off the competitors (Giannatos *et al.*, 2005). However, there are occasions when jackals scavenged on wolf kills without evoking any aggressive responses from the larger canids (Jhala and Moehlman 2008). The golden jackal remains have been found in spotted hyaena scat, though hyaenas have shown to have a distance to golden jackal flesh, consuming them only starving (Kruuk 1972). Even though the golden jackal (*Canis aureus*) is the most common wild canid in India, little information is available on its ecology (Jhala and Moehlman 2008). Aiyadurai and Jhala (2006) conducted a study on home range, habitat use, food habits and ranging patterns of golden jackals in Velavadar National Park and the surrounding Bhal region of Gujarat, India. The mean home range of jackals in Velavadar National Park was 29.77

sq km. The home ranges were much larger than those reported for jackals in Bangladesh 0.6-1.1 sq km by Poche *et al.*, (1987) and 0.5 sq km by Jaegar *et al.*, (2001) and in Ngorongoro crater 5.1 sq km by Poche *et al.*, (1987), but similar to those reported in Serengeti 10.34-23 sq km by Van Lawick-Goodall and H. Lawick-Goodall (1971). The average home range overlap in the Bhal jackal was 14-16%, whereas the core areas of each jackal were almost exclusive. Feeding ranges of several jackals in the Bhal overlapped as also reported by Van Lawick and Van Lawick-Goodall (1971). Jackals were observed to range over large distances in search of food and suitable habitat. Jackals were reported to use nine different habitats, namely grassland, medium *Prosopis*, dense *Prosopis*, village outskirts, saline wasteland, haplophytic scrub, fallow fields, mud flat and others (road edges, canal etc.). There was a marked difference in the habitat selection of jackals between night and day. Village outskirts were preferred at night, while grassland and *Prosopis* thickets were selected during the daylight hours. Scat analysis showed that blackbuck (33%) and cattle (32%) form the major food items followed by vegetation matter (24%) and hare (12%). Blackbuck and cattle remains combined, comprised more than 60% of the prey remains in jackal scats. Later on, Patil and Jhala 2008 studied movement patterns and habitat use by golden jackal in Bhal region of Gujarat. In an average, the jackal was found to travel about 8.6 km every night (with an average rate of 0.74 km per hour) and 9.55 km per 24 hours. Aiyadurai (2006) has also reported night forays of the jackals in Bhal to be around 6.2 km per hour with an average rate of 0.7 km per hour. The jackal was observed to travel in excess of 20 km during one night. They also made observation on the activity and habitat use by jackal. They found resting as the major activity during the daytime while during night it was movement. Feeding was performed for a very short duration during the night hours, when it was actually moving in search of food. They

also found that most of resting time was spent in the dense and medium *Prosopis* thickets while most of the moving time in open field and sparse *Prosopis* patches.

Majumder *et al.*, 2011 studied food habits and temporal activity patterns of the golden jackal and jungle cat (*Felis chaus*) in Pench tiger reserve, Madhya Pradesh, India. They found that rodents contributed the maximum in the diet of the two predators (40% in golden jackal and 63.6% in jungle Cat). The estimated dietary overlap between jackal and jungle cat was 0.9 (90%). With regard to temporal activity pattern, jackal showed variation in activity pattern as they were found more active in the

early morning and at night while jungle cat was found active mostly in the night hours. The same study was carried out by Chourasia *et al.*, 2012, who observed food habits of golden jackal and striped hyaena (*Hyaena hyaena*) in Sariska tiger reserve in Rajasthan. They found vegetative matter contributed maximum (17.57%) in jackal's diet followed by rodents (15.77%), chital (10.81%), sambar (5.41%) and nilgai (4.05%), while nilgai and domestic cattle contributed maximum (24.76% each) in the diet of striped hyena, followed by Sambar (17.14%), chital (16.19%) and vegetative matter (10.48%). The estimated dietary overlap between jackal and striped hyaena was 67%.

**Table 2. Diet Composition of Jackals (*Canis aureus*) from various Locations in Europe, Asia and Africa**

Country	n	Food Items in Golden Jackal's Diet								Source
		Small mammals	Medium mammals	Birds	Other vertebrates	Carcasses	Invertebrates	Plants	Garbage	
Tajikistan, South-western	235	31	1	20	9	10	14	32	-	Geptner and Naumov, 1967
Azerbaijan, Kurdamirskoj region	17	29	47	65	-	-	6	-	-	Geptner and Naumov 1967
Georgia, Abkaza	134	32	58	57	5	10	1	-	-	Geptner and Naumov 1967
Uzbekistan, Ternez region	553	25	16	3	3	2	28	23	-	Volozhenikov 1972
Uzbekistan, Syrdaria basin	498	23	7	11	4	10	16	24	5	Taryannikov 1974
Tanzania, Serengeti National Park	37	22	35	3	-	5	100	51	3	Lamprecht 1978
Uzbekistan, Aydark	279	75	5	33	45	1	7	7	-	Ishunin 1980
Pakistan, Punjab	110	82	2	16	3	-	-	-	-	Khan and Beg 1986
India, Keoladeo National Park	102	27	-	24	5	5	4	37	-	Sankar 1988
India, Sariska Tiger Reserve	140	75	-	40	16	11	17	43	4	Mukherjee <i>et al.</i> , 2004
Hungary, South-	814	68	1	3	1	5	11	12	-	Lanszki <i>et al.</i> , 2006

western										
Bangladesh, Ishurdi and Mirzapur	657	59	-	31	2	10	10	15	-	Jaeger <i>et al.</i> , 2007
Greece, Nestos River delta	95	3	3	19	5	3	33	34	-	Lanszki <i>et al.</i> , 2009
Israel, Britannia Park	396	23	9	30	18	39	21	50	9	Borkowski <i>et al.</i> , 2011
India, Pench Tiger Reserve	50	51	5	4	7	34	-	-	-	Majumder <i>et al.</i> , 2011
India, Sariska Tiger Reserve	104	20	-	7	2	37	7	27	-	Chourasia <i>et al.</i> , 2012
Bulgaria	95	44	15	36	13	24	13	60	-	Stoyanov 2012
Bulgaria	16	49	-	6	2	-	8	25	-	Markov and Lanszki 2012
Pakistan, Chitral	25	52	-	13	-	6	6	13	11	Shabbir <i>et al.</i> , 2013
Serbia, Negotin	30	16	4	7	-	56	-	7	13	Cirovic <i>et al.</i> , 2014
Serbia, Surcin	12	28	6	-	-	62	-	6	-	Cirovic <i>et al.</i> , 2014
Serbia, Smederevo	55	25	8	1	-	62	-	4	-	Cirovic <i>et al.</i> , 2014
Serbia, Svilanjac	21	27	6	6	-	58	-	3	-	Cirovic <i>et al.</i> , 2014
Serbia, Velika Plana	20	22	-	-	-	63	-	7	-	Cirovic <i>et al.</i> , 2014
Serbia, Velika Gradiste	72	21	5	4	1	64	-	3	3	Cirovic <i>et al.</i> , 2014

n= Number of scats.

**Small mammals**= Rodents, *Lepus* sps., *Hystrix* sps., *Mustela* sps.

**Medium-sized mammals**= *Felis* sps., *Canis* sps., *Vulpes* sps. etc.

**Other vertebrates**= Amphibians, reptiles and fish.

**Carcasses**= Wild and domestic ungulates.

**Plant materials**= Seeds and Fruits

## Ecology

Due to the tolerance against dry habitats and omnivorous diet, the golden jackals occur in wide variety of habitats. These ranges from the Sahel desert to the evergreen forests of Myanmar and Thailand. They occupy semi-desert, short to medium grassland and Savannahs in Africa, and forested, mangroved, agricultural, rural and semi-urban habitats in India and Bangladesh (Clutton-brock *et al.*, 1976, Poche *et al.*, 1987). A greater number

live around human settlements with abundant food resources and shelter (Prater, 1980). This adaptability permits jackals to have the ability to forego water (Kingdon, 1977) and they have been observed on Pirotan Island in the Gulf of Kutch, India where there is no fresh water. Jackals can commute between this Island and the mainland by traversing through mangroves and small Islands that are exposed during extreme low tides. Jackals have been reported at elevations of 3,800m in the Bale Mountains

of Ethiopia (Sillero-Zubiri *et al.*, 2004) and are well-established around hill stations at 2,000m in India (Prater 1980). High densities of jackals are observed in areas with abundant food and shelter. In India, jackal populations achieve high densities in pastoral areas such as Kachchh, Maharashtra, Rajasthan and Haryana. Based on known density estimates for parts of India and considering that about 19% (*i.e.*, about 637,000km<sup>2</sup>) of the geographical area of India as forest cover, jackal populations (and that jackals are also found outside forested habitats) has a minimum population estimate of over 80,000. It seems not unreasonable for the Indian subcontinent (Jhala and Moehlman 2008). A good pattern of golden jackal distribution and density in India and other parts of the world has been obtained from the data of shooting records (Stoyanov, 2012). The density was estimated dividing population size to the respective area.

**Table 3. Golden Jackal's (*Canis aureus*)  
Densities estimated in Different Parts of the World**

Country	Density Estimate, Jackals/10 Km
Tanzania	40
Greece	30
Israel	25
India	20
Bulgaria	15
Hungary	13.6
Azerbaijan	7.3
Romania	0.8

It may be pointed out here that the highest density of the species in the country is actually the mean density for particular selected areas with aggregations of jackals in that country. These data are very scarce. Responses of golden jackals (*Canis aureus*) to broadcasted howling were investigated in rural Bangladesh. In the study carried out in 1996, two hypotheses were tested, that the howl response shows the same annual trends reported for other *Canis*, being high during the season of pairing-mating when territories are being established, and low during the denning season when there is a risk to vulnerable

young from advertising the location of their den to rival conspecifics, that the frequency of approach responses (confrontation) varies inversely with howl responses and is higher during denning when howling is low. Thus, the results support both hypotheses and are consistent with the primary function of howling being as a passive means of territory maintenance whereby dominant animals advertise their locations to facilitate mutual avoidance between groups and thereby reduce accidental confrontation. The jackals in Africa have been studied intensively as compared to the Asia (Kruuk 1972). Data on species' presence in Ethiopia, Somalia and Eritrea are found by Yalden *et al.*, (1980, 1992). Status and distribution of the species are discussed in Ginsberg and Macdonald (1990). They also gave information on the species' ecology. Some data on the species' distribution and ecology in Morocco are analyzed by Aulagnier and Thévenot (1986), Kerrouani *et al.*, (1996) and Ribi (1992). The main reference for the ecology of golden jackal in Africa are Lamprecht (1978) and Moehlman (1978, 1979, 1983). Both the authors studied coexisting jackals in the Serengeti, the former focused on diet and foraging behaviour while the later on their social behaviour. Moehlman (1983) made some very interesting observations on various aspects of social behaviour, such as social dominance, subordination relationships, communal howling, courtship and hunting. Ferguson (1978, 1981), Row-Row (1982), Loveridge and Macdonald (2001) have studied the socioecology, home range and movement patterns of black-backed jackal, *Canis mesomelas* in South Africa. Krukk (1972) observed social relationships between spotted hyaenas with that of the Golden and black-backed jackals. The only study on the golden jackal's ecology in Central Africa is one by McShane and Grettenberger (1984) that investigated its feeding habits. Variation in habits, diet and behaviour are also found in different environmental conditions as shown by Macdonald (1983) in Israel. The evidences for

scale-free patterns in the foraging trajectories of side-striped jackals, *Canis adustus*, widely distributed African canid were presented by Atkinson *et al.*, (2004). They used radio-tracking techniques for their study. Loveridge and Macdonald (2003) investigated the niche separation along habitat use, activity and dietary axes between two sympatric jackal species *Canis adustus* and *Canis mesomelas* in north-west Zimbabwe. It was found that dietary overlap was high, especially in the dry season, but activity periods differed between the species, with *C. adustus* being more nocturnal than *C. mesomelas* and the two jackal species used different habitats.

### Jackal-Human Conflict and Threats: Indian Scenario

Though the golden jackal is not big enough to make humans as prey, there are still incidences of jackals attack and aggression towards humans. Scientific literature as well as news paper clips appeared where jackals are reported attacking humans, even there are incidences of death of persons attacked by jackal. Generally it is seen that in the places where jackals live in large spaces as Savannah forests or remote deserts areas, these conflicts happened hardly ever, but in areas densely populated by people as also jackals and other mammals, attack on humans are more common than in earlier. Experts reported that the main reason behind human-jackal conflict is the industrialization and urbanization of forest cover area resulting in habitat shrinkage and to cope with this situation jackals are moving towards to human habitat (Jhala and Moehlman 2008). The other reason for this conflict may be human itself. The illegal dumping of garbage and sometimes carcasses of turkeys, hens and cattle near their agricultural farms provide a rich food for the potential predators like jackals, resulting mainly in cattle predation and conflict with humans also (Yom-Tov *et al.*, 1995). In India, such incidences are also reported. Recently, in September 2009, a jackal has spread panic in Sitadih village under Angada block in Bihar.

Four villagers were injured following attacks by the jackal (<http://timesofindia.indiatimes.com/four-hurt-in-jackal-attack/>). The forest officials have also mentioned a jackal attack on 20 residents of Lali village under Namkom block in Bihar in July 2009. A jackal was also reported killing an old man and injured 24 people in Buxan village in Azamgarh District, Uttar Pradesh in November 2009. The similar case also came in light in Bihar's Gopalganj District, where nearly 100 people have been bitten and injured by jackal in June 2007. The veterinarian pathologists suggested that an animal (in this case jackal) launching seemingly pointless attack on humans is surely a rabid. It is claimed to injure human being in the mad phase of disease and after this phase it will die soon. The golden jackal is a widespread and fairly common species, found at high densities in suitable areas and able to thrive even close to human settlement (IUCN 2009; Macdonald 2006; Sillero-Zubiri *et al.*, 2004). Over its entire range except in protected areas like National Parks and Sanctuaries, the jackal population is continuously declining. The main threat to the species comes from the reduction in forest covered area and food non-availability (IUCN 2009; Sillero-Zubiri *et al.*, 2004). The traditional land use practices like livestock rearing and dry farming that were earlier conducive to the survival of jackals and other wildlife are now being steadily replaced by industrialization and intensive agriculture; wilderness areas and rural landscapes are being rapidly urbanized resulting in less food availability and reduced habitats. Jackal populations adapt to some extent to this change and may persist for a while, but eventually disappear from such areas (Giannatos 2004). Persecution and hunting are important factors for their declination. In India, pastoralists occasionally use poison to kill predators like wolves and leopards that predate on livestock and jackals are killed by scavenging such poisoned kills. Sometimes illegal poisoning of jackals are also reported where they predate on livestock and



damage crops (Yom-Tov *et al.*, 1995), but the species is not generally as damaging as the red fox (*Vulpes vulpes*) or grey wolf (*Canis lupus*) (Giannatos 2004) and may even benefit humans by scavenging waste and controlling pest species such as rodents and rabbits (Nowak 1991).

Some tribal communities like the *Kolis vaghris* in Gujarat and Rajasthan and *nari kuravas* in Tamil Nadu to kill and eat jackals. Beside this, there is a threat from organized poaching for skin, fur and tail which are sometimes marketed. Predation by other carnivores also poses a threat to golden jackal. In Kutch, jackals are predated by striped hyaenas (*Hyaena hyaena*). Spotted hyaenas also have been observed to kill and feed on golden jackals (Kruuk 1972; Kingdon 1977). Singh (1983) reported that pythons (*Python morulus*) were a major predator of jackals in Corbett National Park, India. Jackals are often chased and sometimes killed by feral dogs when they approach human habitation. Other than this, besides dogs, jackals are supposed to be the most common road kills on rural roads in India (Sillero-Zubiri *et al.*, 2004) and the incidence of road kills increases during the breeding season from February to March (Jhala and Sharma, 1997). Now-a-days, a greater threat is coming from infectious diseases which have attracted increased attention in recent years and can be an important as well as intractable extinction risk for many species (Funk *et al.*, 2001). A number of reviews have highlighted how disease issues are particularly relevant to canids. Canids are the source of human disease such as rabies, Leishmaniasis or hydrated cysts (*Echinococcus granulosus*). Moreover, threatened canids have suffered high disease-related mortality (Young 1994; Funk *et al.*, 2001; Cleaveland *et al.*, 2002, 2003; Woodroffe *et al.*, 2004). Since jackals live in close proximity to human habitation, they have been reported to be susceptible to a large spectrum of canine pathogens commonly found in domestic dogs (*Canis familiaris*), including rabies (Foggin 1988), *Babesia canis* (Van

Heerden 1980), *Ehrlichia canis* (Van Heerden 1979), *Leishmania donovani* and *Toxoplasma gondii* (Van der Merve 1953), *Ancylostoma canium* and *Echinococcus granulosus*. Jackals in India are often infected with diseases like rabies, distemper and rabid jackals frequently attack domestic livestock, dogs and humans (Jhala pers. Comm.). Skin diseases like mange and parasites like ticks and fleas are common in jackals in areas where they occur at high densities. In Tanzania, golden jackals had positive serological test resulted to canine parvovirus, canine herpesvirus, canine coronavirus and canine adenovirus (W.B. Karesh pers. Comm.), while in a serological survey conducted in Kenya (Alexander *et al.*, 1994), all the three species of jackals (golden, side-striped and black-backed jackals) had antibodies for canine parvovirus, canine distemper, rabies and ehrlichiosis. Golden jackals are also reported to be infected (80%) with seven species of helminth parasites in Bangladesh (Shaikh *et al.*, 1982). Based on these surveys, it is concluded that as jackals are most abundant wild carnivores, then also being more susceptible to canine pathogens, they could serve as an important indicator of species to monitor the exposure of rare and endangered canids to specific canine diseases.

### Legal Protection Status

Currently, jackals are slated to be Scheduled III species in India and are placed under Appendix II of CITES. In India they are declared as “species with least concern” and could be considered as “species requiring no immediate protection”. However, no hunting of any wild animal is permitted under the current legal system in India, jackals are afforded the least legal protection mainly to control trade of skin, fur and tail with caution and knowledge that populations throughout its range are likely declining.

### CONCLUSION

Based on the present study it may be concluded that the after their decline in the beginning of twentieth century, the entire jackal

population is now confined to a few clusters grouped into 7 sub-areas with criteria such as connectivity and isolation. 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. Studies on the ecological and genetic profiles of the golden jackal, *Canis aureus* in Asia are still in their infancy compared with the detailed work and conservation efforts carried out in Europe and Africa. Therefore, relevant ecological as well as genetic aspects are needed to make an effective conservation strategy for golden jackals. The information on ecological factors affecting the demographic status of the species viz., habitat fragmentation, and poaching, hunting and increased probability of disease should be priorities to broaden the existing knowledge base. Further, the existence of knowledge gaps in the systematics and population genetics of golden jackal needs a series of molecular work to get a better insight of genetic parameters viz., genetic diversity, inbreeding and gene flow to help make conservation plans accordingly. It is expected that this review will generate a baseline data for future monitoring of golden jackal, *Canis aureus* not only in Asia but worldwide.

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