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Diet composition of golden jackals in Israel

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The diet of the golden jackal (*Canis aureus*) was studied in 2002 and 2003 in Park Britannia (ca. 4000 ha) in central Israel. The aim of the study was to understand the kinds of anthropogenic food that allow jackals to be present at a high density. The scats (396 in total) were classified by season: summer (June–September) or autumn (October–November) as well as by origin from either the southern or northern part of the study area, which experience different levels of human pressure. The main food category was ungulates (39.4% frequency of occurrence), 80% of which were domestic animals — which we assume were mostly consumed as carrion. Other common food types included fruit (31.3%), birds (30%), small mammals (23.5%) and invertebrates (21.2%), while garbage was found in only 9.1% of the scats. Biomass of the jackal diet was dominated by ungulates (67.3%), with domestic ungulates consumed mostly as carrion, comprising 84% of the total. Jackal diet did not differ by season or level of human pressure. However, there was remarkable micro-scale variability in food composition as the summer jackal diet differed significantly among the dens. Our results suggest that the high availability of domestic animal carcasses due to the local carrion disposal system may be responsible for the present jackal density in Israel.

Introduction

In human-disturbed habitats, the most vulnerable species are the largest and most specialised species, often top predators (Crooks & Soule 1999, Cardillo 2003, Swihart *et al*. 2003). In their absence, generalist mesopredator species can become overabundant as a result of a lack of competition and predation pressure by top predators, that is, through top-down processes (Soule *et al*. 1988, Palomares & Caro 1999). After mesopredator release from top predator pressure, food abundance usually limits their numbers (bottom-up processes). However, predator density may again increase when prey density increases, for example after the appearance of additional food resources (e.g., anthropogenic food: livestock or garbage; Yom-Tov & Mendelssohn 1988, Yom-Tov 2003). In particular, subsidisation with anthropogenic food augments predator density and in some cases predators achieve high abundances in urban or suburban areas (Fedriani *et al*. 2001). Sustained control of mesopredators is, therefore, often necessary to preserve native threatened species or to reduce predator–human conflicts.

An important question is how to optimise predator management (Sillero-Zubiri *et al*. 2004, Baker *et al*. 2008). Lethal means of carnivore control are often impractical or ineffective due to the high compensation response of the predator population (Sillero-Zubiri *et al*. 2004, Baker *et al*. 2008). Management practices for mesopredators should instead focus on removing the habitat disturbances that allow the mesopredator density to increase. This may include reintroduction and protection of top predators (Dickman *et al*. 2009, Johnson & VanDerWal 2009) and/or, which seems easier, decreasing the availability of extra anthropogenic food associated with the mesopredator density increase (Baker *et al*. 2008). Knowledge of food habits as well as seasonal and spatial variations in diet composition can provide insight into processes such as population limitation by food that are required for the management of overabundant mesopredators.

The diet of predators inhabiting natural and human-disturbed habitats varies depending on the level of urbanisation (Tremblay *et al*. 1998, Fedriani *et al*. 2001). In human-altered habitats, the availability of anthropogenic food is often spatially diversified, which consequently leads to small-scale spatial variation in canid food composition (Brillhart & Kaufman 1995, Lovari *et al*. 1996, Farias & Kittlein 2008). Therefore, predator diet varies depending on both the level of urbanisation and the spatial scale of anthropogenic food abundance (Tremblay *et al*. 1998, Fedriani *et al*. 2001). This variation may determine the scale at which populations of overabundant predator species could be most effectively managed. The composition of a predator's diet often exhibits seasonal changes, as has been demonstrated for, among others, golden jackals (Volozheninov 1972, Lanszki *et al*. 2006). However, in areas where jackal diet is dominated by human-induced food available year-round, there may be little seasonal variation in dietary composition of this omnivorous species.

In Israel, top predators like the bear *Ursus arctos syriacus* and the leopard *Panthera pardus tulliana* went extinct in the beginning of the 20th century, and populations of the grey wolf *Canis lupus* have decreased dramatically as a result of fragmentation and shrinking natural habitats (Mendelssohn & Yom-Tov 1987). The last top predator species present in the study area is the striped hyena *Hyaena hyaena*. These events created expansion opportunities for generalist mesopredators, especially the golden jackal *Canis aureus*, which became very common around human settlements by the 1940s, with a density of approximately one pair per km^2 (Yom-Tov & Mendelssohn 1988). Despite a poisoning campaign in 1963/1964 during which its numbers were seriously affected (as were those of many other predators), golden jackal populations recovered and, in some cases, exceeded previous densities (Mendelssohn & Yom-Tov 1999). For instance, in the Golan Heights, jackal density increased from approximately 0.2 indiv. km^{-2} to 2.5 indiv. km^{-2} between the early 1970s and the late 1980s. The jackal's population size in this region is now considered "artificially large" (Yom-Tov *et al*. 1995). Recently jackal density in the southern Golan Heights has been estimated at 11 indiv. km^{-2} (D. Saltz unpubl. data). At present, it is the most numerous carnivore in the country. One of the more important conservation problems almost certainly caused by increased jackal density is the decreasing density of the northern subspecies of Mountain gazelle (*Gazella gazella gazella*), which is considered vulnerable in the Israeli red book and is endemic to central and northern Israel (Dolev & Perevolotsky 2005).

The golden jackal is an opportunistic forager. It preys on invertebrates, reptiles, birds and mammals (mainly small and medium-sized) and also feeds on carrion or garbage (Volozheninov 1972, Mukherjee *et al*. 2004, Lanszki *et al*. 2006). There is a common supposition that high garbage availability is responsible for the jackal population increase (Yom-Tov *et al*. 1995, Mendelssohn & Yom-Tov 1999). Data regarding small-scale spatial variation in jackal food habits are so far very limited and, to our knowledge, confined to only one study (Macdonald 1979). The main focus of that study was jackal social behaviour, so dietary composition was analysed from that perspective with rather limited representation (performed for jackals using a carnivore feeding site). Therefore, there is in fact no direct evidence that garbage is indeed consumed at significant rates

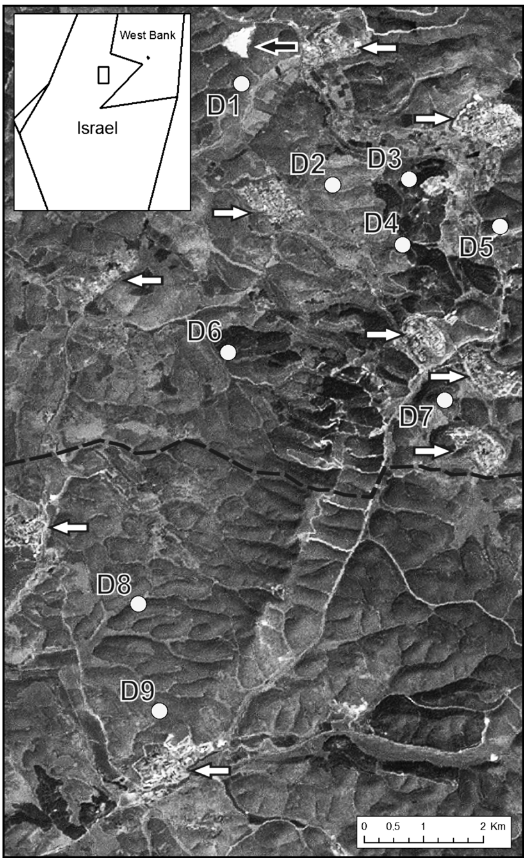

Fig. 1. Map of the study area. Grey points = jackal dens, white arrows = human settlements, black arrow = large garbage dump, dotted line = line dividing the study area into northern and southern parts.

by jackals. Second, there is no information on what sort of garbage predominates in the jackal diet, as several options are potentially available. Mendelssohn and Yom-Tov (1999) speculated that the main source may be unburied garbage in unofficial dumps, dead poultry disposed of illegally by farmers raising hens and turkeys, or the food left by tourists at picnic sites. According to Yom-Tov *et al*. (1995), the jackal population increase in the Golan Heights might be at least partly attributed to illegal dumping of carcasses of turkeys, hens and cattle.

The main aim of this study was to describe the food habits of jackal populations in order to determine whether and what sort of anthropogenic food may be responsible for the dramatic increases in jackal density within the last few decades in Israel. Specifically, we attempted to answer the following questions: (i) does jackal food composition differ between areas exposed to different human pressures, and (ii) are there small-scale and (iii) seasonal variation in jackal food habits.

Material and methods

Study area

Much of the Israeli Mediterranean zone consists of forested areas planted for human leisure purposes. These are typically mono-cultural tree stands, covering over 850 km^2 in total. Our study area was located in Britannia Park (Fig. 1; 31°40´N, 34°50´E), a Jewish National Fund (JNF) project covering an area of 40 km^2 located along the Judean foothills and its nearest vicinities. It is a typical Mediterranean forested park in a habitat that was naturally dominated by *Quercus calliprinos*. The climate is typically Mediterranean with cool, wet winters and hot, dry summers with mean annual precipitation of 500 mm. The study area was divided into two regions: the northern and the southern parts. The northern part of the park includes a mosaic of human-made forests, mostly 50-year-old pines (*Pinus halepensis*), along with carob (*Ceratonia siliqua*) and other fruit tree orchards, and small patches of natural maquis. The southern part consists mostly of natural maquis. There are also more human disturbances (settlements and tourists) in the northern region than in the southern part of the park (Fig. 1). Settlement coverage (5.8%) and human density (61 indiv. km^{-2}) in the northern part of the study area were higher than in the southern part (2.7% and 14.3 indiv. km^{-2}, respectively). Furthermore, a large garbage dump is located in the northern part of the area (Fig. 1).

We did not estimate the jackal density in the study area. However, according to Mendelssohn and Yom-Tov (1987) the density of jackals south-west of Jerusalem (where Britannia Park is located) is especially high and reaches 4 indiv. km^{-2}. But the density is probably higher. During rather incidental (unequal spatial and temporal effort) counts of carcasses of jackals killed by cars on roads around the park, made every 3–4 weeks in 2002–2005, depending on the year, 50–65 dead jackals were recorded (R. Manor unpubl. data). Thus, total jackal mortality in the area was higher, indicating high local population density. Grazing by domestic animals was common in both parts of the park. In total, there were 700–800 cattle and 350–500 sheep and goats (part of the year) grazing in the park. Sheep constituted over 90% of the total number of sheep and goats (J. Borkowski pers. obs.). Moreover, several camels were kept in the northern part of the park. Occasionally, illegal dumping of dead goats, sheep and poultry took place in the area. Other carnivorous mammals present in the area were striped hyenas (*Hyaena hyaena*), red foxes (*Vulpes vulpes*) — both being relatively rare species — and Egyptian mongoose (*Herpestes ichneumon*), which is a common species. The presence of stray dogs was recorded only sporadically.

Scat collection and analysis

The study was conducted between March 2002 and November 2003. Scats were collected when randomly walking through different areas of the park, both along and far from roads and near jackal dens. Jackal scats were distinguished from those of other predators first on the basis of their size. Although jackal density was much higher than that of other mammalian predators, in order to exclude the collection of scats of other predators, only those between 20 and 30 mm in diameter were classified as coming from jackals. Fox and the mongoose scats are smaller (less than 20 mm in diameter), while hyena scats are much larger (more than 35 mm in diameter; Chame 2003 and pers. obs.). Besides its size, scat's shape was also considered (*see* Chame 2003 for details). Moreover, dens chosen for scat collection were found by jackal radio-telemetry (H. Berger unpubl. data) or direct observation. Scats were air-dried, stored at room temperature and analysed following standard procedures (Jędrzejewska & Jędrzejewski 1998). Food habits were determined by the identification of undigested fragments of food items remaining in the scats. All food remains were separated and identified with the aid of keys (Niethammer & Krapp 1978, 1982, Pucek 1981, Harrison & Bates 1991) and the Mammal Research Institute, Polish Academy of Sciences reference collection. Hairs were washed and cleaned in alcohol for 1–3 hours, and guard hairs were identified according to cuticle scales and medulla patterns (Teerink 1991, and our material collected from the study area). Plant seeds were compared to a collection of seeds gathered in the study area. Diet composition was expressed in two ways: (1) as frequency of occurrence, and (2) as percentage of the biomass consumed. The frequency of occurrence in scats was defined as the number of scats with remains of a particular prey species compared with the total number of scats. The percentage of fresh biomass consumed was obtained by weighing all dry food remains and then multiplying by the corresponding coefficient of digestibility, such as insectivores and small rodents 23; medium-sized mammals 50 (Cape hare *Lepus capensis*, Indian crested porcupine *Hystric indica*, *Felis* sp., *Canis* sp., Egyptian mongoose *Herpestris ichneumon*); carcasses 118; birds 35; amphibians and reptiles 18; insects 5; fruit, seed and other plant material 14 (Jędrzejewska & Jędrzejewski 1998).

Statistical analysis

For analytical purposes, the study period was divided into two seasons: summer (June–September) and autumn (October–November). The effect of the level of urbanisation on the jackal diet was analysed by comparing jackal food composition in the northern and southern parts of the study area. In order to capture fine-scale summertime variability in jackal food composition, scats of both pups and adults were collected around nine jackal dens located in different areas of the park and in its nearest vicinity (seven and two in the northern and southern parts of the study area, respectively). We used a log-linear analysis (Sokal & Rohlf 1995) of the frequency of prey occurrence data. We did not use the Bonferroni correction of the alpha level because this approach has been increasingly criticised by statisticians and ecologists in recent years as being too conservative (e.g. Moran 2003). The biomass of jackal food composition in different seasons and areas was compared using a *G*-test.

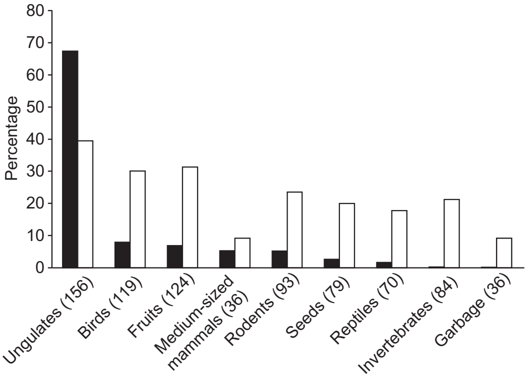

Fig. 2. General composition of the jackal diet in Park Britannia, Israel, on the basis of biomass estimation (black bars) and frequency of occurrence (white bars). Sample sizes in parentheses.

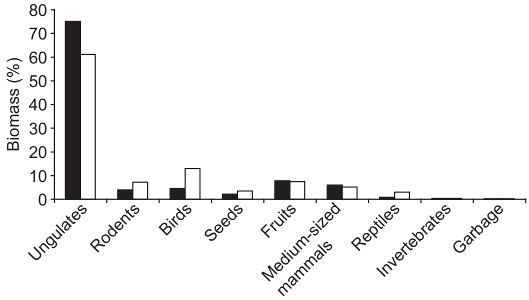

Fig. 3. Comparison of jackal food habits between northern (black bars) and southern (white bars) parts of the study.

Results

Food habits in Park Britannia

In total, 396 scats were collected (241 and 155 from the northern and southern parts, respectively; 302 and 94 in summer and in autumn, respectively). In terms of biomass, ungulates dominated the jackal diet, representing 70% of the biomass consumed with an approximate 40% frequency of occurrence (Fig. 2). Within the ungulate biomass eaten by jackals, domestic ungulates (cattle, goats, camels and sheep), supposedly mostly carrion, constituted as much as 84%. Cattle (34% of the ungulate biomass eaten) and goats (26% of the ungulate biomass eaten) were predominant among the ungulates consumed. Besides these, gazelles (14% of the ungulate biomass eaten), camels (11% of the ungulate biomass eaten) and sheep (11% of the ungulate biomass eaten) were recorded. Undetermined ungulates constituted 11% of the ungulate biomass eaten. Birds were relatively frequently consumed food items, but comprised only 8% of the biomass eaten (of which turkeys and chickens constituted 71%). Fruit, medium-sized mammals and rodents together did not exceed 8% of the biomass consumed (Fig. 2). The proportion of garbage was as low as 0.1% of the biomass consumed and was found in 9.1% of scats.

With one exception, frequencies of jackal food categories varied neither between seasons nor between parts of the study area (log-linear analysis for each food category between two seasons and two regions (Fig. 3): $\chi^2 < 2.98$, df = 1, $p > 0.05$). Furthermore, all interactions between season and region were not significant (log-linear analysis: $\chi^2 < 2.27$, df = 1, $p > 0.05$), which suggests high stability of the jackal diet composition year-round in both regions. Significant seasonal variation was observed in the occurrence of rodents in the jackal diet ($\chi^2 = 8.89$, df = 1, $p = 0.003$), with a higher proportion of rodents eaten in autumn than in summer. There were no differences in biomass of food consumed by jackals either between seasons ($G = 3.74$, df = 8, $p > 0.05$) or between parts of the study area ($G = 8.43$, df = 8, $p > 0.05$). Diet composition (in terms of frequency) differed significantly among the dens (for each food category $\chi^2 > 13.81$, df = 6, $p \leq 0.006$). One exception was medium-sized mammals, which occurred in similar proportions in the diets of jackals inhabiting various dens ($\chi^2 = 6.71$, df = 6, $p = 0.35$). Although ungulates were the dominant food item in the majority of dens, the specific composition of the remainder of the diet was different among the dens (Fig. 4). Additionally, the types of ungulates consumed differed remarkably among the dens (Fig. 5).

Discussion

A review of jackal diet studies

A total of 13 studies were used in the review of golden jackal diets (Table 1). The diets described included a broad spectrum of food types, includ-

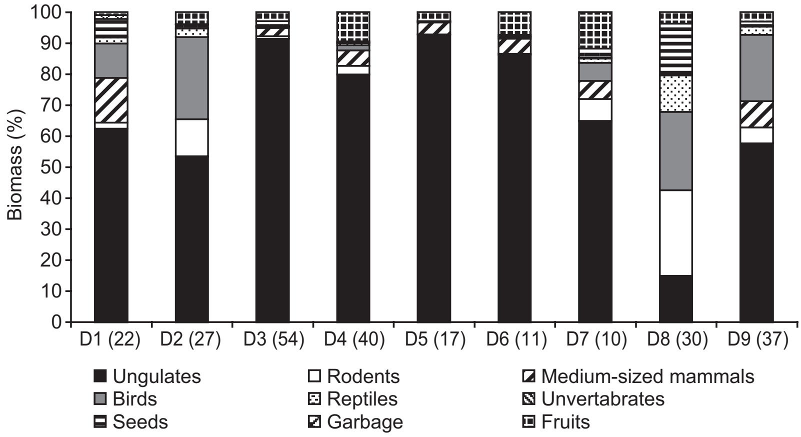

Fig. 4. Jackal food composition from scats collected around dens in different parts of the study area (in parentheses scat sample size for each den).

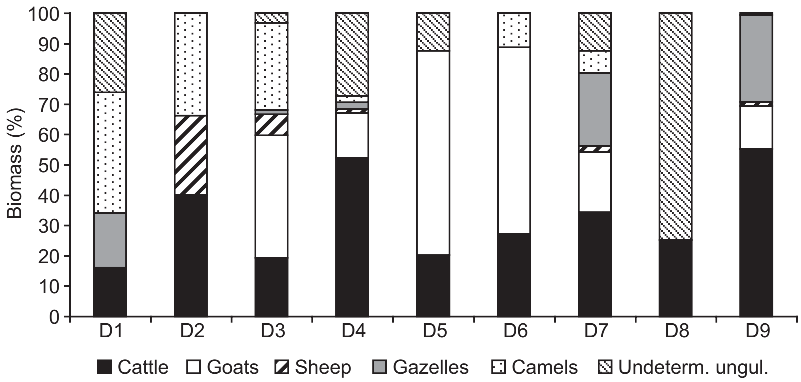

Fig. 5. Share of different ungulate species in the diet of jackals from different parts of the study area.

ing small and medium-sized mammals, birds, reptiles, amphibians, fish, invertebrates, seeds and fruit as well as garbage. Despite the fact that various methods were used to estimate the diet composition in the reviewed papers, it was possible to detect some general patterns. Small mammals were an important part of the jackal diet in 12 of the 13 studies (more than 20% of dietary composition). The most frequently eaten animals were rodents (mice *Mus* spp., gerbils *Meriones* spp., voles *Microtus* spp. and rats *Rattus* spp.). The next most important prey were birds (more than 20% of diet composition in 7 of 12 studies) and plant material (in 6 of 12 studies). Medium-sized mammals were important only in three studies, where, for example in Azerbaijan and Abkhazia, jackal hunt coypu (*Myocastor coypus*). Other than mammals, vertebrates constituted a notable share of the jackal diet in only one study where they fed on fish. Except for the present study, the share of ungulates in the jackal diet did not exceed 11%. The proportion of livestock in the diet was even lower in most cases. Only in this study were large domestic mammals (presumably mostly scavenged) the most important part of the jackal diet.

Geographical comparisons show that the golden jackal is an opportunistic predator with a generalised diet. Small mammals, birds and plant material (fruit and seeds) were the most important food items throughout the jackal's geographic range. Small rodents were often found to form a major part of the golden jackal's diet. In contrast, in this study, ungulates were the main forage of golden jackals in Park Britannia in Israel. Among the ungulate species identified, domestic species constituted as much as 84% of jackal food biomass. Among the domestic ungulates in the jackal diet, cattle and goats predominated. Wild ungulates, mostly mountain gazelles consumed probably as a result of jackal predation on young fawns, did not constitute a major

Table 1. Diet composition of jackals (*Canis aureus*) from various locations in Europe, Asia and Africa. Diet composition is expressed as frequency of occurrence of prey items (O), relative frequency of occurrence (RO) and volume of ingested prey remains (V). *n* = number of stomachs or scats. Prey groups: small mammals and medium-sized mammals: *Lepus* sp., *Hystric* sp., *Felis* sp., *Canis* sp., *Vulpes* sp., *Mustela* sp.; other vertebrates: amphibians, reptiles, fish; carcasses: carcasses of both wild and domestic ungulates (percentage of livestock in parentheses); plant: plant material (fruit and seeds). Sources: 1 = this study, 2 = Jaeger *et al.* (2007); 3 = Mukherjee *et al.* (2004); 4 = Sankar 1988; 5 = Khan & Beg (1986); 6 = Geptner & Naumov (1967); 7 = Tariannicov (1974); 8 = Ishunin (1980); 9 = Volozheninov (1972); 10 = Lanszki *et al.* (2009); 11 = Lanszki *et al.* (2006); 12 = Lamprecht (1978).

Country, locality	*n*	Food categories in jackal diet								Methods	Source
		Small mammals	Medium-sized mammals	Birds	Other vertebrates	Carcasses	Invertebrates	Plant material	Garbage		
Israel	396	23	9	30	18	39	21	50	9	O	1
Bangladesh,Ishurdi and Mirzapur	657	59	–	31	2	10	10	15	–	O	2
India, Sariska Tiger Reserve	140	75	–	40	16	11	17	–	4	O	3
India, Keoladeo National Park	102	27	–	24	5	5 (0)	4	37	–	RO	4
Pakistan, Punjab	110	82	2	16	3	0	–	–	–	O	5
Tajikistan, south-western	235	31	1	20	9	10	14	32	–	O	6
Uzbekistan, Syrdarja basin	498	23	7	11	4	10 (8)	16	24	5	V	7
Uzbekistan, Aydarsk	279	75	5	33	45	1 (1)	7	7	–	O	8
Uzbekistan, Ternez region	553	25	16	3	3	2 (0)	28	23	0	V	9
Azerbeijan, Kurdamirskoj region	17	29	47	65	0	0	6	–	–	O	6
Georgia, Abkazja	134	32	58	57	5	10 (10)	1	–	–	O	6
Greece, Nestos River Delta	95	3	3	19	5	3 (3)	33	34	–	RO	10
Hungary, south-western	814	68	1	3	1	5 (1)	11	12		RO	11
Tanzania, Serengeti National Park	37	22	35	3	–	5 (0)	100	51	3	O	12

food item (14% of ungulate biomass). Nevertheless, taking into account the high density of jackals in the area, their real impact on the vulnerable gazelle population may be higher than suggested by the share of gazelles in the jackal's diet. The observed high density of jackals in the study area may be fully or partly related to the carcasses supplied by human activity. For instance, over twenty jackals were once observed with a spotlight within 150 m of a cow carcass (H. Berger pers. comm.). A similar relationship between the jackal density and cattle carcass abundance was suggested to exist in several parts of India, where due to religious beliefs, carcass availability is high (Jhala & Moehlman 2004). Although, probably to some extent cattle calves killed by jackals were also consumed by them, domestic ungulate carcasses were major food of jackals in Park Britannia. In the Golan Heights, approximately 2% of the calves die due to predation, mainly by jackals (Yom-Tov *et al*. 1995). Since it happens mostly when the calves are very small, in terms of biomass this is not an important food category. Moreover, sheep and goat herds in the study area are guarded by shepherds who greatly reduce possibilities of jackal predation.

Contrary to common views (e.g. Yom-Tov *et al*. 1995, Mendelssohn & Yom-Tov 1999), neither garbage nor poultry from farms were important food for jackals around Park Britannia. However, garbage is often digested completely so that no remains can be found in the scats (Litvaitis 2000). Therefore, we may have underestimated the importance of garbage to the jackals of Park Britannia, but the proportion of garbage in the diet is most probably not higher than a few percent. Golden jackals around towns and villages in Bangladesh were reported to eat garbage (Poché *et al*. 1987), however, the authors provided no information on the share of the total diet constituted by this forage. In Greece, golden jackals were not observed around garbage dumps, though their absence was attributed to the numerous stray dogs using the dumps (Giannatos 2004). Our micro-scale analysis of the jackal diet also confirmed that garbage was not an important source of forage. The highest consumption of garbage was recorded in the case of jackals from den D1 (located near the garbage dump), but even here it was as low as 1.3% of total food biomass (Fig. 4).

Based on domestic animal statistics and death rates, Yom-Tov *et al*. (1995) estimated that among anthropogenic animal food categories available to jackals in the Golan Heights, turkeys comprised the majority (61%) while cattle comprised only 36%. The numbers are different to those found in this study. However, we estimated the jackal food composition on the basis of real consumption rather than potentially available food, as was the case in the study of Yom-Tov *et al*. (1995). Additionally, since that study was published in 1995, many large poultry farms (Yom-Tov *et al*. 1995) have adopted dead bird disposal systems while little has been done regarding domestic ungulates. Therefore, in the general jackal food composition calculated in this study, birds (represented mainly by poultry) were not the most important forage category, despite the fact that their share in some areas was much higher than average. For instance, in three dens, birds constituted around 20% of jackal food biomass (Fig. 4).

As already mentioned, predator's diet differs depending on the level of urbanisation (Tremblay *et al*. 1998). Contrary to this, jackal food was similar in both parts of the park despite different levels of human pressure. This result may partly be derived from the fact that jackals in the southern part of the park at least occasionally fed in human settlements; however, two other factors probably play more important roles. First, the small-scale variability in the jackal diet may mimic the differences between the areas. Second, diets of jackals in both areas were dominated by domestic ungulates and therefore did not vary significantly. Furthermore, there were no seasonal differences in the jackal diet. Domestic ungulates dominated the diet throughout the year and the only seasonal difference in the diet concerned rodents. This result strongly suggests constant carcass availability throughout the year.

In this study, the jackal diet differed remarkably at the micro-scale level among dens. The differences concerned all of the food categories consumed by jackals. This result shows that the jackal's diet is strongly dependent on food availability within their home ranges, and in fact every studied jackal family ate the same food types, but in different proportions. Therefore, our study confirms that jackals are opportunistic foragers and emphasises the high ecological plasticity of this species (*see* Table 1). This characteristic could also be seen, for instance, in the case of ungulate consumption in our study. Although this forage dominated at all but one (D8) study sites, the relative proportions of species consumed differed substantially among the dens, reflecting local availability of particular ungulates and consequently their carrion. However, it should again be noted that either cattle or goats dominated in most of the localities.

Camel remains were present in scats from six out of nine dens. Although the number of camels kept in the area was low, bad management that probably causes high mortality as well as large body size might permit camels to serve as somewhat important forage for many jackals. This observation clearly shows that farms containing "exotic" species may provide jackals with abundant forage and suggests that efforts should be made to close such farms or at least to limit their number.

Den D8 was located in an area of the park with relatively little livestock grazing and at the greatest distance from human settlement among all the studied dens in the current research. Jackals from that den ate relatively few ungulates and depended more heavily on natural forage types like rodents, plants and reptiles. In addition, no single forage type dominated their diet and most food categories were represented in comparable proportions.

These data support the hypothesis that in addition to the release of mesopredators caused by decreasing the density of a top predator (top-down), increases in food abundance (bottom-up) may also be responsible for mesopredator density changes (Elmhagen & Rushton 2007). The high jackal density in Israel is probably related to the lack of top predators (especially the grey wolf), which usually limits the number of mesopredators, similar to the cases of coyote and wolf in North America (Berger & Gese 2007). However, the excessive supply of anthropogenic food probably permits the jackal population to increase to the observed high density. A clear example of the importance of anthropogenic food for Israeli canids (specifically the red fox) was recently provided by Bino *et al*. (2010).

Although the proportion of sheep in grazing herds is significantly higher than that of goats, an inverse relationship was observed in the jackal's diet. In terms of ungulate biomass consumed by jackals, the share of sheep was only 3%, while that of goats was as high as 26%. Goat meat is rarely consumed by humans, with the exception of meat from young animals, and therefore shepherds may provide more care and attention to sheep than to goats. This example shows that it is possible, at least to some extent, to efficiently control the mortality of domestic ungulates. Therefore, stricter regulations for goat keeping should probably be introduced.

In areas where mesopredators occur in their natural habitats, human-induced changes that dramatically increase the availability of anthropogenic food (especially carrion of domestic ungulates and poultry) may present the risk of a drastic increase in predator population densities. High jackal density may negatively affect not only prey species but also cause zoonoses (Waner *et al*. 1999, Shamir *et al*. 2001). Therefore, prior to such changes, careful planning for the disposal of this sort of food is advisable. Such planning should be done with the understanding that food habits of a predator may be very flexible and may vary considerably on a small scale, as our study has confirmed. Therefore, attention should be given to all potential anthropogenic food sources available to managed predator species within a given area.

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