

Dietary Habits of the Golden Jackal (*Canis aureus* L.) in the Eastern Croatia

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Summary

In the past fifteen years, a considerable increase in size of the golden jackal (*Canis aureus*) population has been recorded in the eastern part of Croatia. Dietary habits have been determined in the period 2008-2011 by analysing the content of 238 stomachs. Golden jackal is typical omnivorous and opportunistic forager which consumes easiest accessible food, according to season and habitat, primary animal food, such as carcasses, rodents and meat waste. Parts of big game animals were found consumed in the period of main hunting season during the winter. Small animals were frequently present in the diet during the spring and summer, in the season of breeding and cub-rearing. Meat waste originated from livestock has been consumed periodically, during the pig slaughtering season at rural households. Plant material occurred occasionally in diet of the golden jackal, depending on time of crop harvest or ripening of fruits. There is no conflict between golden jackal and sectors of livestock and agriculture in the eastern Croatia.

Key words

diet, golden jackal, season, Croatia

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Aim

Data on feeding habits of adult golden jackals living in various parts of Europe are still insufficient (Macdonald 1983). Some authors considered that golden jackal is collector of meat waste and carcasses (Setzer 1961; Dorst 1970), and occasional scavenger (Rowe-Rowe 1976). Research on diet composition of the golden jackal in southwestern part of Hungary indicated that meal consisted of 54% animal and 46% plant food (Lanszki and Heltai 2002), with rodents and carcasses of even-toed ungulates (*Artiodactyla*) as very important food source during the winter and spring (Lanski et al. 2006; Lanski and Heltai 2010).

Golden jackal in northern Dalmatia (Croatia) mostly feed upon hares and quails, but sometimes can attack sheep (Kryštufek 1984). In southeast part of Bulgaria the golden jackal seriously threatened livestock; 1 053 attacks were reported in the period from 1982 to 1987, mostly upon sheep, lambs as well as game animals like red deer calves (Genov and Vassilev 1991). In the past fifteen years, a considerable increase in size of the golden jackal (*Canis aureus*) population has been recorded in the eastern part of Croatia. Since the golden jackal, as a member of the family Canidae, is a predator, negative attitude that its increased population can cause significant harm upon game animals in the hunting grounds, is still widely present. The aim of this study was to determine the feeding habits of the golden jackal in the area of eastern Croatia. Habitat diversity and the high population density of the golden jackal were the main reasons of choosing this area.

Material and methods

Research of diet composition of the golden jackal was carried out in the area of eastern Croatia, in the period 2008-2011, by collecting stomach specimens from individuals shot during the hunting or found killed in road traffic accidents. Consumed and undigested content of 238 stomach samples has been analysed. According to season, 43 specimens were collected in spring, 51 in summer, 77 in autumn and 67 in winter. Qualitative stomach content analysis was done in the laboratory by using stereo microscope (5 x magnifications). Identification keys were used for identification of mammalian hair (Teerink 1991) and bird feathers (Day 1966). For evaluation of diet habits, the coefficient of emptiness (CV) was calculated (Hureau 1970): $CV (\%) = \text{total number of empty stomach} / \text{total number of stomach analysed} \times 100$. Frequencies of occurrences for each diet component (F) was calculated (Holden and Raitt 1974): $F (\%) = \text{frequency of one diet component} / \text{total frequency of all diet components} \times 100$. Diet components and their frequencies were classified according to season and food category. The chi-square statistical test was performed on the frequencies of diet components in order to examine differences between seasons and components.

Results and discussion

Out of 238 analysed stomach samples, 33 were empty, without any food traces. These were found in individuals shot during the evening time, when animal did not take any food and pre-

viously consumed meal is already digested. Related to seasonal aspect, the golden jackal had empty stomach more often in the spring (CV = 23.3%) and summer (CV = 19.6%), when the hunting season is closed and quantity of animal waste available in the environment is low. Oppositely, the CV values were lower in the autumn (9.1%) and winter (9.0%), suggesting that food sources are more achievable to golden jackal.

In total of 205 filled stomachs, following diet components were recorded: only animal remains in 113; only plant remains in 5; mixed animal and plant remains in 87; artificial material (plastic bags and aluminium foil) with other components in 5 stomachs. Seasonal distribution of frequencies

Table 1. Seasonal distribution of number (N) of analysed stomachs of golden jackal and frequencies (F in %) for each main category of diet components

Diet component	Spring		Summer		Autumn		Winter	
	N	F (%)	N	F (%)	N	F (%)	N	F (%)
Waste of livestock	1	2.3	0	0.0	13	16.9	21	31.3
Carcasses of livestock	6	13.9	7	13.7	6	7.8	3	4.5
Waste of game animals	7	16.3	13	25.5	29	37.7	25	37.3
Carcasses of game animals	2	4.7	3	5.9	6	7.8	5	7.5
Small animals	14	32.6	23	45.1	12	15.6	0	0.0
Plant food	1	2.3	49	96.0	20	15.9	10	15.3

(%) for each diet category in analysed number (N) of filled stomachs is given in Table 1.

Results obtained shows that diet of the golden jackal in the area of eastern Croatia is not such diversified (Bošković et al. 2009; Bošković et al. 2010). For the comparison, Lanszki et al. (2006) reported that in coastal area of Greece diet of the golden jackal contains 20 plant and 37 animal species, including portion of marine invertebrates collected during the period of low-tide (Lanszki et al. 2009). Despite the availability of animal food throughout the year, percentage of animal tissue originated from livestock (F=27.9%) in diet composition of the golden jackal in eastern Croatia is relatively low. Higher values, above 50% were reported in Greece (Giannatos 2004), Israel (Macdonald 1979; Yom-Tov et al. 1995) and Bulgaria (Stenin et al. 1983).

Results of the performed chi-square statistical test $\chi^2 (15, N=276) = 110.54, p < 0.001$, are presented in Table 2. Differences between seasons and diet components have been verified.

Animal waste and remains of carcasses originated from livestock (pigs and cattle) dominated in the late autumn and winter (Table 2). This is period of traditional pig slaughtering season at rural households in eastern Croatia. Meat waste consisting of fat tissue, intestines and parts of skin is thrown away outside the settlements, despite the fact that this is improper and unsafe treatment of animal waste, which makes it easily accessible to the

Table 2. Differences between diet components and season verified by Chi quadrat test

Diet component		Spring	Summer	Autumn	Winter
Waste of livestock	Count	1.0	0.0	13.0	21.0
	Expected count	3.9	12.0	10.9	8.1
Carcasses of livestock	Count	6.0	7.0	6.0	3.0
	Expected count	2.5	7.6	6.9	5.1
Waste of game animals	Count	7.0	13.0	29.0	25.0
	Expected count	8.3	25.5	23.1	17.2
Carcasses of game animals	Count	2.0	3.0	6.0	5.0
	Expected count	1.8	5.5	5.0	3.7
Small animals	Count	14.0	23.0	12.0	0.0
	Expected count	5.5	16.9	15.3	11.4
Plant food	Count	1.0	49.0	20.0	10.0
	Expected count	9.0	27.5	24.9	18.6



Figure 1. Rodents and fruit remains in the stomach content of the golden jackal (Author: Ivica Bošković)

golden jackal. Remains of pig's muscles were not recorded in any of analysed stomachs. Cattle remains (muscle tissue, skin with hair) were recorded in five samples, probably taken from animal waste and carcasses disposed in the vicinity of the cattle farms.

Animal waste and parts of carcasses originated from big game animals: wild boar (*Sus scrofa*), roe deer (*Capreolus capreolus*) and red deer (*Cervus elaphus*) were mostly found consumed during the late autumn and winter, when the main hunting season is on-going. Skin and hairs of wild boar were recorded in 64 analysed stomachs (F=43.9%). The muscle tissue were present in 16 samples (F=7.8%), and it was usually found in individuals shot near the minefields. In such areas hunting management is not possible, so the wounded game in searching for shelter become an easy prey to the golden jackal.

The muscle tissue of roe deer was present in eight analysed stomachs, while skin, hair and viscera were present in 21 samples (F = 10.2%). Remains of red deer calf, probably caught by predation, were found in only two samples. Skin and viscera of red deer, but without muscle tissue, were found in

five stomachs (F = 2.4%) only during autumn-winter period. The results obtained correspond to researches carried out in Bulgaria (Demeter and Spassov 1993) and Hungary (Lanszki et al. 2006), which find out low consumption of red deer and roe deer in diet of the golden jackal, while the wild boar has been consumed in high portion.

Category of small animals comprises groups of wild and domestic animals, such as: rodents, rabbit, domestic cat, pheasant, poultry and insects. Golden jackal in eastern Croatia catches and consumes various small animals more frequently during the summer, as it is shown in the results of performed Chi quadrat test (Table 2). This is a period of breeding and cub-rearing when less meat waste is accessible in the hunting ground. Intensive reproduction cycle in the nature enlarges the population of small animals in natural and semi-natural habitats, giving a good food source to the golden jackal. Main characteristic of the summer season is ripening of wild and cultivated fruits, as well as crops, and stomach content is usually mixture of animal and plant food (Figure 1).

Rodents were consumed seasonally, with high frequency in spring and summer. During the tillage operations done during summer, rodents were recorded in 30 stomachs (F=14.6%).

Mouse species (*Apodemus agrarius*, *Apodemus sylvaticus*, *Mus musculus*), and the common vole (*Microtus arvalis*), were found in 25 samples, mainly in golden jackal culled on agricultural land. Black rat (*Rattus rattus*) was found in five samples, in the individuals culled near the settlements, animal carcass disposal sites or found killed in road traffic accidents. Research in Hungary (Lanszki et al. 2006), reported rodents: the European water vole (*Arvicola terrestris*), black rat (*Rattus rattus*) and dormouse (*Myoxidae*) as frequent component in diet spectrum of the golden jackal. Remains of rabbit were found in two stomachs (F=1.0%), and of domestic cat in four stomachs (F=2%). Remains of poultry were recorded in 16 stomachs (F=7.8%), and it is equally distributed in all seasons. Insects and their larvae were found in 14 stomachs (F=6.8%), represented with grasshoppers (*Orthoptera*), housefly (*Musca domestica*), cockchafer (*Melolontha melolontha*) and mole cricket (*Gryllotalpa vulgaris*). Higher percentage of insects has been reported in diet of the golden jackal living in the Mediterranean area: 29.5% on the Pelješac peninsula at Croatian Adriatic coast (Radović and Kovačić 2010), 18% in Greece (Lanszki et al. 2009), 17% in India (Mukherjee et al. 2004) and 10% in Bangladesh (Jaeger et al. 2007).

The frequency of plant remains (undigested fruits, vegetables, seeds, branches, grasses and dried leaves) in analysed stomachs amounted to 44.9%. Plant material was found mixed with animal food in 87 stomachs, while five stomachs were filled with only digested plant remains.

In the lowland landscape of eastern Croatia dominates agricultural land (in average 62% of total land surface) suitable for intensive growing of various annual crops. Golden jackal likes to consume immature seeds of maize (*Zea mays*), common oat (*Avena sativa*) and sunflower (*Helianthus annuus*). Maize seeds were found in 13 stomachs (F= 6.3%), and those of sunflower in seven stomachs (F=3.4%), during the month of

August, after the harvest. Consumption of maize seeds in diet of young golden jackals has been reported also from Greece (Lanszki et al. 2009). Fruits were found in 58 stomachs (F = 28.3%). Depending of ripening time, following wild fruits were present in diet of the golden jackal: black mulberry (*Morus nigra*), greengage (*Prunus domestica*), blackthorn (*Prunus spinosa*), hawthorn (*Crataegus* spp.) and blackberry (*Rubus fruticosus*). Golden jackal in the eastern Croatia consumed fruits more often during the drought summer period, especially juicy fruits of the black mulberry and the greengage. During the autumn and winter period, wild pear (*Pyrus piraster*) was found in 13, and wild apple (*Malus communis*) in three stomachs.

Conclusions

Golden jackal living in the eastern Croatia is typical opportunistic forager which consumes easiest accessible plant and animal food, according to season and habitat. Improper discarding of animal waste of livestock from rural households and farms, as well as of game animals in the hunting grounds, provides sufficient food sources to golden jackal and supports their dense population. Determined diet habits clearly points out that golden jackal was incorrectly treated as damaging species in the hunting grounds. Researches confirmed that golden jackal rarely predate livestock and game animals, having a beneficial role by scavenging waste and controlling pest species, like rodents. During the shortage of animal waste, golden jackal can predate on wild animals. Up to now, there is no recorded attack on livestock, indicating absence of conflict between golden jackal and sectors of livestock and agriculture in the eastern Croatia.

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