



Diet composition of the golden jackal (*Canis aureus* L.) on the Pelješac Peninsula, Dalmatia, Croatia

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Abstract

Background and Purpose: No previous field investigations have been conducted on the biology and ecology of the native population of golden jackals (*Canis aureus* L.) from Dalmatia. The object of this study was to determine the feeding habits of this poorly studied population.

Materials and Methods: The diet composition of golden jackals from Dalmatia was examined by scat analysis. From winter 1995 to spring 1997, field visits were made every season to the golden jackal habitat on the Pelješac Peninsula in Dalmatia, Croatia and scats of golden jackals were collected ($n=130$). Scats were washed out, dried and sorted. Classification of components was made under appropriate magnification.

Conclusions: Both animal and plant components were found. Scat included from one to four components. The highest frequency was found for mammals (50.3%) followed by fruit seeds and vegetables (34.1%), insects (29.5%), birds (including eggs; 24.8%), artificial materials (24%) and branches, leaves and grass (24%). In scats containing mammal remains, the highest incidence was for large mammals (unidentified large mammals of the order Artiodactyla and Lagomorpha). Small mammals were found but in a negligible frequency. The most important fruits for jackals are *Ficus carica* L. (14%), *Vitis vinifera* L. (14%) and *Juniperus oxicedrus* L. (4.6%). The most important orders of insects are Orthoptera (16%), Coleoptera (12%) and Dytioptera (3%), and for birds order Charadriiformes (6%). The negligible amount of small mammals found in scats differed from the majority of investigations carried out elsewhere.

Results: The results show the close relation of the population with human settlements and regional agricultural habits.

INTRODUCTION

The golden jackal (*Canis aureus* L.) is a mammal from the order Carnivora, suborder Fissipedia and family Canidae. It is widespread in south-west Europe, Caucasus, south-west Asia, Turkistan, Iran, Afghanistan, the Middle East, Arabian peninsula, Pakistan, India, Sri Lanka, Indochina, Africa, from Morocco, Algeria, and Libya in the north, to Sudan, Somalia, Ethiopia, Nigeria, Chad, Tanzania, Senegal and Ethiopia in the south (1).

The distribution of the golden jackal (*Canis aureus* L.) in Europe is extremely dynamic, with vagrants often reported from localities outside the species' permanent range (2). Throughout history, jackals in Europe have been restricted to the Balkans and adjacent regions. Permanent populations occur only along the Mediterranean and Black Sea

coasts. During recent decades, there has been a large expansion in the jackal's range within Croatia, Serbia, Bulgaria and Romania (2). Vagrants occasionally appear in north-eastern Italy, Slovenia, Austria, Hungary and Slovakia (2).

Golden jackals in the Dalmatian region have been known since 1491 through reports from killings (3). Their presence in Dalmatia corresponds well with the Anatolian-Balkan distribution range and could be explained by the invasion of Europe via the Bosphorus Strait at the end of the Pleistocene (3). For some time, the population remained small and consequently indigenous people believed that jackals were not members of an autochthonous fauna, but were instead introduced from Africa. Craniometrical research by Kryštufek and Tvrtković (4) proved this theory to be untrue. Although regarded as a pest and constantly persecuted, its population has constantly increased over the centuries. They established a permanent population in northern Dalmatia between 1920 and 1980, thereafter spreading further northwest.

Research on territorial expansion of golden jackals in Europe revealed a new theory (3): that its expansion could be related to a reduction of the area occupied by wolves.

Golden jackals are opportunistic and will venture into human settlements to feed on garbage (5). In some areas, they are known to subsist almost entirely on garbage and human waste (6). Volozheninov (7) reported small mammals as the main prey for jackals from southern Uzbekistan. Similarly, Reimov and Nuratdinov (8) reported small mammals and birds as the most important food for golden jackals of the Amu dar't valley (Afghanistan). Where sympatric to other large predator species, jackals usually scavenge on their prey (9) and do not prey upon large mammals (7). Jaeger *et al.* (2001) found rodents to be the most important food source for golden jackals from Bangladesh, while Poché *et al.* (10) stated that sugar cane, melon and vegetables are also very important. Khidas (11) found that jackals from Algeria preyed mostly upon macaca monkeys (*Macaca sylvanus*, L.) and domestic animals. Little is known about the feeding ecology of the jackals of Asia Minor and Caucasus. Few data from SE Europe have been reported to date. According to Kryštufek (1), jackals from Ravni Kotar (northern Dalmatia, Croatia) mostly feed upon hares (*Lepus europaeus* Pal.) and quails (*Coturnix coturnix* L.), but sometimes also attack sheep (*Ovis aries* Pal.). Small mammals from the orders Rodentia and Artiodactyla seem to have major importance in the jackal diet in Hungary (13). Preliminary reports from Greece show that rodents, insects, carrion and fruits comprise the jackal diet (14), and there are no observations (reports) that they feed at garbage dumps. In Israel and Bangladesh, golden jackals were reported as scavengers eating mostly garbage and carrion, but also as important rodent predators (10, 15). Several studies on the golden jackal show that rodents occur in more than 60% of scats (12, 16, 17).

Recent research on the golden jackal diet during winter and spring in Hungary (13) found (showed) that small mammals, mainly rodents, hold a dominant role in the diet of the golden jackal, whereas, the carcasses of ungulates, mainly wild boar (*Sus scrofa* L.) played a secondary role (55% and 24% of occurrence respectively).

Study area

Research on the diet composition of golden jackals was conducted on the Pelješac Peninsula, which is situated in the central Dalmatian region. The peninsula spreads from Cape Lovište in the northwest (43°02'47"N, 17°00'20"E) to Cape Vratnik in the southeast (42°45'30"N, 17°46'30"E) and is 71.1 km in length. Habitat diversity and the high jackal population density were the main reasons of choosing this specific area for the research.

The area belongs to the Mediterranean phytogeographical region and can be divided into two distinct climatic zones: Mediterranean-littoral and Mediterranean-mountainous zone (18). Specific xerothermic evergreen vegetation pertaining to the *Quercus ilicis*-*Pinetum halepensis* and *Junipero phoeniceae*-*Pinetum halepensis* (alliance Oleo-Ceratonion) associations is found in restricted areas, mainly in the south-western part of the peninsula. The vegetation of Pelješac consists primarily of thermophilic evergreen forests of holm oak (ass. *Fraxino orni-Quercetum ilicis* and *Ostryo-Quercetum ilicis*) and of degraded forms such as garrigue (e.g. ass. *Erico-Cistetum cretici*). Kermes oak forests (ass. *Fraxino orni-Quercetum cocciferae*) grow in only a few places (Orebić, Potomje) in restricted areas. Mediterranean forests of Dalmatian black pine (*Pinus nigra* subsp. *dalmatica*, ass. *Quercus ilicis*-*Pinetum dalmaticae* and *Erico manipuliflorae*-*Pinetum dalmaticae*) grow within the Hemi-Mediterranean vegetation zone (19).

The populations of many native plant species on the peninsula have been reduced by human activities, while others are spread and cultivated. At low altitudes, several plant species such as olive (*Olea europaea* L.), fig (*Ficus carica* L.) and various vegetables are cultivated over large areas. Farther from the sea, extensive vineyards are located, as are white and black mulberry (*Morus alba* L. et *niger* L.), almond (*Prunus amygdalus* L.), English walnut (*Juglans regia* L.), service tree (*Sorbus domestica* L.), wild cherry (*Prunus avium*), and pomegranate (*Punica granatum* L.).

Birds on the Pelješac Peninsula are numerous, especially species from the order Charadriiformes such as gulls and Passeriformes, which breed in substantial numbers in the area. The peninsula is important as a migrating route for many birds during the spring and autumn migrations (20). The amphibians on the peninsula are represented by several species (*Bufo viridis*, *Pelodytes punctatus*, *Hyla arborea*, *Triturus vulgaris*) and the fauna of reptiles comprise 17 species from genus *Lacerta*, *Podarcis*, *Emys*, *Testudo*, *Pseudopus*, *Hemidactylus*, *Natrix*, *Coluber*, *Platyceps* and *Vipera* (21). Some foreign animal

species have been introduced in recent decades such as mouflon (*Ovis musimon*, Pal.) and wild boar (*Sus scrofa* L.). Animal production (goat and fowl) is rare and of no importance.

MATERIAL AND METHODS

The diet of golden jackals was studied through scat analysis. Scats were collected from winter 1995 to spring 1997 in every season and at every habitat on the peninsula (n=130). Habitats included in scat gathering were Mediterranean forests and scrubs, agricultural areas, permanent water courses, beaches, landfills and mountains.

Scats were washed to remove detritus and were then dried and sorted. Components were classified as follows: plant remains into 1) vegetable and fruit and 2) branches, leaves, grass; animal remains into 1) mammals (hair and bones), 2) birds (including eggs), 3) insects (including Miriapoda and Chilopoda), 4) fish and 5) snails. Classification of components was made under appropriate magnification. Determination was made to the lowest taxonomic level possible. Methods of preparation and identification of mammal hairs is described in identification guides (22, 23). Seeds and bird feathers were identified using reference collection.

The frequencies of occurrence were calculated as simple proportion of the number of scats including the specific component to the total number of scats analysed.

RESULTS

Both animal and plant remains were found in the scats of golden jackals from Dalmatia as well as remains from landfills. Scats included from one to four components (Figure 1).

Plant remains were divided into: fruit seeds (including vegetables) and branches (including grass and dried leaves). Animal remains were divided into five classes as follows: insects (Insecta), birds (including eggs) (Aves), mammals (Mammalia), fish (Pisces) and snails (Gastropoda). Artificial materials such as plastic bags, cans and metal were also found.

The highest frequencies of occurrence were found for mammals (50.3% of examined scats). In 44% of scats with mammal remains, identification was impossible due to a total lack of hairs, however, bones found ex-

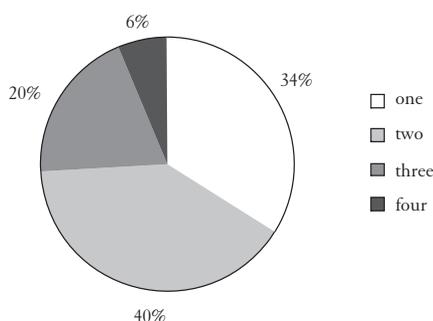


Figure 1. Types of golden jackal scats by the number of components.

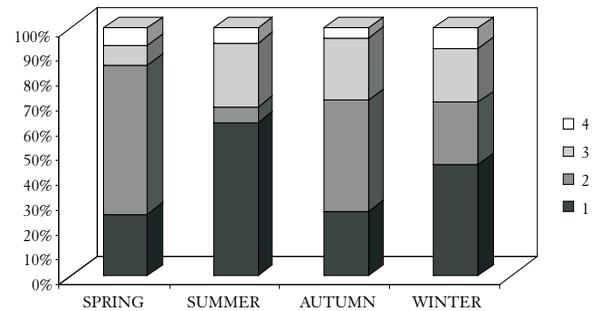


Figure 2. Types of golden jackal scats by the number of components by season.

cluded small mammals. Hairs of mouflon (*Ovis musimon* Pal.) were found in 12.4% of scats while hairs of wild boar (*Sus scropha* L.) and animals from the order Lagomorpha were found in the same percentage (7%). Remains from small mammals were found in only one scat (*Glis glis* L. as well as hairs from domestic dog, *Canis lupus familiaris* L.). Hairs of golden jackals were found in a small frequency (7%).

Fruit and vegetables were found in 34.1% of scats. The most important fruit were grapes (*Vitis vinifera* L.) and cultivated fig (*Ficus carica* L.), both found in 14% of scats and prickly juniper (*Juniperus oxicedrus* L.) in 4.6%.

Fish and snails were found in irrelevant frequencies (1.5% and 0.7% respectively). Insects were found in 29.5% of scats; the orders Orthoptera (16%), Coleoptera (12%) and Dytioptera (3%) were most important.

Birds including eggs comprise a significant component of the diet of golden jackals from the Pelješac Peninsula since their remains were found in 24.8% of examined scats. 40% of bird feathers remained unidentified due to the poor structure of the remains. Remains of birds from orders Charadriiformes, Falconiformes, Passeriformes, Anseriformes, Columbiformes and Ralliformes were successfully identified.

Branches, dried leaves and grass were found in the same frequency (24%) as the artificial material (plastic bags, cans, and metal). We found several scats that contained only grass or branches (4%).

DISCUSSION

The study results show the major importance of human activity and habits on the golden jackal diet compo-

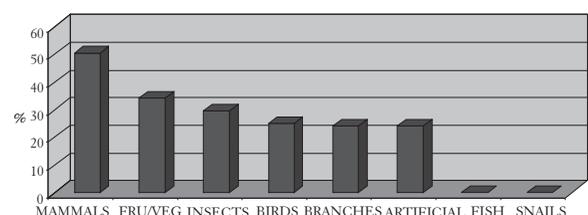


Figure 3. Frequencies of occurrence for groups of remains found in scats.

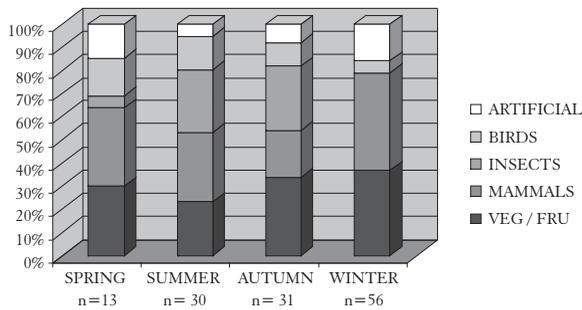


Figure 4. Major components of scats by season where scats are collected.

sition on the Pelješac Peninsula. Cultivated plants and introduced mammal species have become an important part of the jackal’s diet, as well as human garbage.

Mammals are the most frequent component since the remains were found in 50.3% of scats analysed. The majority of scats containing mammal remains were unidentified due to a total lack of hair in the scats. Bone examination excluded the presence of small mammals. Half of the scats with unidentified mammal remains contained some artificial material, so obviously the animal fed on garbage. Human leftovers are an important component of the golden jackal diet, especially in the winter and spring. Mammals from the order Artiodactyla have the second highest frequency of mammals. Mufflon (*Ovis musimon*, Pal.) and wild boar (*Sus scrofa* L.) were introduced species on Pelješac during the second half of the 20th century (name, personal communication, year). According to this study, golden jackals from the Pelješac Peninsula seem to adjust to the new species very well. Mammals from the order Lagomorpha are an important food source for golden jackals, although not to the extent reported by Kryštufek (1) for the northern Dalmatian population.

Remains of small mammals (*Glis glis* L.) were only found in one scat. Therefore small mammals do not seem to have a substantial influence on the diet of the jackal population. This finding differs from the results of several studies on golden jackals (16, 17).

Lanszki and Heltai (13) found that in winter and spring ungulates (especially *Sus scrofa* L.) played an important role in the jackal diet, but still stated small mammals as the most important food source. High frequency of occurrence of mufflon and wild boar hair in scats from the Pelješac Peninsula, with the absence of small mammals, could be the result of high availability of ungulates in the peninsula in contrast to the more difficult hunt of small mammals in karst areas compared to other areas where the golden jackal diet was investigated.

Fruit and vegetables as the second most frequent component again show the importance of human presence on the golden jackal diet. During summer and autumn, jackals often visit fields, vineyards and orchards, even approaching humans during the daytime. Importance of fruit and vegetables is more pronounced during

the spring and autumn seasons. Results of this research coincide with the research of Kowalski and Kowalska (24) who stated that in seasons when fruits are edible, they can be found in 40% of scats (in this research scats from summer and autumn contained 31% and 54.8% of fruit remains). They also mentioned fig (*Ficus carica* L.) and prickly juniper (*Juniperus oxicedrus* L.) as the most important plants, whereas in this research, apart from fig, the most important is grapes (*Vitis vinifera* L.) followed by prickly juniper (*Juniperus oxicedrus* L.). Insects are also important in the diet, especially during summer and autumn. The results of this research coincide with the results of Lamprecht (1978) who found insects from the orders Orthoptera, Coleoptera and Dytioptera as playing an important part in the diet of jackals in the Serengeti. This study shows that birds are an essential food source throughout the spring to autumn period. Birds from the order Charadriiformes dominated.

Parts of branches, evergreen tree needles and grass were found in 24% of scats, though its role in the diet is not in the nutritional value of grass but rather in the expulsion of food remains and intestinal parasites (25).

Artificial materials occur in 24% of scats, and indicate the importance of landfills on the golden jackal diet. Regular visits of jackals to the landfills were observed during this study. Parts of fish were found in a small frequency (1.5%). In scats containing fish, we also found artificial materials, indicating that the animal most likely fed on garbage. However, on several occasions during fieldwork the authors observed golden jackals searching for food on beaches.

The study confirms the opportune behaviour of the golden jackal and its ability to adapt to various conditions in the field. The irrelevant amount of small mammals found in scats differs from the majority of investigations conducted elsewhere. Possible differences in diet composition from year to year have already been proven for certain canid species (26) Thus, further research of the diet composition of golden jackals from Pelješac is necessary.

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APPENDIX

TABLE 1

List of all components found in golden jackal scats from Pelješac.

PLANT COMPONENT	
branches, leaves, grass	
fruit seeds and vegetables	vegetables
	Vitis vinifera
	Ficus carica
	Juniperus oxicedrus
	Quercus sp.
	Poaceae indent.
	Palmae indent.
	Medicago orbicularis
	Ceratonia siliqua
	Helianthus anuus
	Sorbus domestica
	Mirta communis
	Olea europea
	Pyrus sp.
	Juncaceae ident.
ANIMAL COMPONENT	
Gastropoda	Gastropoda indent.
Miriapoda	Chilopoda indent.
Insecta	order Orthoptera
	Tetigoniidae indent.
	Acrididae indent.
	Orthoptera indent.
	Anacridium aegyptium
	order Coleoptera
	Calosoma sycophata
	Cetonia sp.
	Carabus sp.
	order Dycyoptera
	Mantoydea indent.
	order Diptera
	Tipulidae sp
Pisces	Pisces indent.
Aves	Aves indent
	eggs
	Charadriformes indent.
	Falconiformes indent.
	Anseriformes indent.
	Rallidae indent.
	Passeriformes indent.
	Columbiformes indent.
	order Artiodactyla
Mammalia	Ovis musimmon
	Sus scrofa
	order Lagomorpha
	Lagomorpha indent.
	Lepus europeus
	Oryctolagus cuniculus
	order Carnivora
	Canis familiaris
	Canis aureus
	Canidae indent.
	Mustela sp.
	Unidentified homogenous detritus
	Artificial materials