

Autumn-Winter Diet and Food Niche Overlap between Red Fox (*Vulpes vulpes* L., 1758) and Golden Jackal (*Canis aureus* L., 1758) in Two Regions in Bulgaria

Albena Vlasseva*, Tsenka Chassovnikarova & Nasko Atanassov

Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences, 1 Tsar Osvoboditel Blvd., Sofia 1000, Bulgaria; E-mail: mirchevaa@yahoo.com

Abstract: The feeding habits of the red fox (*Vulpes vulpes*) and golden jackal (*Canis aureus*) were studied in two regions in Bulgaria (Upper Thracian Lowland and North Eastern Dobrudzha). The regions are located in a human dominated landscape, under different climatic conditions, crops, land use and human population density. Stomach content analysis of 234 foxes and 256 jackals resulted in identification of 21 and 22 food items, respectively. Rodents were the most consumed food item for red fox and golden jackal (27% and 21%, respectively). Secondary food items were herbaceous plants (11%) and wild birds (8%) for red fox, and apples (6%), carrion (9%) and waste (8%) for jackals. Diets and distribution of food components of the investigated species in both studied regions were almost similar. Significant differences of food niches breadth in both species were identified. The wider one was detected for the jackal. The level of the food niches overlap was high for the two study areas. Probably this is the reason for the withdrawal of foxes in areas with higher altitude when reaching high density of jackals in the sympatry areas such as the Upper Thracian Lowland and NE Dobrudzha.

Key words: *Vulpes vulpes*, *Canis aureus*, diet, food niche overlap

Introduction

Red Fox (*Vulpes vulpes*) and Golden Jackal (*Canis aureus*) are widespread predator species living in sympatry in many areas in Bulgaria. The diet of the red fox has been investigated widely in this country (ATANASOV 1958, PESHEV 1963, GRIGOROV 1987, KYURKCHIEV 2008, PETROV *et al.* 2016) while knowledge of eating habits of the jackal is insufficient (MARKOV & LANSZKI 2012, STOYANOV 2012, RAICHEV *et al.* 2013). As far as we know, trophic interactions between both species have been a subject of only two studies in Bulgaria (RAYCHEV 2002, KIRKOVA *et al.* 2011). In his survey, RAYCHEV (2002) showed a high trophic niche overlap of the fox and the jackal, similarly to LANSZKI & HELTAI (2002) and LANSZKI *et al.* (2006). A food niche overlap of the species was a prerequisite for competition between them.

The aim of the present study is to establish the diet composition, breadth and degree of food niche overlap between the Red Fox and Golden Jackal during a season when food resources are limited in areas with different natural and climatic conditions and the highest population numbers of both species in Bulgaria.

Materials and Methods

Study area

Investigations on diet composition of the red fox and golden jackal was carried out by collecting stomach samples from individuals shot during the hunting season in 2008-2011. Study areas were situated in South-Central (Upper-Thracian Lowland) and North-Eastern Bulgaria (Dobrudzha) (Fig. 1). Both localities were in

*Corresponding author

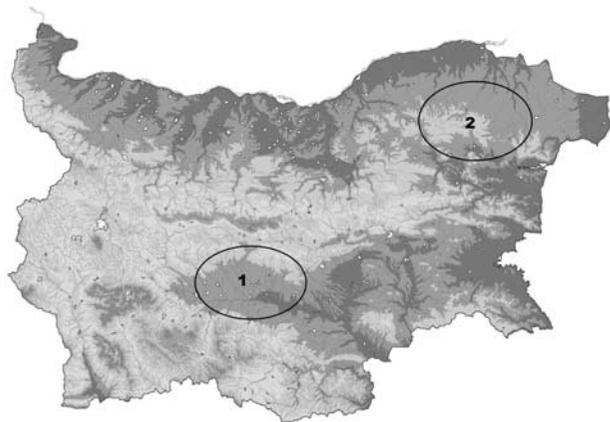


Fig. 1. Studied areas in Bulgaria, 1) Upper-Thracian Lowland; 2) North-East Dobrudzha

human-dominated agricultural areas. The main differences between them are in climatic conditions, crops, land use and human population density.

Materials

Samples of fox and jackal stomachs collected during the winter periods of 2008-2011, when activities for predator control were conducted, were studied. The consumed and undigested content of 493 stomach samples from two regions (Fig.1) has been analyzed, 193 foxes and 189 jackals from Thracian Lowland and 42 foxes and 69 jackals from North East Dobrudzha, respectively. Empty stomachs of foxes and jackals were excluded from the analysis. Stomachs were removed from carcasses in the field and frozen (-10°C) until the analysis in the laboratory, according the standard procedure (ROPER & LÜPS 1995). The content was washed through a 0.5 mm wire sieve, dried and macroscopically divided by 24 main food categories (21 for foxes and 22 for jackals). Small fractions of stomach content was analysed by using stereo microscope (5x magnifications). Identification keys were used for recognition of mammalian hair (TEERING 1991) and a reference collection of hairs belonging to the known mammal species presented in the studied regions.

Data analyses

The food composition of *V. vulpes* and *C. aureus* are presented as relative frequency (Fr%) of food types in each sample (LOCKIE 1959), calculated as percentage. Trophic niche breadth was calculated using the LEVINS measure (BA). The Levins' index varies between 0 (minimal niche breadth) and 1 (maximal niche breadth) (LEVINS 1968). The trophic niche overlap was calculated using Morisita's index of similarity (C) and varies between 0 (total separation) to 1 (total overlap) (MORISITA 1959, LEVINS 1968).

Reliable differences of the basic food group usages in different regions were evaluated by χ^2 -test.

Results and Discussion

Diet composition

Rodents were dominant in the autumn-winter diet of red fox in both regions, although in North-East Dobrudzha first place is shared with carrion (Fig. 2). Secondary food items in Thracian Lowland were herbaceous plants (Fr%= 11), wild birds (Fr%= 9) and brown hare (Fr%= 7). In North-East Dobrudzha, poultry (Fr%= 2) were equally represented with plant food (herbaceous plants, rose hip, maize). Other food items in the diet of the fox in Thrace were underrepresented, while in Dobrudzha though fewer in number, these elements were of more significance (wild boar, roe deer, wild birds and waste) (Fr% =6.25).

The red fox diet in the Thracian Lowland was more diverse than in North-East Dobrudzha, where comparatively the small number of food items was at the expense of their higher significance.

With regard to the jackals' diet, the same trends were observed as for foxes. Main food items in autumn-winter diet of the jackal in Thracian Lowland were rodents (Fr= 25.45%), carrion (Fr% =9), waste and apples (Fr%= 7). Secondary food items were brown hare, wild birds and domestic dog (Fr% =5). Additional food items with less significance were roe deer, domestic pig and cat, fish, plant food (Fr%= 3.64); wild boar domestic bird, corn, pears and grape (Fr% =1.82).

Trophic niche breadth and overlap

Food niche breadth according to the standardized Levins' index (BA) and degree of overlap (C) by Morisita's index of similarity are shown in Table 1.

Significant differences were identified among food niches breadth in both species and regions. The diet of two species was more diverse in NE Dobrudzha (BA fox = 0.56, BA jackal = 0.81, C = 0.72) and niche overlap was lower than in Thracian Lowland (BA fox = 0.39, BA jackal = 0.48, C= 0.91) where niche overlap was almost complete.

Discussion

The results of this study clearly show a great similarity in the autumn-winter diet of red fox and golden jackal in the Thracian Lowland and North East Dobrudzha. The diet of both species in NE Dobrudzha was composed of many food items with low significance probably associated with shortag-

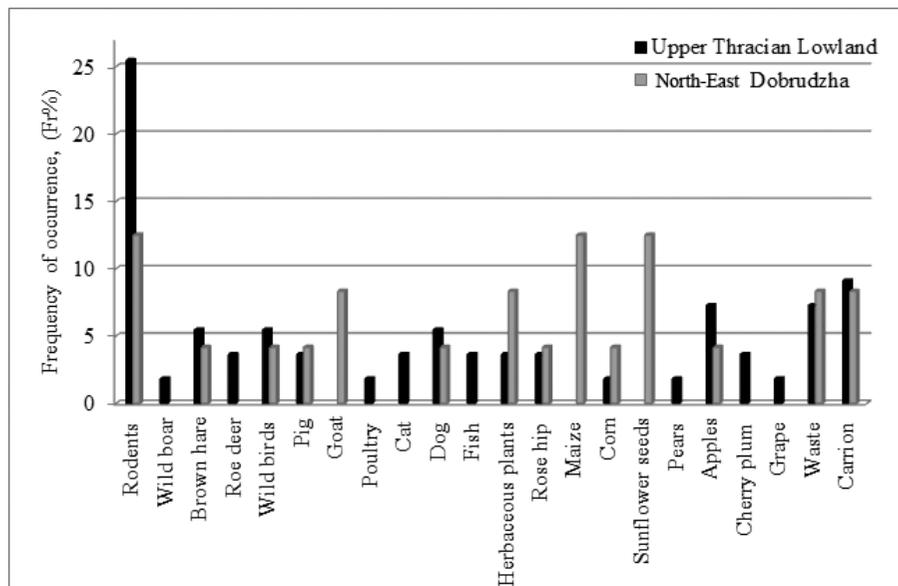


Fig. 2. Frequency of occurrence (Fr %) of different types of food in the stomachs of the red fox (A) and the golden jackal (B)

Table 1. Food niche breadth (B_A) and degree of overlap (C) between red fox and golden jackal in the autumn-winter season

	Upper Thracian Lowland		North-East Dobrudzha	
	<i>V. vulpes</i>	<i>C. aureus</i>	<i>V. vulpes</i>	<i>C. aureus</i>
BA	0.39	0.48	0.56	0.81
C	0.91		0.72	

es of food resources due to the harsher continental climate, land use (mainly monocultures) and scarce natural vegetation. According to our research, rodents are the preferred foods of both, as shown by the other authors (JEDRZEJEWSKA & JEDRZEJEWSKI 1992, CARVALHO & GOMEZ (2001), RAYCHEV (2002), LANSZKI et al. 2006, DELL'ARTE et al. 2007, STOYANOV 2012, MARKOV & LANSZKI 2012).

Regarding the opinion whether the foxes and jackals are pest species GENOV & VASSILEV (1991), STENIN et al. (1983) and RAYCHEV et al. (2013) demonstrated that golden jackals in central Bulgaria consumed wild and domestic mammals mostly as carrion. Our study showed insignificant presence of wild and domestic ungulates in red fox and golden jackal diets, which had been reported also by STOYANOV (2012). The minimum amount of these food components in diet of both species were an indicator of the current condition of forestry and agriculture, namely reduced populations of small game species and almost complete lack of livestock.

The significant rate of carcasses of the diet of both species shows their preferences to consume carrion, rather than hunting. In Bulgaria, similarly to Israel

(SOVADA *et al.* 1995) and Serbia (PENEZIC & ĆIROVIĆ 2015), jackals feed in landfill sites. However, in countries like Hungary, there is no practice to create regulated and unregulated dumps and Hungarian jackals do not feed in dumps and use other food (LANSZKI *et al.* 2010). This is an evidence for adaptability of both species and their ability to inhabit parts in proximity with urban areas. This represents a good opportunity for experts to control effectively their numbers as indicated by SOVADA *et al.* (1995) in Israel. The variety of food items were approximately equal in both species and areas, which indicates that fox (PETROV *et al.* 2016) and jackals are not only opportunists but they may also be considered as facultative specialists.

Standardized trophic niche breadth value on the basis of frequency occurrence was highest in Bulgaria (Thracian Lowland $BA=0.91$; North-East Dobrudzha $BA=0.72$), then Greece and Israel and lowest in Hungary ($BA=0.48, 0.31, 0.14$, respectively (LANSZKI *et al.* 2010). Considering the degree of overlap of food niche we might assume that the red fox and golden jackal compete at the sympatric regions. This may be the reason for fox to divert to regions with higher altitude. Studies in Israel showed that in areas with a high density of jackals, the number of foxes significantly decreased (SOVADA *et al.* 1995).

In order to understand the actual relationship between the red fox and the golden jackal further studies are needed comprising all seasons and more areas in Bulgaria. Also similar surveys should be performed for feral dogs. This is very important given the growing number of feral dogs that could be one of the main food competitors for the red fox and golden jackal.

References

- ATANASOV N. 1958. The red fox in Bulgaria. Sofia, Bulgarian Academy of Sciences, 324 p. (In Bulgarian).
- CARVALHO C. J. & GOMES P. 2001. Food habits and trophic niche overlap of the red fox, European wild cat and common genet in the Peneda-Geres National park. *Galemys* **13**(2): 39-48.
- DELL'ARTE L., LAAKSONEN T., NORRDAHL K. & KORPIMAKI E. 2007. Variation in the diet composition of a generalist predator, the red fox, in relation to season and density of main prey. *Acta Oecologica* **31**(3): 276-281.
- GENOV P. & VASSILEV K. 1991. Density and damages caused by jackal (*Canis aureus* L.) to livestock in Southern Bulgaria. *Ecology* (Bulgarian Academy of Sciences) **24**: 58-65.
- GRIGOROV G. 1987. Ecological studies on the red fox (*Vulpes vulpes*) and its influence on the abundance of the European hare (*Lepus europeus*). PhD Dissertation, Forest Research Institute, Bulgarian Academy of Sciences (In Bulgarian).
- JĘDRZEJEWSKI W. & JĘDRZEJEWSKA B. 1992. Foraging and diet of the red fox *Vulpes vulpes* in relation to variable food resources in Białowieża National Park, Poland. *Ecography* **15**: 212-220.
- KIRKOVA Z., RAYCHEV E. & GEORGIEVA D. 2011. Studies on Feeding Habits and Parasitological Status of Red Fox, Golden Jackal, Wild Cat and Stone Marten in Sredna Gora, Bulgaria. *Journal of Life Sciences* **5**: 264-270.
- KYURKCHIEV S. 2008. Annual food spectrum of the red fox (*Vulpes vulpes* L.) in Central Rhodopes. *Sbornik dokladi. Jubilee scientific conference on Ecology*, Plovdiv, pp. 200-207. (In Bulgarian).
- LANSZKI J. & HELTAI M. 2002. Feeding habits of golden jackal and red fox in south-western Hungary during winter and spring. *Zeitschrift für Säugetierkunde* **67**: 128-136.
- LANSZKI J., GIANNANTOS G., DOLEV A., BINO G. & HELTAI M. 2010. Late autumn trophic flexibility of the golden jackal *Canis aureus*. *Acta Theriologica* **55**: 361-370.
- LANSZKI J., HELTAI M. & SZABO L. 2006. Feeding habits and trophic niche overlap between sympatric golden jackal (*Canis aureus*) and red fox (*Vulpes vulpes*) in the Pannonian ecoregion (Hungary). *Canadian Journal of Zoology* **84**: 1647-1656.
- LEVINS R. 1968. Evolution in changing environment. Princeton University Press, Princeton, 120 p.
- LOKIE J. D. 1959. The estimation of the food of foxes. *Journal of Wildlife Management* **23**: 224-227.
- MARKOV G. & LANSZKI J. 2012. Diet composition of the golden jackal, *Canis aureus*, in an agricultural environment. *Folia Zoologica* **61** (1): 44-48.
- MORISITA M. 1959. Measuring of the dispersion and analysis of distribution patterns. *Memoires of the Faculty of Science, Kyushu University, Series E. Biology* **2**: 215-235.
- PENEZIC A. & ČIROVIĆ D. 2015. Seasonal variation in diet of the golden jackal (*Canis aureus*) in Serbia. *Mammal Research* **60**: 309-317.
- PESHEV T. 1963. The food of the fox (*Vulpes vulpes* L.) in some regions in Bulgaria. *Godishnik na Sofijskiya Universitet, Biologicheski Fakultet* **58**: 87-119. (In Bulgarian).
- PETROV R. P., POPOVA E. D. & ZLATANOVA D. P. 2016. Niche Partitioning among the Red Fox *Vulpes vulpes* (L.), Stone Marten *Martes foina* (Erxleben) and Pine Marten *Martes martes* (L.) in two Mountains in Bulgaria. *Acta Zoologica Bulgarica* **68**(3): 375-390.
- RAYCHEV E. 2002. Investigations on the food and some morphometric features of the red fox (*Vulpes vulpes*), the jackal (*Canis aureus*), the wildcat (*Felis silvestris*) and the stone marten (*Martes foina*) in the regions of Central Balkan and Surnena Sredna Gora Mountains. –PhD Dissertation. Thracian University, Stara Zagora. (In Bulgarian).
- RAYCHEV E., TSUNODA H., NEWMAN C., MASUDA R., GEORGIEV D. & KANEKO Y. 2013. The Reliance of the golden jackal (*Canis aureus*) on anthropogenic foods in winter in Central Bulgaria. *Mammal Study*, **38**: 19-27.
- SOVADA M. A., SARGEANT A. B. & GRIER J. W. 1995. Differential effects of coyotes and red foxes on duck nest success. *Journal of Wildlife Management* **59**: 1-9.
- STENIN G., KOLEV N. & MITOV I. 1983. Some aspects of jackals's dispersion. *Lovno i ribno stopanstvo* 39(7): 28-30. (In Bulgarian).
- STOYANOV S. 2012. Golden jackal (*Canis aureus*) in Bulgaria. Current status, distribution, demography and diet. *International Symposium on Hunting, "Modern aspects of sustainable management of game population"* Zemun-Belgrade, Serbia, 22-24 June 2012. pp. 48-56.
- TEERING B. J. 1991. Hair of West European mammals. Cambridge (Cambridge University Press). 224 p.