

Food composition of red fox in the Tatra National Park

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Food composition of the red fox *Vulpes vulpes* (Linnaeus, 1758) was analysed on the basis of 144 scats found in the Tatra National Park (1270–2100 m a.s.l.), Poland. The most important kind of food were small and medium mammals (54% and 43%, respectively). Pine voles were the staple food in the group of determined small mammals, within determined medium mammals the most important was the marmot. Refuse left by tourists occurred in every sixth scat. Most intensively used by foxes were habitats situated at the altitude of 1401–1600 m a.s.l., probably due to favourable food and shelter conditions offered by this zone.

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Introduction

There has been little research on the food composition of the red fox *Vulpes vulpes* (Linnaeus, 1758) in mountain areas (Kotovščikova 1936-cited after Heptner and Naumov 1967, Leinati *et al.* 1961, Rosa *et al.* 1991). In Poland, studies of the diet of the red fox concentrated mainly on lowland parts of the country (Rzebik-Kowalska 1972, Goszczyński 1974, Pielowski 1976, Goszczyński 1986, Jędrzejewski and Jędrzejewska 1992). This project was aimed at estimating diet composition of foxes in Tatra Mountains, south Poland.

Study area, material and methods

Research was carried out within a radius of approximately three kilometers from Gąsienicowa Alp in the Tatra Mountains (49°15'N, 20°00'E). Forest (41%) and mountain pine (37%) dominated within the study area (Table 1). The main habitat of the zone between 1201 and 1600 m a.s.l. was forest (69%). In the next zone, i.e. over 1601 m a.s.l. mountain pine predominated (51%). That zone was characterised by a lack of forest.

Touristic trails were walked and surveyed. Scats were collected in 1987 (from June until the end of August), 1989 and 1990. The locations of scats found were marked on a map and the altitude noted.

Table 1. Percentage area of habitat types within various altitude belts of the study area in the Tatra National Park.

Habitat type	Altitude zone (m a.s.l.)		
	1201-1600	1601-1800	Total
Forest	69	—	41
Mountain pine	17	51	37
Rocky area	3	34	10
Mountain pasture	11	13	11
Pond	—	2	1

The lowest site was at an altitude of 1270 m and the highest at 2100 m. The material was divided into two zones (1200-1600 and over 1601). In total, 144 excrements were collected (63 samples from the belt 1200-1600 m a.s.l. and 81 from > 1601 m).

After the initial drying in the field, the material was analysed in a laboratory. First, the scat samples were thoroughly dried, then rinsed through a sieve, where undigested parts remained, and finally the food remains were identified. In order to assess biomass eaten by foxes, dried and weighed remains were multiplied by correction factors (Lockie 1959, Goszczyński 1974). In this paper, the following values of correction factors were used: marten and marmot - 50, chamois - 118, bones of larger mammals - 30, undetermined hair of larger mammals - 84, small mammals - 23, birds - 35, fruit - 14, lizards - 30. Whenever possible, mammal species were determined on the basis of teeth (rodents) and hairs (Dziurdzik 1973).

The study area was classified into the following habitat classes: forest, dwarf mountain pine, rocky area, mountain pasture and pond. A map (scale 1:10 000) was used to delineate the habitat classes. Borders were drawn on the tracing paper, considering the accepted altitude belts. Next, within the altitude belts respective pieces of tracing paper were cut out and weighed to estimate the percentage area for each category. This method gave a slightly simplified picture of the terrain because of its steep topography. To estimate the intensity of the fox use of habitat, the empirical distribution of faeces found in each zone were compared with their theoretical distribution by χ^2 -test. Using the map and a curvemeter, the length of each tourist trail in each belt was assessed. Next, the general number of excrements was divided into four groups dependent on the length of tourist trails within the zone.

Results

The most important food for the red fox were the small and medium size mammals - 54.0% and 42.6% of biomass, respectively (Table 2). Other kinds of food (birds, lizards, insects, grass and moss) composed only 3.4% of biomass. In the case of refuse, percentage of biomass was not estimated. On the basis of paper or foil, it is difficult to state what kind of food was left by tourists.

Percentage of occurrence of small mammals was 81.2% and that of medium mammals - 43.7%. Other common components of fox diet were fruits (58.3%) and insects (41.0%). Grass and moss were consumed accidentally while catching rodents and insects. Refuse was found in 16.7% of scats.

Table 2. General composition of food of the red fox in the Tatra National Park, Poland.

Food category	Percent of consumed biomass	Percent of occurrence
Small mammals	54.0	81.2
of this:		
<i>Microtinae</i> (undetermined)		18.8
<i>Pitymys tatricus</i>		19.7
<i>Pitymys subterraneus</i>		4.3
<i>Pitymys</i> sp.		12.8
<i>Microtus agrestis</i>		7.7
<i>Microtus nivalis</i>		6.0
<i>Clethrionomys glareolus</i>		4.3
<i>Sorex araneus</i>		0.8
Undetermined		25.6
Medium mammals	42.6	43.7
of this:		
Undetermined		78.0
<i>Marmota marmota</i>		9.0
<i>Martes martes</i>		5.0
<i>Rupicapra rupicapra</i>		4.0
<i>Artiodactyla</i> (undetermined)		4.0
Birds	0.3	12.5
Lizards	0.1	4.1
Insects	0.3	41.0
Fruits	2.1	58.3
Grasses and mosses	0.6	22.2
Refuse	—	16.7

Within the group of small mammals, the most frequent species were: *Pitymys tatricus*, undetermined *Microtinae* and rodents from the genus *Pitymys*. Other small mammals were *Microtus agrestis*, *M. nivalis*, *Pitymys subterraneus*, *Clethrionomys glareolus* and *Sorex araneus* (Table 2). Among larger mammals, the following groups were identified: *Marmota marmota*, *Martes martes*, *Rupicapra rupicapra*.

Comparison of the food composition between altitude zones (Table 3) by testing for a two percentage did not show any significant difference ($p < 0.05$). Distribution of the number of scats within the altitude zones was significantly different from theoretical distribution ($\chi^2 = 68.5$, $p < 0.01$, $df = 3$). Assuming that the number of fox excrement samples in the altitude belts is an indicator of fox activity, it is possible to state that the most intensively visited zone was between 1601 and 1800 m. In the other belts an unexpectedly small number of faeces were found on the basis of theoretical distribution.

Table 3. Composition of fox food within each altitude belt (number of remains, in particular small mammal categories), % Biom – % of biomass, % Occur – % of occurrence.

Food type	Altitude zones (m)			
	1201–1600		over 1600	
	% Biom	% Occur	% Biom	% Occur
Small mammals	55.1	80.6	53.2	83.7
of this:				
<i>Microtinae</i> undet.		18.4 (7)		30.6 (15)
<i>Pitymys tatricus</i>		28.9 (11)		24.6 (12)
<i>Pitymys subterraneus</i>		5.3 (2)		6.1 (3)
<i>Pitymys</i> sp.		15.8 (6)		18.4 (9)
<i>Microtus agrestis</i>		15.8 (6)		6.1 (3)
<i>Microtus nivalis</i>		5.3 (2)		10.2 (5)
<i>Clethrionomys glareolus</i>		10.5 (4)		2.0 (1)
<i>Sorex araneus</i>		–		2.0 (1)
Medium mammals	42.8	43.5	42.6	45.0
Birds	0.1	11.3	0.4	13.7
Lizards	0.1	4.8	0.1	3.7
Insects	0.3	43.5	0.2	40.0
Fruits	1.2	54.8	2.9	62.5
Grasses and mosses	0.4	27.4	0.6	18.7
Refuse	–	14.1	–	17.7
Number of analysed scats	63	63	81	81

Discussion

Small mammals are the most frequent component of the red fox diet in the Tatra Mts. It corroborates results of many studies in lowland habitats, among others those by Rzebik-Kowalska (1972), Goszczyński (1974), Kożena (1988), and also those regarding mountain areas (Lošikariev 1970).

The percentage of other components of the fox diet in the Tatra Mts differs from the diet of those predators from the lowlands of Poland. The most important food for fox in the Tatra Mts besides small mammals are bigger mammals, probably mainly carrion, killed by both *Canis lupus* and *Lynx lynx* (Zelina 1985) and avalanches (Gašienica-Byrcyn 1975). In the forests of Białowieża National Park, foxes also quite commonly consume dead ungulates and the remains of lynx and wolf prey (Jędrzejewski and Jędrzejewska 1992). In central and western Poland, carrion was eaten considerably less frequently (Goszczyński 1986). In lowland regions of the country, besides small mammals, the basic prey of fox were hares *Lepus europeaus* and birds (Rzebik-Kowalska 1972, Goszczyński 1974). Lack of hares and the low contribution of birds in the food of fox from the Tatra Mts were caused by the lower density of these prey in mountainous areas than in

lowlands. Moreover, the lack of farms in the Tatra National Park limits the consumption of poultry, which is the fox's common prey in the lowlands.

In mountainous areas, the genus *Pitymys* seems to have the same importance in the fox diet as the genus *Microtus* in lowlands. Pine voles are probably most frequently found in mountain regions and are easy to catch. The contribution of marmot to the fox diet may be higher than is suggested from the results of this paper. Marmot can comprise a significant part of the group of undetermined larger mammals. There were examples of complete destruction of marmot colonies by foxes (cf Gašienica-Byrcyn 1975).

Because of a high level of refuse digestibility it is difficult to assess their real contribution to the fox diet. It was assessed that refuse occurred in every sixth fox scat. In urban and suburban foxes, refuse was a main component of the diet (Doncaster and Macdonald 1991).

There is no significant difference in fox diet between altitude zones, which could arise from frequent "vertical movements" of foxes. The highest fox activity in the zone 1601–1800 m can be explained by several factors. In the Tatra National Park, intermediate altitude zones (1401–1800 m) are characterised by the highest contribution of shrubby and pasture areas, which are probably preferred by microtines. At the same time, these areas enable foxes to hunt effectively not only on the ground but also by digging rodents from their burrows. Besides, zones covered with mountain pine (60%) may create favourable shelter conditions for foxes.

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