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SUMMER FOOD NICHE COMPARISON BETWEEN THE RED FOX AND GENUS *MARTES* IN MOUNTAIN HABITATS

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Abstract: The red fox *Vulpes vulpes* and the two species from genus *Martes* (the Stone marten *Martes foina* and the Beech marten *Martes martes*) inhabit common habitats in Bulgaria, but their food preferences and competition are poorly studied.

In our study, we tried to evaluate their summer food preferences based on scat analyses of 139 martens' scats and 151 fox scats from Rhodopi (West and East), Osogovo and Pirin mountains where species overlap their distribution. As the scats of the two martens are indistinguishable between each other, in our analyses, we considered the comparison of martens scats with the fox only on the genus's level. This is a preliminary study of a larger research.

In the scats, we identified both plant and animal (invertebrate and vertebrate) components. The food niches in both genera are unexpectedly narrow, due to significant preferences to a limited number of food items. The biggest overlap of the food niche in summer in the three mountains is observed in rodents, insects, wild plums, blackberries, dog rose and juniper fruits. The fox in Western Rhodopi uses twice as many types of food (and has lesser overlapping in the food niche) than martens and almost equal number in Osogovo and Pirin. 14 scats of fox from East Rhodopi, Osogovo and Pirin and 1 of *Martes* from Osogovo contained garbage (plastic, nylon and even glass). Other anthropogenic foods (tomato, cucumber and pepper) were also found.

INTRODUCTION

The red fox (*Vulpes vulpes*) and the two species of genus *Martes* (stone marten *M. foina* and pine marten *M. martes*), present in Bulgaria are abundant (except for the pine marten which is poorly studied), as their distribution and occupancy in the mountains overlap to a great extent. Moreover, the species are functional food competitors (Lanszki et al., 2007).

The species are generally well studied in Europe, but there is little data on the food preferences, and niche overlap of these species in Bulgaria (Vasileva et al., 2005) as the red fox diet is better studied (Atanasov, 1958; Grigorov, 1987; Peshev, 1963; Ruskov, 1953). Partial studies were also done on stone marten (Georgiev, D. 2013; Georgiev and Raichev, 2009). All these studies, but one (Vasileva et al., 2005) were conducted in lowland, human dominated landscapes (up to 800 m. alt., rarely above 1000 m.).

To fulfil the gaps of this knowledge in our study, we aimed to identify the summer food preferences and niche overlap of the target species through scat analyses in three different mountains – Osogovo, Rhodopi (Western and Eastern) and Pirin, in areas above 800 m. altitude. The choice of these mountains is based on the spatial overlap in the distribution of the three species and the completely different geographical characteristics in each mountain and thus, habitats.

Due to the fact that the two *Martes* species live in the same habitats and their scats cannot be distinguished in the field without DNA analyses (Posluszny et al., 2007) in the current study, we consider the comparison only between the fox and the genus *Martes*.

MATERIALS AND METHODS

The three mountains differ significantly in their appearance: Pirin Mountain has rugged, steep slopes covered mainly with coniferous (pine) forests. The Osogovo Mountain has relatively flat ridges and gradually ascending slopes covered mainly with deciduous (beech) forests. The two parts of Rhodopi Mountain also differ from each other – the Western higher part, is covered with vast coniferous forests while the Eastern lower part is more influenced by the Mediterranean climate forming more Mediterranean habitats.

During the summer period (June-August) 2011 - 2014 we collected and analysed totally 139 scats from *Martes* sp. and 151 scats from red fox. The scats were collected opportunistically during other studies. The number of scats per mountain per species is presented in Table 1. The scats were processed and analysed according to the methods of Kruuk and Parish (1981).

Table 1. Number of scats per mountain collected and analyzed.

Mountain	**Red fox**	***Martes sp.***
Western Rhodopi	43	27
Eastern Rhodopi	47	51
Pirin	36	41
Osogovo	36	42

The results of the scat analyses were statistically processed with the following methods:

Shannon-Weaver index (Shannon and Weaver, 1949) was used to evaluate the diversity of food types used by *Martes* sp. and *V. vulpes*, based on the following formula:

$$H' = -\sum p_i \ln p_i$$

where: **H'** – Shannon-Weaver diversity index; $\mathbf{p_i}$ – proportion of samples containing food type i; ln $\mathbf{p_i}$ – natural logarithm of this proportion.

Jaccard's index (Jaccard, 1912) was calculated to determine the similarity between food types used by *Martes* sp. and *V.vulpes* in the different mountains:

$$J = \frac{S_c}{S_a + S_b + S_c}$$

where: **J** – Jaccard's index of similarity; $\mathbf{S_a}$ – number of food types used by species 1; $\mathbf{S_b}$ – number of food types used by species 2; $\mathbf{S_c}$ – number of food types common to both species.

The composition of *Martes* sp. and *V.vulpes* food was presented in two ways (Lockie, 1959):

– frequency of occurrence (F%) – the percentage of scats containing different food types relative to the total number of analysed samples;

– level of significance (Fr%) – the frequency of occurrence in relation to the total occurrence of the food type.

We determined the food niche breadth (B) in the different mountains for the target species using the Levins index (1968):

$$\mathbf{B = 1 / \sum p_i^2}$$

where: **B** – food niche breadth; $\mathbf{p_i}$ – relative abundance of food type i (level of significance).

The food niche breadth is standardized to express it on a scale from 0 to 1, using the following formula (Hurlbert, 1978):

$$\mathbf{B_A = (B-1)/(n-1)}$$

where: $\mathbf{B_A}$ – standardized Levins food niche breadth; **B** – Levins food niche breadth; **n** – number of observed food types.

We measured the degree of overlap (C) between the food niches, using the simplified Morista index as modified by Horn (Morista, 1959; Horn, 1966):

$$\hat{C}_H = \frac{2\sum_i^n \hat{p}_{ij}\,\hat{p}_{ik}}{\sum_i^n \hat{p}_{ij}^2 + \sum_i^n \hat{p}_{ik}^2}$$

where: $\mathbf{C_H}$ – simplified Morista Index of overlap between species j and species k; $\mathbf{p_{ij}}$ – proportion resource i is of the total resources used by species j; $\mathbf{p_{ik}}$ - proportion resource i is of the total resources used by species k; **n** – total number of resource states.

To determine whether there are statistically significant differences in the food composition of *Martes* sp. and *V.vulpes* in the different study areas we performed the χ^2 test (using SigmaPlot version 13.0, from Systat Software, Inc., San Jose California USA, www.sigmaplot.com).

RESULTS AND DISCUSSION

The types of food in the different mountains of the target species are presented in Table 2 (for *Martes* sp.) and Table 3 (for *Vulpes vulpes*). There is a significant difference in the diet composition identified in the scats of *Martes* and *Vulpes* in Western and Eastern Rhodopi.

Table 2. Number of samples, frequency of occurrence and significance of the different food types in *Martes* sp. in all studied areas.

	Western Rhodopi			Eastern Rhodopии			Osogovo			Pirin			Total		
type of food	**No samples**	**F%**	**Fr%**	**No samples**	**F%**	**Fr %**	**No samples**	**F%**	**Fr%**	**No samples**	**F%**	**Fr%**	**No samples**	**F%**	**Fr%**
wild boar	0,0	0,0	0,0	0,0	0,0	0,0	3,0	2,2	1,1	0,0	0,0	0,0	3,0	2,2	0,4
heath-berries	0,0	0,0	0,0	0,0	0,0	0,0	13,0	9,4	4,8	0,0	0,0	0,0	13,0	9,4	1,6
white mistletoe	6,0	4,3	4,9	12,0	8,6	3,6	0,0	0,0	0,0	0,0	0,0	0,0	18,0	12,9	2,2
white fir	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	11,0	7,9	10,5	11,0	7,9	1,3
reptiles	0,0	0,0	0,0	5,0	3,6	1,5	3,0	2,2	1,1	0,0	0,0	0,0	8,0	5,8	1,0
hawthorn	0,0	0,0	0,0	12,0	8,6	3,6	9,0	6,5	3,3	0,0	0,0	0,0	21,0	15,1	2,5
rodents	30,0	21,6	24,6	116,0	83,5	34,5	94,0	67,6	34,4	32,0	23,0	30,5	272,0	195,7	32,5
cherry plum	21,0	15,1	17,2	20,0	14,4	6,0	16,0	11,5	5,9	5,0	3,6	4,8	62,0	44,6	7,4
hare	0,0	0,0	0,0	0,0	0,0	0,0	2,0	1,4	0,7	0,0	0,0	0,0	2,0	1,4	0,2
wild strawberry	2,0	1,4	1,6	0,0	0,0	0,0	0,0	0,0	0,0	11,0	7,9	10,5	13,0	9,4	1,6
wild cherry	0,0	0,0	0,0	3,0	2,2	0,9	5,0	3,6	1,8	2,0	1,4	1,9	10,0	7,2	1,2
tomato	0,0	0,0	0,0	2,0	1,4	0,6	0,0	0,0	0,0	0,0	0,0	0,0	2,0	1,4	0,2
cornel fruits	7,0	5,0	5,7	12,0	8,6	3,6	3,0	2,2	1,1	0,0	0,0	0,0	22,0	15,8	2,6
garbage	0,0	0,0	0,0	0,0	0,0	0,0	1,0	0,7	0,4	0,0	0,0	0,0	1,0	0,7	0,1
pupae	0,0	0,0	0,0	0,0	0,0	0,0	2,0	1,4	0,7	0,0	0,0	0,0	2,0	1,4	0,2
cucumber	0,0	0,0	0,0	2,0	1,4	0,6	1,0	0,7	0,4	1,0	0,7	1,0	4,0	2,9	0,5
blackberry	1,0	0,7	0,8	3,0	2,2	0,9	9,0	6,5	3,3	10,0	7,2	9,5	23,0	16,5	2,8
coleopters	23,0	16,5	18,9	41,0	29,5	12,2	31,0	22,3	11,4	14,0	10,1	13,3	109,0	78,4	13,0
spiders	0,0	0,0	0,0	0,0	0,0	0,0	1,0	0,7	0,4	0,0	0,0	0,0	1,0	0,7	0,1
birds	0,0	0,0	0,0	3,0	2,2	0,9	0,0	0,0	0,0	1,0	0,7	1,0	4,0	2,9	0,5
amphibians	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	3,0	2,2	2,9	3,0	2,2	0,4
peppers	0,0	0,0	0,0	0,0	0,0	0,0	1,0	0,7	0,4	1,0	0,7	1,0	2,0	1,4	0,2
grasshopper	0,0	0,0	0,0	6,0	4,3	1,8	15,0	10,8	5,5	0,0	0,0	0,0	21,0	15,1	2,5
plant matter	0,0	0,0	0,0	6,0	4,3	1,8	11,0	7,9	4,0	1,0	0,7	1,0	18,0	12,9	2,2
juniper	4,0	2,9	3,3	22,0	15,8	6,5	15,0	10,8	5,5	3,0	2,2	2,9	44,0	31,7	5,3
corn	0,0	0,0	0,0	0,0	0,0	0,0	1,0	0,7	0,4	0,0	0,0	0,0	1,0	0,7	0,1
cranberry	2,0	1,4	1,6	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	2,0	1,4	0,2
cherry	0,0	0,0	0,0	4,0	2,9	1,2	0,0	0,0	0,0	0,0	0,0	0,0	4,0	2,9	0,5
mulberry	0,0	0,0	0,0	2,0	1,4	0,6	0,0	0,0	0,0	3,0	2,2	2,9	5,0	3,6	0,6
dog rose	23,0	16,5	18,9	59,0	42,4	17,6	37,0	26,6	13,6	6,0	4,3	5,7	125,0	89,9	15,0
apple	3,0	2,2	2,5	6,0	4,3	1,8	0,0	0,0	0,0	1,0	0,7	1,0	10,0	7,2	1,2
total:	**122,0**		**100**	**336,0**		**100**	**273,0**		**100**	**105,0**		**100**	**836,0**		**100**

Table 3. Number of samples, frequency of occurrence and significance of the different food types in red fox in all studied areas.

	Western Rhodopi			Eastern Rhodopiи			Osogovo			Pirin			Total		
type of food	No samples	F%	Fr%	No samples	F%	type of food	No samples	F%	Fr%	No samples	F%	type of food	No samples	F%	Fr%
wild boar	5,0	3,3	2,5	19,0	12,6	7,0	18,0	11,9	4,1	3,0	2,0	2,3	45,0	29,8	4,3
anthropogenic food	0,0	0,0	0,0	0,0	0,0	0,0	1,0	0,7	0,2	0,0	0,0	0,0	1,0	0,7	0,1
heath-berries	0,0	0,0	0,0	0,0	0,0	0,0	12,0	7,9	2,7	0,0	0,0	0,0	12,0	7,9	1,1
white fir	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	11,0	7,3	8,6	11,0	7,3	1,1
reptiles	0,0	0,0	0,0	7,0	4,6	2,6	4,0	2,6	0,9	0,0	0,0	0,0	11,0	7,3	1,1
hawthorn	0,0	0,0	0,0	4,0	2,6	1,5	6,0	4,0	1,4	0,0	0,0	0,0	10,0	6,6	1,0
rodents	77,0	51,0	37,9	110,0	72,8	40,4	182,0	120,5	41,3	50,0	33,1	39,1	419,0	277,5	40,1
cherry plum	19,0	12,6	9,4	8,0	5,3	2,9	19,0	12,6	4,3	6,0	4,0	4,7	52,0	34,4	5,0
wild strawberry	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	3,0	2,0	2,3	3,0	2,0	0,3
wild cherry	1,0	0,7	0,5	3,0	2,0	1,1	7,0	4,6	1,6	0,0	0,0	0,0	11,0	7,3	1,1
cornel fruits	15,0	9,9	7,4	12,0	7,9	4,4	0,0	0,0	0,0	0,0	0,0	0,0	27,0	17,9	2,6
wheat	0,0	0,0	0,0	1,0	0,7	0,4	0,0	0,0	0,0	0,0	0,0	0,0	1,0	0,7	0,1
rabbit	8,0	5,3	3,9	9,0	6,0	3,3	2,0	1,3	0,5	2,0	1,3	1,6	21,0	13,9	2,0
garbage	0,0	0,0	0,0	7,0	4,6	2,6	6,0	4,0	1,4	1,0	0,7	0,8	14,0	9,3	1,3
tortoise	1,0	0,7	0,5	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1,0	0,7	0,1
pear	1,0	0,7	0,5	5,0	3,3	1,8	0,0	0,0	0,0	0,0	0,0	0,0	6,0	4,0	0,6
dog	0,0	0,0	0,0	0,0	0,0	0,0	1,0	0,7	0,2	0,0	0,0	0,0	1,0	0,7	0,1
blackberry	2,0	1,3	1,0	8,0	5,3	2,9	12,0	7,9	2,7	10,0	6,6	7,8	32,0	21,2	3,1
raspberry	1,0	0,7	0,5	2,0	1,3	0,7	0,0	0,0	0,0	0,0	0,0	0,0	3,0	2,0	0,3
mouflon	2,0	1,3	1,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	2,0	1,3	0,2
coleopters	10,0	6,6	4,9	24,0	15,9	8,8	66,0	43,7	15,0	7,0	4,6	5,5	107,0	70,9	10,2
mountain ash	1,0	0,7	0,5	3,0	2,0	1,1	0,0	0,0	0,0	0,0	0,0	0,0	4,0	2,6	0,4
spiders	0,0	0,0	0,0	0,0	0,0	0,0	1,0	0,7	0,2	0,0	0,0	0,0	1,0	0,7	0,1
butterfly	0,0	0,0	0,0	0,0	0,0	0,0	3,0	2,0	0,7	0,0	0,0	0,0	3,0	2,0	0,3
birds	1,0	0,7	0,5	3,0	2,0	1,1	11,0	7,3	2,5	7,0	4,6	5,5	22,0	14,6	2,1
peppers	0,0	0,0	0,0	0,0	0,0	0,0	3,0	2,0	0,7	0,0	0,0	0,0	3,0	2,0	0,3
grasshopper	0,0	0,0	0,0	9,0	6,0	3,3	21,0	13,9	4,8	0,0	0,0	0,0	30,0	19,9	2,9
roe deer	16,0	10,6	7,9	8,0	5,3	2,9	1,0	0,7	0,2	0,0	0,0	0,0	25,0	16,6	2,4
plant matter	1,0	0,7	0,5	2,0	1,3	0,7	11,0	7,3	2,5	6,0	4,0	4,7	20,0	13,2	1,9
juniper	3,0	2,0	1,5	5,0	3,3	1,8	20,0	13,2	4,5	10,0	6,6	7,8	38,0	25,2	3,6
corn	9,0	6,0	4,4	2,0	1,3	0,7	0,0	0,0	0,0	0,0	0,0	0,0	11,0	7,3	1,1
cranberry	17,0	11,3	8,4	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	17,0	11,3	1,6
cherry	1,0	0,7	0,5	3,0	2,0	1,1	0,0	0,0	0,0	0,0	0,0	0,0	4,0	2,6	0,4
mulberry	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	5,0	3,3	3,9	5,0	3,3	0,5
dog rose	9,0	6,0	4,4	15,0	9,9	5,5	34,0	22,5	7,7	6,0	4,0	4,7	64,0	42,4	6,1
apple	3,0	2,0	1,5	3,0	2,0	1,1	0,0	0,0	0,0	1,0	0,7	0,8	7,0	4,6	0,7
общо:	**203**		**100**	**272**		**100**	**441**		**100**	**128**		**100**	**1044**		**100**

Shannon diversity indices for the food types taken by the red fox and *Martes* sp. are presented in Table 4. The values are relatively similar as the most diverse is the diet of *Martes* sp. in Western Rhodopi, and the least – that of the fox in Eastern Rhodopi. In Osogovo and Pirin there is no difference in the diversity of food items in the diet of the target species.

Table 4. Shannon diversity index for food types in the fox and *Martes* sp. diet in the study areas.

	West Rhodopi	**East Rhodopi**	**Osogovo**	**Pirin**	**total**
Martes sp.	0,60	0,50	0,50	0,50	0,50
Vulpes	0,50	0,40	0,50	0,50	0,40

The values of the Jaccard indices for the food type in the diet of the species in the different mountains (Table 5) show most similarity in Pirin Mountain and least – in Western Rhodopi. For Eastern Rhodopi and Osogovo the values are similar.

Table 5. Jaccard similarity indices for food types in the diet of *Martes* sp. and *V. vulpes*.

	Western Rhodopi	**Eastern Rhodopi**	**Osogovo**	**Pirin**	**total**
J	0,38	0,56	0,59	0,63	0,60

Wild ungulates (wild boar, roe deer and mouflon) are found only in the fox diet, presumably coming from carcasses. This is similar to the findings from Bialowieza Primary Forest (Jedrzjewska et al., 2001) in Poland, which show that 33% of fox diet in summer consists of carrion. In the Italian Alps 27,1% of the fox diet is based on roe deer (Prigioni et al., 2008). The same conclusions are made for Hungary (Lanszki et al., 2007). The wild hare is also well represented. The abundant supplementary feeding for game species in all study areas is also making a significant impact on fox diet by presence of corn. The fox is also more willing to take garbage in more urban areas.

In the diet of *Martes* sp., there are more plant species – white mistletoe, tomatoes, cucumbers, wild cherries and mulberry. Similar results with plant matter in the marten's diet are obtained from Central Germany (Rogel and Stubbe, 2006), Greece (Vlachos et al., 2010), Italian Alps (Prigioni et al., 2008) and Hungary (Lanszki et al., 2007).

In the four studied regions, the main items in the *Martes* sp. diet are rodents, insects, dog rose, cherry plums, blackberries and juniper. The most frequently encountered food everywhere are the rodents. This is also supported by the

findings from Bialowieza Primary Forest (Jedrzjewski et al., 1993) in Poland and from Northern Italy (Bertolino and Dore, 1995), where the rodents represent 53,1% and 44,8% of the diet of the *Martes* sp. respectively. The second place is taken by insects (*Coleoptera*) and dog rose (Table 2; Fig.1). The results are coherent with those obtained by Martinoli and Preatoni (1995) for the Apennines, where the mammals, mainly rodents are eaten, but insects (mainly *Coleoptera* and *Orthoptera*) are also used (28,0%). The plant matter is represented mainly by *Rosaceae* (19,0%).

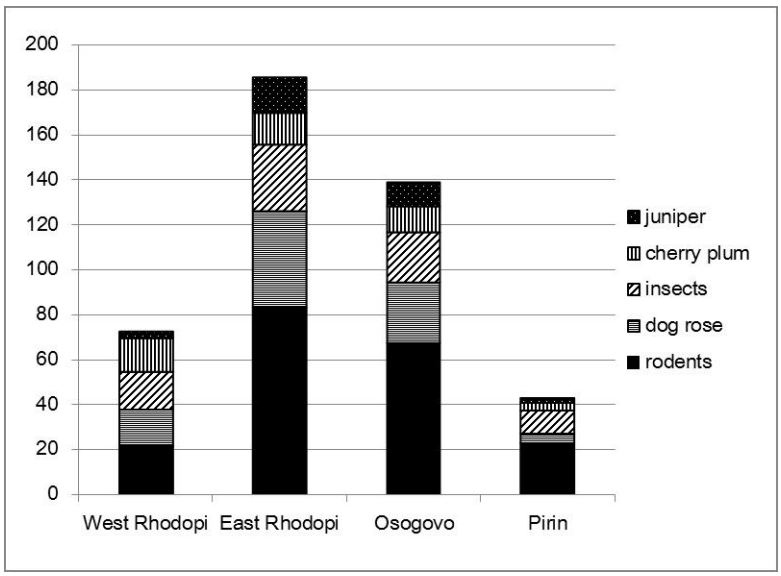

Figure 1. Comparison of F% for different food types in *Martes* sp. in the study areas. Food items only above 20% frequency of occurrence are shown.

χ^2 test shows a significant difference in the food composition of the diet of the genus *Martes* in the four studied areas (χ^2 = 589,831, d. f. =120, P = <0,001).

In Western Rhodopi the rodents sustain 21,6% of the samples with 24,6% significance. Second place is taken by insects and dog rose found in equal number of samples (16,5%), with 18,9% significance. The third place is taken by cherry plums with F% 15,1 and 17,2% significance. Only in Western Rhodopi cranberry is present in the marten's diet, represented by a low level of occurrence – in 1,4% of all samples. Wild strawberry, cucumber and grass species are not found in the samples there.

In Eastern Rhodopi, most of the samples consist of rodents (83,5%) with 34,5% significance. Dog rose is of secondary importance (17,6%), found in 42,4% of the samples. Insects are found in 29,5% of the samples with 12,2% significance. Only in Eastern Rhodopi tomato and cherries are found in *Martes* sp. diet (less than 3% of the samples).

In Osogovo the most frequently taken foods are again rodents, found in 67,6% of the samples with 34,4% significance. Dog roses are of secondary importance with 26,6% occurrence and 13,6% significance. Insects occurred in 22,3% of the samples with 11,4% significance. Only in Osogovo, 7 other types of food are found (heath-berry, wild boar, hare, corn, spiders, garbage and pupae). Heath-berries are of the highest importance from these food types - 9,4%, while the others represent around 1% of the samples.

In Pirin, the most frequently taken foods again are the rodents (23,0% of the samples with 30,5% significance). Insects also are of secondary importance (10,1% of the samples with 13,3% significance). White fir (which is found only in *Martes* sp. in Pirin) and wild cherries are found in 7,9% of the samples with 10,5% significance.

In the four studied areas, wild boar, rodents, cherry plums, rabbit, blueberries, insects, birds, grass species, junipers and dog roses are found in the samples of fox scats. The most frequently observed type of food in all areas are the rodents (found in 277,5% of the samples with 40,1% significance). Coleoptera (F%=70,9; Fr%=10,2) and dog roses (F%=42,4; Fr%=6,1) are of secondary importance (Table 3, Figure 2). Previous studies also concluded that rodents are the main part of the diet of the fox.

Studies from Finland (Lampio, 1952), England (Lever, 1957), Germany (Prost et al., 1975; Greutz, 1978), Sweden (Englund, 1965), Northern Ireland (Fairley, 1970), Holland (van Haaften, 1970), Poland (Rzebik - Kowalska, 1972; Goszsynski, 1974; Pielowski, 1976, 1982), Switzerland (Fuchs, 1973), Scotland (Hewson et al., 1975; Hewson and Leitch, 1983), Denmark (Jensen and Sequeira, 1978) showed that rodents, insects and fruits are also the most used food types by the fox.

The high level of occurrence of rodents in the food of the fox in our study is in cohesion with the findings of Jędrzjewska and Jędrzjewski (2001) in the Bialowieza Primary Forest during the summer. The only difference is in the frequency of occurrence of birds in the fox diet, which is significantly higher than the estimated in our study.

Previous studies in Bulgaria (Ruskov, 1953; Peshev, 1963) show that the most frequently used by the fox food types are wild hare, domestic birds, mice, insects and wild ducks. Our study did not confirm the presence of domestic birds and wild ducks in the fox diet, whereas the rabbits have a much lower frequency of occurrence. These inconsistencies are most likely due to the differences in the studied habitats or the time scale. Our results are supported by the findings of Peshev, 1963 which identified rodents as the most frequently encountered food types in the diet of the fox.

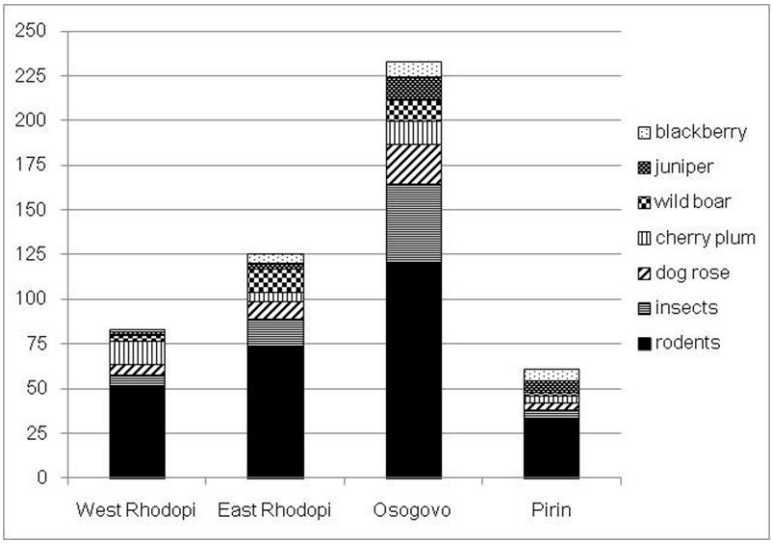

Figure 2. Comparison of F% for different food types in *V. vulpes* in the study areas. Food items only above 20% frequency of occurrence are shown.

χ^2 statistics showed a significant difference in the food composition of *Vulpes vulpes* in the four study regions (χ^2 = 595,782, d.f.=117, p = <0,001).

Rodents are found in 51,0% of the fox samples from Western Rhodopi, with 37,9% significance. Cherry plums are of secondary importance (12,6% of samples, 9,4% significance). Cranberries come in third place with 11,3% occurrence and 8,4% significance. Only in Western Rhodopi tortoises and mouflon remains are found in the fox scats.

In the Eastern Rhodopi, again the greatest share is the rodents (72,5% with 40,4% significance). Of secondary importance are again the insects (Coleoptera) (8,8% in 15,9% of the studied samples). The wild boar is found in 12,0% of the samples (6,7% significance). Only in Eastern Rhodopi reptiles (other than tortoises), hawthorn and grasshoppers were found.

In Osogovo, rodents are again most frequently taken by the fox (F% 120,5, with 41,3% significance). Insects are of secondary importance (F% 43,7%, 7,15% significance). Dog roses take third place with 22,5% occurrence and 7,7% significance. Only in Osogovo 6 other types of food are found in the fox diet: anthropogenic food, heath-berries, domestic dog, spiders, butterflies and pepper.

In Pirin, the frequently taken food by the fox again are the rodents (33,1% of samples, 39,1% significance). White fir comes in second place with 7,3% occurrence and 8,6% significance, followed by blackberries and juniper, found in 6,6% of the samples, with 7,8% significance. White fir, wild cherries and mulberries are found in the fox scats are found only in Pirin.

The cross χ^2 analyses for comparison of the food type occurrence in the *Martes* sp. and *Vulpes vulpes* diets are presented in Table 6.

Table 6. Comparison of food components occurrence in *Martes* and *Vulpes* diets in the studied mountains, according to χ^2 test.

Study areas	χ^2	d.f.	p
Western Rhodopi	88,53	23	<0,001
Eastern Rhodopi	125,62	27	<0,001
Osogovo	50,90	26	0,002
Pirin	34,35	18	0,011
Total	226,83	41	<0,001

Significant difference was identified in the summer food composition of the *Martes* and *Vulpes* diets according to the analyses of the summarized data for the four studied areas. During the analyses of each mountain area separately, a significant difference was found between Western and Eastern Rhodopi Mountain. This may be due to the difference of the habitat and food availability in both parts of the same mountain ridge.

The standardized breadth of the summer food niche of *Martes* and *Vulpes* is presented in Table 7. For both genera, the food niche is narrow, as the widest niche is for *Martes* in Pirin. The narrow niche is due to the presence of a limited preferred food items with considerable significance, nevertheless, that the target species may consume numerous types of food. This shows that although both genus have the potential for extensive diet adaptability, capable of taking diverse food items opportunistically, they are more or less facultative specialists, preferring to take a limited number of food types.

Table 7. Comparison of food components occurrence in *Martes* and *Vulpes* diets in the studied mountains, according to χ^2 test.

	Western Rhodopi	Eastern Rhodopi	Osogovo	Pirin	Total
Martes	0,12	0,11	0,12	0,14	0,13
Vulpes	0,11	0,10	0,09	0,11	0,11
Overlap	0,76	0,91	0,97	0,91	0,94

The level of overlap of the food niches for the different mountains is high, as it is the highest in Osogovo (0,97). This finding is in coherence with Brangi (1995) for the Apennines, where the overlap is also 0,97. Smaller overlap exists in Western Rhodopi Mountain, there the fox is taking twice as many food items than martens. These results are close to those of Lanszki et al. (2007) for Hungary (65,4)

The food competition is probably avoided by spatial displacement and temporal shifts of food preferences to compensate for this competition.

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