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FIRST METHODOLOGICAL-EXPERIMENTAL CONTRIBUTION TO THE STUDY OF THE DIET OF THE RED FOX *VULPES VULPES*

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ABSTRACT - The aims of this study were: to devise an easy method for the evaluation of the differences in the diet between two or more samples of fox scats collected along transects; to elucidate seasonal and local variations in the consumption of mammals. The study area (2000 ha) is located in the Prealps of the province of Belluno (municipality of Ponte nelle Alpi). Before our analysis of the scats, we evaluated the laboratory procedures used by previous Authors (Reynolds and Aebischer, 1991). We suggest a "semi-quantitative" method that allows us to obtain more information than with "qualitative" methods alone.

Key** words: Vulpes **vulpes, diet, Prealps (NE Italy)

INTRODUCTION

The aims of this study were: (1) to devise an easy method for the evaluation of the differences in the diet between two or more samples of fox scats collected along transects; (2) to elucidate seasonal and local variations in the consumption of mammals. The study comprises a period of three years of the collection of scats; this paper presents the results of the first year.

The study area (2000 ha) is located in the municipality of Ponte nelle Alpi in the Prealps of the province of Belluno between 390 m (Ponte nelle Alpi) and 591 m a.s.l. (Roncan). Its morphology is due to glacial and fluvial erosion (Pellegrini and Zambrano, 1979).

The climate of the study area is temperate (average annual temperature: 10.9°C; average annual precipitation: 1138 mm).

The Regional Forestry Map (Carta Forestale Regionale, foglio 063, 1983) indicates five main habitats: woodlands (5%), sparse woodlands (18%), shrubs (2%), meadows (60%), urban areas (15%). The characteristics of these habitats are the presence of new forest areas (Del Favero and Lasen, 1993) and the fragmentary distribution of woods (Pilli, 1998).

MATERIAL AND METHODS

Fox scats were collected during monthly excursions along 10 transects (about 10 Km in total length) representative of the main habitats of the area.

Before our analysis of the scats, we evaluated the laboratory procedures used by previous Authors (Reynolds and Aebischer, 1991).

Each scat was immersed and disintegrated in 70" alcohol. The resulting mixture was strained through a 0.5 mm mesh and the liquid was collected in a beaker. About one-quarter of the contents of the mesh was uniformly placed on a flat-bottomed Petri dish. A grid with 2-cm squares was placed under the Petri dish. The contents of the Petri dish were observed with a binocular microscope at 8x magnification. In every quadrant of the grid, we identified mammals, birds, plants,

Table 1 - Frequency of occurrence of the following categories (CAT): mammals (mm.): Microtidae (Micr.), Muridae (Mur.), Leporidae (Lep.), other mammals (oth. Mm.); birds; plants (pl.); insects (ins.); amphibians or reptiles (amph.-r.); refuse (ref.); earthworms (eart.); total scats (tot. sc.). D: scats collected near the refuse dump; B: scats collected in other transects; F%: frequency of occurrence; FR%: relative frequency.

CAT	TOT		SEASONAL VARIATION (F%)				LOCAL V. (F%)	
	F%	FR%	Winter	Spring	Summer	Autumn	D	B
mm.	52.4	21.3	63.4	52.6	54.8	35.4	56	50.5
Micr.	20.5	8.3	17	23.6	32.2	9.6	22	19.7
Mur.	7.8	3	17	7.8	3.2	0	2	18.6
Lep.	14.1	6	19.5	13.1	9.6	12.9	16	13.1
oth. mm.	9.9	4	9.7	7.8	9.6	12.9	16	6.5
birds	40.4	16.4	36	52.6	45.1	25.8	48	36.2
pl.	61.7	25	63.4	60.3	48.3	74.1	36	75.8
ins.	70.2	28.5	46.3	76.3	93.8	70.9	70	70.3
amp-r.	10.6	4.4	4.8	15.7	16.1	6.4	8	12
ref.	10.6	4.4	21.9	7.8	9.6	3.2	14	8.7
eart.	8.1		12.9	13.3	3.2	3.2	0	12.5
tot. sc.	141	141	41	38	31	31	50	91

insects, amphibians or reptiles and refuse. We could clearly observe materials of different categories in the same quadrant.

This "semi-quantitative" method allows us to assess the relative importance of each food category in the scats in the period or the area considered. The presence of a food category is indirectly quantified by its remains. Comparisons can be made by considering the average number of quadrants in which a category is present (Kruskal-Wallis test).

For the identification of mammalian guard hairs, we used the keys of Day (1966) and Teerink (1991).

The presence of earthworms was assessed by the presence of chaetae in the microscopic fraction.

We made seasonal and local comparisons (the single transect near a refuse dump vs. the other transects). We considered: the total number of scats collected in each unit of comparison; the frequency of occurrence of prey items (X^2 test, using "two by two" contingency tables for every food category; Fowler and Cohen, 1993); the results of "semi-quantitative" analyses (Kruskal-Wallis test); the frequency of occurrence of mammals (X^2 test); the frequency of occurrence of earthworms (X^2 test).

RESULTS AND DISCUSSION

The most frequent food categories observed in the qualitative analyses are plants and insects (Table 1), while the most important ones in the "semi-quantitative" analyses are mammals (Table 2). The latter are present more in winter (Figs. 1, 2); the X^2 test (Table 3) reveals significant differences between winter and autumn, while the Kruskal-Wallis test does not show seasonal variations (Table 4). In the "semi-quantitative" analyses, birds are the second category in the diet; the X^2 test shows significant differences between spring and autumn. Plants are the third trophic resource in the "semi-quantitative" analyses. These data are clearly different from the results of the frequency of occurrence. In fact, as was shown in other studies using different methods (Cavallini and

Table 2 - "Semi-quantitative" method: weight of each trophic category as shown by the average number of quadrants containing that category.

CAT	QUADRANTS	SAEASONAL VARIATIONS				LOCAL V.	
		Winter	Spring	Summer	Autumn	D	B
mm.	19,07801	24,03646	18,89286	20,44956	14,0625	21,5983	17,98109
birds	11,1844	8,95139	15,4256	13,99342	5,3125	12,57062	9,466485
pl.	9,79433	4,70486	6,392855	8,0614	17,37772	4,1056	14,16282
ins.	7,99291	2,050345	9,217265	12,00439	7,766305	6,04485	9,4743
amp-r.	1,865248	0,859375	1,940478	2,171053	1,130435	0,514098	2,536573
ref.	0,404255	1,043405	0,071429	0,605263	0,104257	0,727236	0,184941

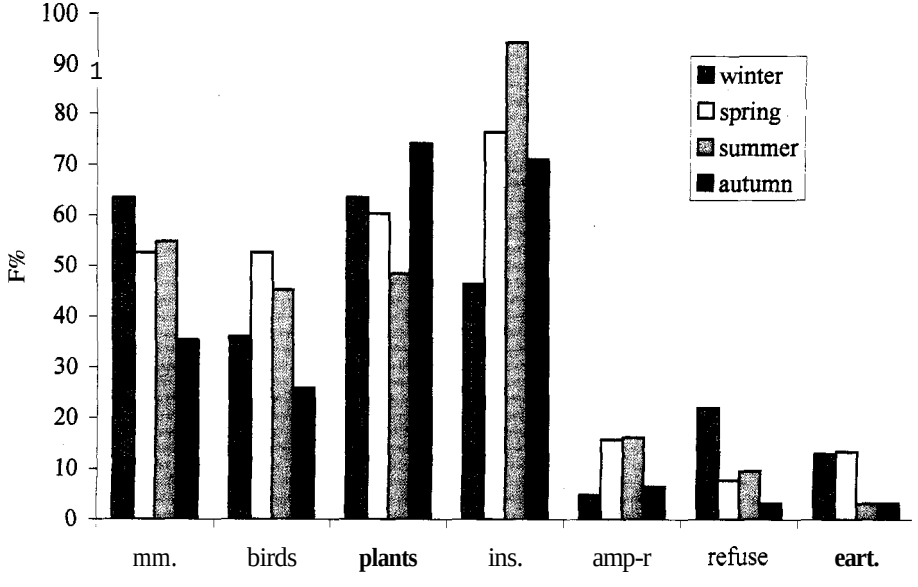

Figure 1 - Seasonal percentage of the different trophic categories, expressed as frequency (F%).

Volpi, 1996), the qualitative analyses could overestimate the importance of categories like plants and invertebrates. The "semi-quantitative" analysis provides, with a limited effort, more information than the "qualitative" analysis alone; above all it highlights the relative importance of the different food categories.

There are no significant differences between the refuse dump and the other transects.

The relative frequency of mammals (RF=21%) is smaller than the values found for the Mediterranean area (Cavallini and Volpi, *l.c.)* and the Ticino Valley (Prigioni and Tacchi, 1991), while it is similar to that recorded by Carada (1998) in woodland and suburban ***ar***-eas of Val di Fiemme. The relative frequency of insects (RF=28%) is clearly higher than that recorded by Prigioni and Tacchi *(l.c.).* The consumption of birds is also high (RF=16%)

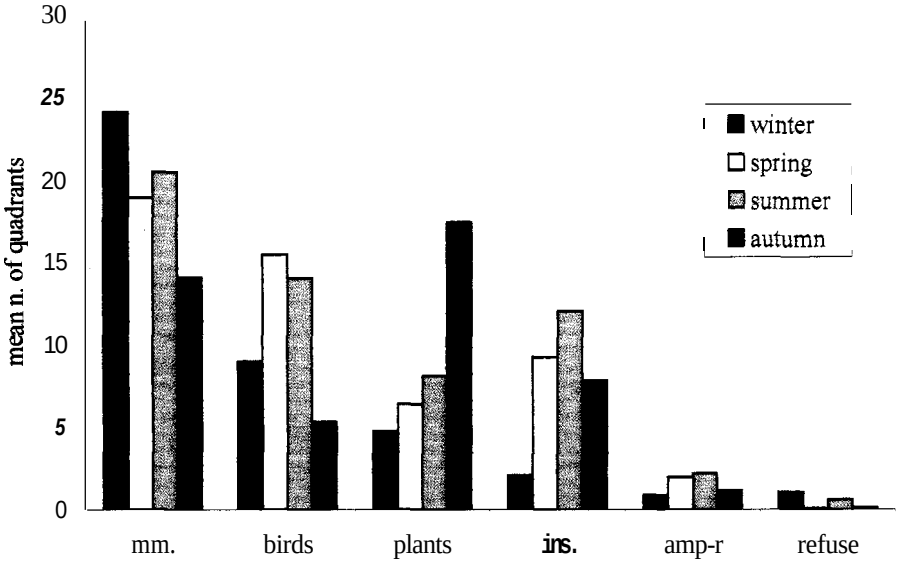

Figure 2 - Seasonal variations obtained with the "semi-quantitative" method.

in comparison with the relative frequency of the Mediterranean area and the province of Trento (Carada, 1998). Finally the frequency of refuse agrees with what was found in Tuscany (Cavallini and Volpi, *l.c.)* and Lombardy (Prigioni and Tacchi, *l.c.)* but it is smaller than the values in other Alpine areas (Carada, *l.c.).*

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Table 3 - Statistical results of the "qualitative" analysis (*p<0.05; **p<0.01). D-B= comparison between areas D and B.

CAT	SEASONAL COMPARISON						D-B
	Sp-Su	Sp-Au	Sp-Wi	Su-Au	Su-Wi	Au-Wi	
mm.	0,092	2,09	0,99	2,4	0,58	5,56*	0,41
Micr.	0,81	1,13	1,69	2,84	4,41*	0,16	0,06
Mur.	1,13	2,63	1,12	2,09	3,34	4,3*	4,89*
Lep.	0,47	0,54	0,31	1,34	1,12	0,22	0,113
oth. .mm.	0,23	1,85	0,17	1,34	0,19	1,91	2,67
birds	0,44	5,17*	2,1	2,6	0,58	1,03	1,85
pl.	1,07	1,52	0,12	4,41*	1,67	1,03	21,57**
ins.	3,98*	0,31	7,49**	5,52*	17,86**	4,44*	0,036
amp-r.	0,1	1,66	2,68	1,61	2,56	0,31	1,055
ref.	0,65	0,56	4,72*	1,33	2,09	5,45*	0,87
eart.	2,26	2,26	0,14	0,51	2,17	2,17	6,39*

Table 4 - Statistical results of the "semi-quantitative" analysis (Kruskal-Wallis test). 1: comparison between areas D and B; *2:* seasonal variations in area B; 3: seasonal variations in area D; 4: seasonal variations in areas B+D.

CAT	1		*2*		3		4	
	X (1)	H (1, N=141)	*X* (3)	H (3, N=91)	*X* (3)	H (3, N=50)	*X* (3)	H (3, N=141)
mm.	0,587	0,672	10,79	8,81	*0*	0,916	5,9	6,45
p=	0,443	0,413	0,012	0,031		0,82	0,116	0,091
birds	1,84	3,14	1,38	2,253	5,73	4,58	5,64	7,05
p=	0,17	0,076	0,709	0,521	0,125	0,204	0,13	0,07
pl.	22,36	26,56	8,43	12,72	3,24	5,85	10,33	15,52
p=	0	0	0,037	0,005	0,35	0,119	0,016	0,001
ins.	0,02	0,023	7,45	11,61	7,47	14,79	14,85	22,94
p=	0,886	0,878	0,058	0,008	0,058	0,002	0,001	0
amp-r.	0,567	0,708	3,23	2,83	3,058	3,13	4,04	3,58
p=	0,451	0,4	0,356	0,418	0,382	0,371	0,256	0,31
ref.	0,92	1,046	10,86	10,86	1,85	*2*	8,49	8,71
p=	0,337	0,306	0,012	0,012	0,6	0,57	0,036	0,033

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