Acta Biologica Szeged. *23* (1—4), pp. 97—107 (1977)

FOOD-BIOLOGICAL INVESTIGATIONS ON THE FOX POPULATIONS IN SOUTHERN HUNGARY

M. ERDEI

Department of Zoology, Attila József University, Szeged

(Received November 20, 1976)

Abstract

In 501 sq.km (between March 1974 and December 1975) 133 fox gastric content, 433 animal remains, and 499 prey remains and excrements were investigated. The percentage of damage and use depends upon the season, the territorial features, and the amount of prey and foxes. The fox is noxius in an intensive small-game area where its tolerable density is 0,14—0,10 fox/sq.km. On the other hand, it is useful in an agricultural district when the noxious rodents became too numerous. Otherwise it is indifferent but its population density should not outnumber 0,17—0,20 fox/sq.km because, as a result of its fecundity, it is difficult ot maintain its number.

Introduction

It is a common distinctive feature of the defective data of Hungarian literature that the fox is not investigated as a member of the biocoenosis, but that anthropocentric polemics are pursued about its economic damage and utility. Lacking methodical food-biological investigations, some authors try on the basis of a few observations or cases to qualify the fox as expressly useful, and other Hungarian authors as expressly noxious or as indifferent.

Foreign researchers are also interested in the problems of use and damage induced by the fox, but in addition, the fox-research there is also motivated by other factors. There are many more foxes elsewhere than in Hungary and that may produce every now and then great rabietic epidemics. SPITTLER (1972) established in Nordrhein-Westfalen that the decrease in the number of foxes was always followed by an increase in the stock of useful small game. The connections between the stock-increase in hares and partridges, with respect to the decrease in the stock of foxes can be demonstrated and expressed even in percentage of the basis of hunting spoils. The different kinds of food are classified by SPITTLER (1972), by reason of their character, into five groups: (1) meat, (2) mice, (3) insects, (4) plants, (5) that of other origin. According to Koenan (1952), the everyday food of the fox is the mouse. According to PETZSCH (1966), the fox yields a not negligible profit, but weighing the pros and cons of use and damage together, it may nonetheless be considered as noxious. According to BEHRENDT (1955), meat is the principle component of the total food. ENGLUND established (1965) that the composition of gastric contents changed continually and dynamically according to the location, season, period, the number of some kinds of prey and foxes, weather, geographical, and other factors. In the prey-list drawn up by him the noxious rodents occurred most frequently among the mammals. Foxes

seem to prefer voles to mice. LOCKIE (1957), Scott and KLIMSTRA (1955) also agree with this, although the number of mice is generally higher. According to LUND (1967), the fox expressly picks and chooses among the small rodents, preferring voles to mice.

In the research material of PAVLOV, LARIN, and GRIBOV (1961) most remains are derived from small rodents. These are followed in order by birds. According to GUZDEV, SOLDATOVA, and BOCHAROVA (1957) mostly rodents, among them field-voles, are hunted by the fox. According to PAVLOV and KIRIS (1956), fish, reptile and amphibian are consumed by the fox but as a last resort. Carrioneating is a common phenomenon in the fox, although it is not always possible to establish (e. g., with poultry) if in the case investigated it was a dead or a stolen specimen, (ENGLUND, 1965). According to MCINTOSH (1963) in the district Canberra in winter, the most important food of foxes is dead sheep. According to MARTENS' information (1971), emu and kangaroo carcasses are also consumed by foxes willingly.

Materials and Methods

In order to establish, what the extent of damage and use induced by foxes in Southern Hungary is, and what the tolerable population level is, I have carried out investigations. The area of investigation was 50,100 ha, consisting of three zones (cf. the sketch map). Zone "A" was 7,600 ha, zone "B" 37,000 ha, and zone "C" 5,600 ha. The height above mean sea level was 78—85 m above the Adriatic. The relief is a perfect plain. In the area mentioned — between March 1974 and December 1975 — the gastric content of 133 foxes, 433 piece animalremains, and 499 prey-remains and excrements found on the ground were investigated. The detailed aims and points of view of my investigations were the following:

1. To analyse the frequency of the single kinds of prey, on the basis of the remains found in the stomach.
2. To establish the relative content of the stomachs investigated.
3. To calculate the total gastric content (biomass).
4. To find the frequency of the occurrence of the single kinds of prey, as compared to the number of stomachs.
5. To make a species-list of prey-animals, on the basis of the gastric contents.
6. To analyse the frequency of the single kinds of prey, on the basis of the remains and excrements found on the ground.
7. To make a list of prey-animals, on the basis of the remains and excrements found on the ground.

Results

1. The single kinds of prey occur in the menu of the fox with different frequencies. The most frequent prey was mammals, which were consumed 52,7 per cent of the time (Cf.: Table 1). The game birds were carried away by the fox mainly in the period of hatching and raising the little chickens. In case of pheasants, even the sex could usually be established, because of the feather-remains from the breast and neck area. In Autumn and Winter, the prey was nearly always a cock, and in Spring and Summer a hen. Small, noxious rodents are also an important food for the fox. Among these, the frequency of the different voles is the highest but it changes according to the seasons. Insects occurred in Summer, with a surprisingly high frequency, but this didn't mean a large proportion of the total food. In the different zones, the single kinds of prey did not occur with the same frequency (cf. Table 1).

2. The summary of the relative gastric contents according to zones shows that the frequency of the single kinds of prey is not always correlated with the relative content, in the zones. This follows from the different sizes of the single animal species, as well. Although the brown hare occurred, e.g., in zone "A" only with a 5,5 per cent frequency, and in zone "B" with a 3,5 per cent frequency, it took part in the relative gastric contents in zone "A" 22,4 per cent of the time, and in zone "B" 18,3 per cent of the time. The small, noxious rodents are closely correlated with one another. The most mispoprotioned conditions are observed with insects and plants (cf. Table 1 and Fig. 1).

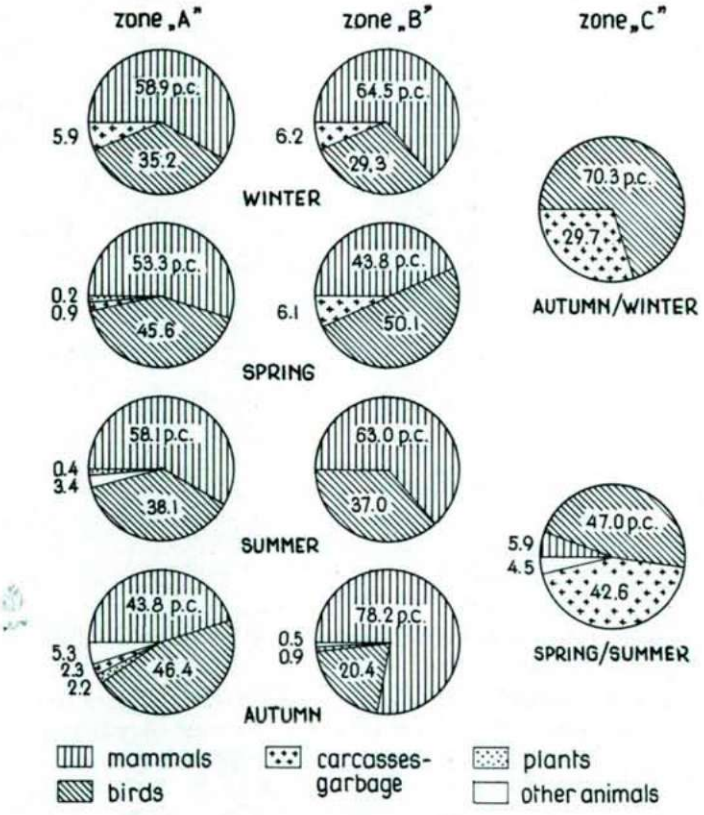

Fig. 1. Relative gastric content.

3. After summarizing all the gastric contents in the area investigated during the period of investigation (1974—1975), the total gastric content was 19,916.4 g. There fell to one stomach an average of 149,7 g. Breaking down the row to 50 g-parts from 5 to 351 g, most stomachs (29) contained between the weight limits of 29 to 200 g. Taking into account the empty stomachs, 66 stomachs contained less than 151 g. With respect to the average weight of gastric contents, there is no essential difference between and within zones, between seasons, and between sexes. But in the stomach

Table 1. Analysis of the frequency of some kinds of prey on the basis of gastric contents (1974—1975).

	Total prey	201		203		29		433	
		pieces							
		"A"		"B"		"C"		together	
		zones							
		number	p.c.	number	p.c.	number	p.c.	number	p.c.
A)	Plants	6	3.0	3	1.5	1	3.5	10	2.3
B)	Invertebrata	48	23.9	55	27.1	—	—	103	23.8
	Mollusca	2	1.0	—	—	—	—	2	0.4
	Insects	46	22.9	55	27.1	—	—	101	23.4
C)	Vertebrata	143	71.1	143	70.4	18	62.0	304	70.2
	Fish	—	—	—	—	1	3.5	1	0.2
	Amphibia	3	1.5	—	—	—	—	3	0.7
	Reptilia	—	—	—	—	1	3.4	1	0.2
	Birds	31	15.4	29	14.3	11	37.9	71	16.4
	game birds	17	8.4	11	5.4	—	—	28	6.5
	poultry	1	0.5	1	0.5	4	13.8	6	1.4
	other birds (and eggs)	13	6.5	17	8.4	7	24.1	37	8.5
	Mammals	109	54.2	114	56.1	5	17.2	228	52.7
	Insectivores	6	3.0	2	1.0	3	10.3	11	2.5
	brown hare	11	5.5	7	3.5	—	—	18	4.2
	mice	16	8.0	37	18.1	2	6.9	55	12.7
	voles	73	36.2	52	25.6	—	—	125	28.9
	hamster/gopher	3	1.5	16	7.9	—	—	19	4.4
D)	Carcasses and								
	garbage	4	2.0	2	1.0	10	34.5	16	3.7
	carcasses	4	2.0	2	1.0	1	3.5	7	1.6
	garbage	—	—	—	—	9	31.0	9	2.1

of young foxes much less food could be found, and even that was of mixed composition, often only carcasses and garbage.

4. I have mostly observed mammals, birds, carcasses and garbage in stomachs. In zone "A" 20 stomachs only contained mammals, out of which 11 were small rodents, and nine brown hares. But brown hares were only found in 11 stomachs and small rodents in 21. An explanation is that the fox, after being satiated with hare, does not feel the need to take further food. The same may also be observed after the consumption of pheasant. In spite of this, in the overwhelming majority of cases, the stomachs exposed did not contain any useful game (cf. Table 2 and Fig. 3).

5. In the gastric contents, I have determined the following species. The numbers ofter species-names denote the number of pieces of remains.

a) Plants

Rubus caesius	5
undetermined species	5

b) Invertebrata

Gastropoda — not determined in detail	2
Insecta	
Acridoidea — not determined in detail	32
Tettigonioideae — not determined in detail	31
Coleoptera	
Geotrupes mutator	7
Anoxia orientalis	5
Polyphylla fullo	3

c) Vertebrata

Pisces	
Carassius auratus gibelio	1
Amphibia	
Anura — not determined in detail	3
Reptilia	
Lacerta agilis	1
Aves	
Phasianus colchicus	23
Perdix perdix	2
Anas plathyrhyncha	2
A. crecca	1
Gallus domestica	5
Corvus frugilegus	1
C. cornix	1
Garrulus glandarius	1
Pica pica	1
Columba domestica	1
Streptopelia decaocto	3
S. turtur	1
Galerida cristata	1
Sturnus vulgaris	1
Turdus pilaris	1
Passer montanus	4
Carduelis carduelis	1
Parus major	1
Vanellus vanellus	1
Larus ridibundus	1
Fulica atra	2
undetermined species	2
eggs	15
Mammalia	
Lepus europaeus	18
Apodemus sylvaticus and *Mus spicilegus*	44
A. agrarius	4

Micromys minutus	5
Rattus norvegicus	2
Clethrionomys glareolus	48
Microtus arvalis	57
Pitymus subterraneus	16
Arvicola terrestris	3
Ondathra zibethicus	1
Cricetus cricetus	13
Citellus citellus	6
Erinaceus europaeus	1
Talpa europaea	1
Sorex araneus	6
Neomys fodiens	3

d) Carcasses and garbage

Carcasses	
Capreolus capreolus	1
Anser erythropus	1
A. domestica	1
Meleagris gallopavo	1
undetermined species	3
Garbage	
pork-lard	1
sausage	1
pork	1
bread	1
potatoes	1
paper	2
hide	1
plastic	2

6. In the stomach only food-remains reffering to a certain point of time can be found. But in the neighbourhood of burrows food-remains referring to a longer period can be found, provided that these — owing to their quality — do remain for a longer, than a shorter time. Included in this class, for instance, are some bone remains, feathers, and various finds in exrements. The frequency of some species is many times greater than the frequency calculated from the gastric contents, e.g., that of the hamster (cf. Tables 1 and 3). That of birds is also higher. The reason for this is that the parts of some species, left over by the fox (e.g., the wing of the pheasant) do remain for a long time. The remains found in the burrows and their close neighbourhood cannot replace, even if systematized, the prey and species lists made on the basis of the stomachs exposed. They may call attention to certain facts (in the present case to the extreme frequency of hamsters) that otherwise would remain obscure. I omit publishing a species-list made on the basis of remains found on the ground because its data are already summarized in Table 3.

My investigations performed on the food-biology of the fox *(Vulpes vulpes* L.*)* on the basis of the animal-remains found in the stomachs and of prey-remains and

Table 2. Comparison of the number of pieces of prey to the number of the receiving stomachs (1974—1975).

Total number of stomachs		62		62		9		133	
		"A"		"B"		"C"		together	
		zones							
		prey	stom.	prey	stom.	prey	stom.	prey	stom.
		pieces							
A)	Plants	6	6	3	1	1	1	10	10
B)	Invertebrata	48	6	55	4	—	—	103	10
	Mollusca	2	2	—	—	—	—	2	2
	Insects	46	4	55	4	—	—	101	8
C)	Vertebrata	143	—	143	—	18	—	304	—
	Fish	—	—	—	—	1	1	1	1
	Amphibia	3	1	—	—	—	—	3	1
	Reptilia	—	—	—	—	1	1	1	1
	Birds	31	28	29	25	11	6	71	59
	game birds	17	17	11	11	—	—	28	28
	poultry	1	1	1	1	4	4	6	6
	other birds (and eggs)	13	10	17	13	7	2	37	25
	Mammals	109	33	114	39	5	2	228	74
	insectivores	6	1	2	2	3	1	11	4
	brown hare	11	11	7	7	—	—	18	18
	mice	16	6	37	7	2	1	55	14
	voles	73	13	52	11	—	—	125	24
	hamster/gopher	3	2	16	12	—	—	19	14
D)	Carcasses and								
	garbage	4	4	2	2	10	6	16	12
	carcasses	4	4	2	2	1	1	7	7
	garbage	—	—	—	—	9	5	9	5

excrements, are summarized in the following. The data on the population-density are determined on the basis of number-estimation (applying statistics of shooting and visual observations).

The relative ratio and frequency of some kinds of prey change in the gastric contents. The ratio of use and damage also changes. It depends on the season and zone (cf. Figs. 1 and 2).

In the stomachs, both with respect to the total weight and to the relative content, mammals, birds, carcasses and garbage constitute most of the prey. Mammals and birds are vertebrata. Invertebrata, and plants contributed minimally to the gastric contents analyzed.

In the fox population living in the neighbourhood of gargabe-heaps containing digestible organic matter no individuals with an empty stomach were found during the investigation.

Rodents accuring frequently in the area investigated also accur more frequently in the prey. Rodents found rather rarely are also rare in the prey.

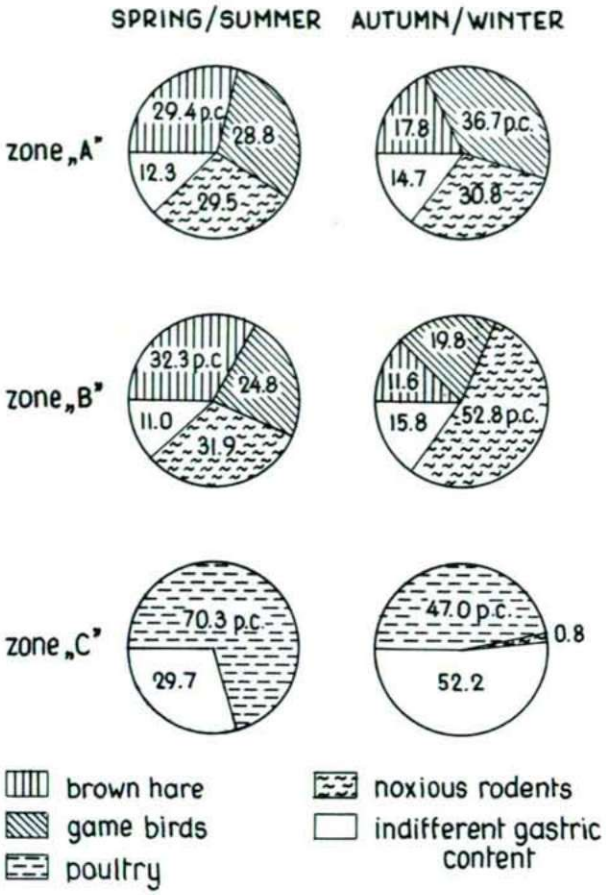

Fig. 2. Use and damage on the basis of the relative gastric content.

From the bird species living wild in the area investigated, only the pheasant can be found with high frequency in the prey-list. The other species, in however large numbers they live in the area, occur only occasionally in the prey-list.

In winter, the wounded cock-pheasant is prey more frequently than the hen-pheasant. In spring and summer, due to hatching, the-pheasant is more frequent.

The massacre of brown hares and game birds, as well as the stealing of poultry, may be regarded as a harmful activity of the fox.

On the other hand, the destruction of the noxious rodents, and the cleansing role it carries out as a so-called „litter-bearer" in forests and meadows are to its credit.

In the area investigated, the activity of the populations living in zone "A" is expressly harmful owing to the destruction, mainly in spring and summer, of the nesting pheasants with their nestlings. But the activity of the populations living in

Table 3. Analysis of the frequency of some kinds of prey on the basis of remains and excrements found on the ground (1974—1975).

	No. of finds	112 "A" zones		259 "B" zones		78 "C" zones		449 together	
		piece	p.c.	piece	p.c.	piece	p.c.	piece	p.c.
A)	Plants	5	4.5	2	0.7	—	—	7	1.6
B)	Invertebrata	23	20.5	8	3.1	2	2.6	33	7.3
	Mollusca	3	2.7	—	—	—	—	3	0.7
	Insects	20	17.8	8	3.1	2	2.6	30	6.6
C)	Vertebrata	82	73.2	249	96.2	53	67.9	384	85.5
	Fish	2	1.8	—	—	1	1.3	3	0.7
	Reptilia	1	0.9	—	—	—	—	1	0.2
	Birds	43	38.4	16	6.2	47	60.2	106	23.6
	game birds	27	24.1	9	3.5	4	5.1	40	8.9
	poultry	2	1.8	2	0.7	39	50.0	43	9.6
	other birds (and eggs)	14	12.5	5	2.0	4	5.1	23	5.1
	Mammals	36	32.1	233	90.0	5	6.4	274	61.0
	insectivores	3	2.7	—	—	—	—	3	0.7
	brown hare	7	6.2	8	3.1	4	5.1	19	4.2
	mice	9	8.0	9	3.5	1	1.3	19	4.2
	voles	14	12.5	13	5.0	—	—	27	6.0
	hamster/gopher	3	2.7	203	78.4	—	—	206	45.9
D)	Carcasses and								
	garbage	2	1.8	—	—	23	29.5	25	5.6
	carcasses	2	1.8	—	—	5	6.4	7	1.6
	garbage	—	—	—	—	18	23.1	18	4.0

zone "B" is expressly useful in spring and summer, owing to the destruction of the noxious rodents (cf. Fig. 2).

All their other activities are indifferent from the point of view of man.

The number of foxes living in the area investigated is somewhat above that tolerable. The 0,23 fox/sq.km density must be decreased to 0,17—0,20 fox/sq.km. This means that one fox may occur in 500—600 ha.

In the areas that, owing to their conditions, are particularly suitable for pheasant nesting, the locally tolerable number ought to be decreased to a 0,14—0,10 fox/sq.km density. This means that one fox may occur in 700—1.000 ha. So many foxes, however, are necessary, mainly for hygienic reasons.

The fox is at the end of the food-chain and, in the area, there is no longer any natural anemy that would impede its multiplication. This activity remains, therefore, the task of the man.

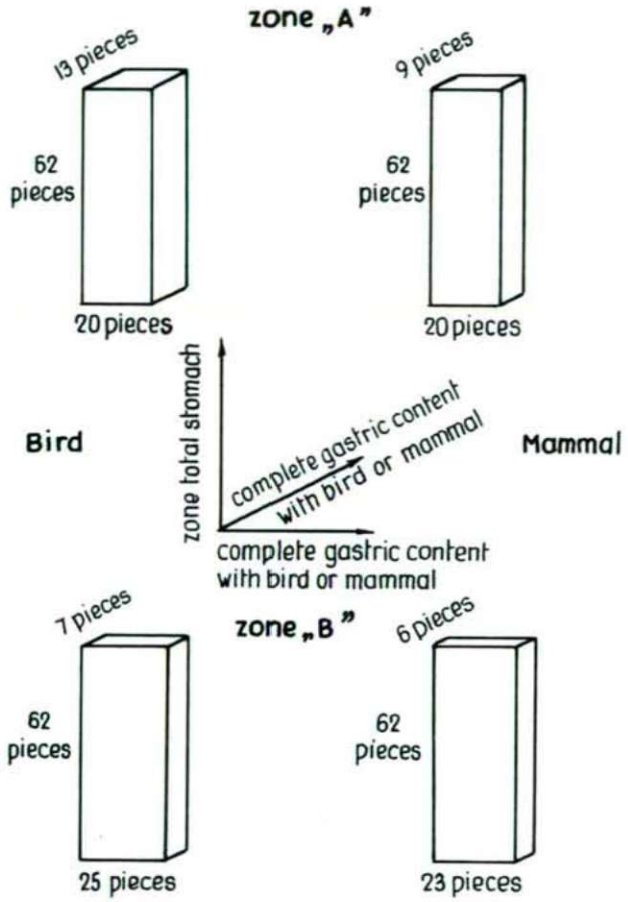

Fig. 3. Frequency of the complete gastric contents in case of birds and mammals.

As a procedure for reducing their number I don't propose poisoning (bait) and gassing. The food and eggs poisoned will damage the fox least. The protected and very rare birds of prey, however, often take them up. As for taking poisonous gas out into nature and into the hunting-ground, I refuse that on principle.

In order to impose restrictions on the number of foxes, I suggest the hunting-like procedures: shooting, foxdriving, and in the vicinity of breeding stations I propose trapping.

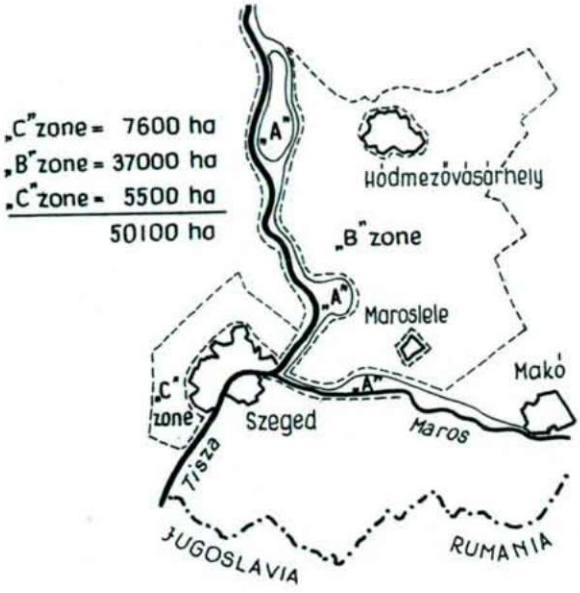

Fig. 4. Area of ivestigation (Sketch map).

References

BEHRENDT, G. (1955): Beiträge zur Ökologie des Rotfuchses *(Vulpes vulpes* L.*)* — Zeitschrift für Jagdwissenschaft *1*. 161—183.

COMAN, B. J. (1973): The diet red foxes, *Vulpes vulpes* L. in Victoria. — Australia J. Zool. *21*, 391—401.

ENGLUND, J. (1965): Studies on food ecology of the red fox (Vulpes v.) in Sweden. Viltrevy, *3*, 377—485.

GUZDEV, V. V., SOLDATOVA, A. N. and BOCHAROVA, O. M. (1957): Letnee pitanie lisitsy *(Vulpes vulpes* L.*)* v Prieruslanskikh Peskakh. — Zoologichesky Zhurnal, *36*, 1424—1426.

KOENAN, F. (1952): Der Rotfuchs. — Leipzig.

KOCKIE, J. D. (1957): Small rodent prey of the fox and marten. Bull. Mamm. Soc. Brit. Isles. No. *8*.

LUND, HJ. M.-K. (1962): The red fox in Norway. II. The feeding habitats of the red fox in Norway. — Papers Norwegian State Game Res., 2nd Ser. (12), 1—79.

MARTENS, P. N. (1971): Observations on the food of the fox (*Vulpes vulpes* L.) in an arid environment. C.S.I.R.O. Wildl. Res. *16*, 73—75.

MCINTOSH, D. L. (1963): Food of the fox in the Canberra district. — C.S.I.R.O. Wildl. Res. *8*, 1—20.

PAVLOV, M. P. and KIRIS, I. B. (1956): Pitania lisitsy *(Vulpes vulpes L.)* v. Priazovskikh plavnyakh Kubani, zaselennykh nutriey *(Myocastor coypus* MOL.*)*. — Zoologichesky Zhurnal *35*, 897—907.

PAVLOV, M., LARIN, B. and GRIBOV, Z. (1961): Lisitsa. Ohota i ohotnich'e hozyaystvo *8*, 20—23.

PETSCH, H. (1969): Uránia Állatvilág. Ragadozók rendje. Uránia Animal Kingdom. Order of predators, 213—295. Budapest.

SCOTT, TH. G. and KLIMSTRA, W. D. (1955): Red foxes and a declining prey population. Monogr. Univ. S. 3, No. 1. Pp. 123.

SPITTLER, H. (1972): Über die Auswirkung der durch die Tollwut hervorgerufenen Reduzierung der Fuschspopulation auf den Niederwildbesatz in Nordrhein-Westfalen. — Hamburg und Berlin.

Address of the author:
DR. M. ERDEI
H—6723 Szeged,
Tarján ltp. 507. A. III/11.
Hungary