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Diet of the Long-eared Owl *Asio otus* in Yugoslavia

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Introduction

The Long-eared Owl *Asio otus* has a circumpolar distribution in the boreal, temperate, Mediterranean and steppe climatic zones (Mikkola 1983). It is widespread in Yugoslavia (Matvejev & Vasić 1975).

The diet of the Long-eared Owl has been studied all over Europe (summarized by Schmidt 1974, Marti 1976, Cramp 1985). Almost all authors emphasize the importance of *Microtus* voles in the diet and some of them even regard the owl as a "vole specialist" (Goszczynski 1981). Although much field work has been done on the Long-eared Owl, there are only a few studies on small mammal availability and species prevalence (Goszczynski 1981, Nilsson 1981, Village 1981, Wijnands 1984).

In this paper I describe the diet of the Long-eared Owl in northern Yugoslavia, its hunting habitat, and its main hunting strategy.

Study area

The study was carried out on the Ljubljana moor (Ljubljansko barje, 46°00′ N, 14°30′ E), a 5–10 km wide depression south of the city of Ljubljana (Slovenia, Yugoslavia). The study area is about 160 km^2 and lies 287–290 m above sea level.

A hundred and fifty years ago, before it was drained, Ljubljana moor was the most southern raised bog in Europe. Today, there are only a few raised bog fragments, all of which have reached their full development in forest of the *Pino sylvestris–Betulletum* and *Betulo–Quercetum roboris* types (Martinčič 1987). Draining changed the rest of Ljubljana moor into marshes or agricultural land (Seliškar 1986), with scarce tree vegetation of *Salix* spp., *Quercus* spp., *Alnus* spp. and *Abies* spp. (personal observations). In spite of all efforts, occasional floods still occur.

Material and methods

Owl pellets were collected during the breeding seasons (January to August) of 1984–1986 and 1988–1989 over the entire Ljubljana moor area. Of 66 samples, 59 were obtained from raised bog fragments and the other 7 from marshes. Each sample consisted of pellets collected in one day from the nest site, or under the roosting tree. In 1986 only samples from raised bog fragments were analysed. For the study of annual variation

in the diet, the results of a pellet analysis in 1980 (Kryštufek 1980) were also included.

All the prey animals whose remains were found in the pellets obtained from the dense vegetation of raised bog fragments were considered to come from these fragments, even though the owls hunted in open grassland surrounding the fragments. The prey animals in pellets found in marshes far from the raised bog fragments were considered to come from marshes.

Small mammal species were identified according to Kryštufek (1985). The number of individuals of different species was determined from skull remains with or without mandibles (minimum method). Birds and insects were not identified because of their low number.

Common vole *Microtus arvalis* and common pine vole *Pitymus subterraneus* skulls without mandibles were not identified to species. They were assigned to these two species according to their proportion in pellet samples.

For the study of annual variation in the diet, only prey species with a proportion of 1% or more were taken into consideration. Mice and shrews were considered as collective groups; 1) yellow-necked mouse *Apodemus flavicollis* and wood mouse *A. sylvaticus*, and 2) common shrew *Sorex araneus*, Miller's water shrew *Neomys anomalus*, lesser white-toothed shrew *Crocidura suaveolens* and bicoloured white-toothed shrew *C. leucodon*. For the study of the diet in relation to the availability of small mammals, only pellets from the close vicinity of snap-trapping places were taken into account.

The abundance of small mammals was assesed by snap-trapping in three localities in 1985, 1986,

Table 1. Diet of the Long-eared Owl on the Ljubljana moor during 1984–1989 (+ means less than 0.1%). The sources are: A = this study, B = Mikuska & Vuković (1980), C = Kovačić (1984)

Species	N	Percent by number	Percent by weight	Weight (g)	Source
Microtus arvalis	1142	57.6	55.4	24	A
M. agrestis	337	17.0	22.5	33	A
Microtus spp.	5	0.2	0.3	28	A
Pitymys subterraneus	181	9.1	5.9	16	A
Clethrionomys glareolus	70	3.5	3.1	22	A
Arvicola terrestris	16	0.8	3.2	98	B
Voles total	1751	88.2	90.4		
Apodemus sylvaticus	100	5.0	3.8	19	A
A. flavicollis	25	1.3	1.0	20	A
Apodemus spp.	42	2.1	1.6	19	A
Micromys minutus	3	0.2	+	7	B
Mice total	170	8.6	6.4		
Sorex araneus	5	0.3	0.1	9	A
Neomys anomalus	1	+	+	13	A
Crocidura leucodon	13	0.7	0.3	11	B
C. suaveolens	8	0.4	0.1	5	B
Crocidura sp.	1	+	+	8	B
Shrews total	28	1.4	0.5		
Muscardinus avellanarius	2	0.1	0.1	27	C
Talpa europae	10	0.5	1.9	95	B
Mammals total	1961	98.8	99.4		
Birds total	15	0.8	0.6	20	C
Insects total	8	0.4	+	1	C
Total	1984	100.0	100.0		

1988 and 1989. Two of them were in the surroundings of raised bog fragments and one in the marshes. Small mammals were snap-trapped in spring and early summer without pre-baiting. Their relative abundance was determined on the basis of line trapping — one line trap consisting of 30 snap traps 5 m apart, operating for one night, and on the basis of the minimum method (Grodzinski et al. in Hansson 1975) — two grids in 1985 and two in 1986, each with 6 × 6 stations 15 m apart and two traps per station. The grids were trapped for five nights. Altogether 1248 traps were laid in 4 years.

Results

Small mammals formed the most abundant prey group (99% by number and by weight) in the pellets of the Long-eared Owl. The other prey items were birds and insects (Table 1). The average weight of the prey individuals was 25 g.

The proportions of prey species in the pellets correlated positively with the proportions established by snap-trapping in open habitats (grasslands in surrounding of bogs and in marshes). The correlation between the proportions of prey species in the pellets and the proportions established by snap-trapping in closed habitats (woods, scrubs and surrounding of marshes and in bogs), was negative, but not significant (Table 2).

In the raised bog fragments, the pooled proportions of common and field voles in the diet of the Long-eared Owl were fairly stable during the study, although the species proportions varied considerably. On marshes, both the pooled and separate proportions of common and field voles varied, the field vole being the main prey in all the years of the study (Table 3).

In 1978–1981 the results of snap-trappings on raised bog fragments showed a ratio between the field and common vole of 48:1 (Kryštufek, personal communication). In the years 1980 and 1984 the field vole was also the dominant prey species of the Long-eared Owl (Table 3). After 1985 the snap-trapping results showed a ratio of 1:12 between the field and common vole. Pellet analysis from the same period revealed that the dominant prey species was the common vole (Table 3). In marshes (data from 1989), the field vole was the most frequent species in pellets (Table 3) and in snap-trappings (snap-trapping ratio between field and common vole 2:1).

Discussion

The importance of small mammals in the diet of the Long-eared Owl on the Ljubljana moor agrees with the results of numerous pellet analysis carried out in other areas of Europe (Schmidt 1974, Marti 1976, Cramp 1985). The low proportion of

Table 2. Correlations between proportions of prey species in pellets (P) of the Long-eared Owl and proportions established by snap-trapping in open (O) and closed (C) habitats.

	1985			1986			1988		1989	
	O	P	C	O	P	C	O	P	O	P
Microtus arvalis	88.8	69.1	0.0	38.5	66.1	0.0	94.2	63.2	93.9	84.4
M. agrestis	4.8	16.5	4.8	46.1	20.9	0.0	0.0	14.0	0.0	6.6
Pitymus subterraneus	3.2	5.6	4.8	7.7	8.8	0.0	2.9	9.9	0.9	5.4
Clethrionomys glareolus	1.6	3.2	42.8	0.0	1.0	100	0.0	4.4	0.9	0.6
Mice	0.0	4.2	38.1	0.0	1.5	0.0	0.0	7.0	0.0	2.4
Shrews	1.6	1.4	9.5	7.7	1.7	0.0	2.9	1.5	4.3	0.6
N	63	71	21	13	147	16	102	272	214	167
r	0.98		−0.50	0.74		−0.30	0.98		0.99	
P	< 0.01		< 0.5	< 0.1		NS	< 0.01		< 0.01	

Table 3. Proportions of the most important prey species in the diet of the Long-eared Owl in raised bog fragments and marshes during 1980, 1984–1986 and 1988–1989. The data from 1980 are derived from Kryštufek (1980).

	raised bog fragments						
	1980	1984	1985	1986	1988	1989	Total
Microtus arvalis	18.4	30.3	67.4	63.3	56.1	66.4	53.6
M. agrestis	59.1	57.6	11.4	17.7	13.1	12.3	23.5
M. arvalis +M. agrestis	77.5	87.9	78.8	81.0	69.2	78.7	77.1
Pitymus subterranus	13.4	1.5	9.7	10.1	10.8	6.9	9.6
Clethorionomys glareolus	–	7.6	2.2	1.2	3.2	1.7	2.2
Mice	1.1	3.0	6.0	1.2	11.3	8.8	7.2
Shrews	–	–	1.5	2.4	1.6	1.5	1.3
N	381	66	134	169	809	658	2217

	marshes						
	1980	1984	1985	1986	1988	1989	Total
Microtus arvalis	–	22.1	36.4	–	8.6	20.0	16.2
M. agrestis	–	37.5	54.4	–	50.0	73.3	48.0
M. arvalis and M. agrestis	–	59.6	90.9	–	58.6	93.3	64.2
Pitymus subterraneus	–	17.3	–	–	12.9	–	12.8
Clethrionomys glareolus	–	19.2	9.0	–	14.3	–	14.2
Mice	–	3.8	–	–	12.8	–	7.4
Shrews	–	–	–	–	–	–	–
N	–	52	11	–	70	15	148

shrews, moles, birds and insects in the diet is also in good accordance with the majority of earlier studies. The results of this study support the opinion that the Long-eared Owl is specialized on vole-sized small mammals.

On the basis of a prey species list (mostly species that inhabit farmlands, grasslands, marshes and deserts), Marti (1976) suggested that open areas are the main hunting habitat of the Long-eared Owl. This suggestion is supported by the correlations between the proportions of prey species in pellets and snap-trappings in open and closed habitats presented in this study.

The different proportions of Mi*crotus* voles in the diet of the Long-eared Owl in different years correspond with the different proportions in the hunting territory of the owl. Two possible reasons for changes in the proportions of *M. arvalis* and *M. agrestis* in the hunting habitat are: variable moisture of the soil, which causes one *Microtus* species to become more abundant than the other (see Myllymäki 1977) and competition between coexisting predators feeding on similar food (see Korpimäki 1987). These findings indicate that the Long-eared Owl is an opportunist when hunting *Microtus* voles.

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