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Winter diet composition of urban long-eared owls (*Asio otus*) in Rzeszów (SE Poland)

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Abstract: Diet variation of the long-eared owl (*Asio otus* Linnaeus, 1758) was investigated on the basis of pellets collected in winter season 2007/2008 from a communal roosting site in a municipal cemetery in Rzeszów (a city in south-eastern Poland). We assumed that the proximity of human settlements would affect the diet composition of this predator, resulting in a higher proportion of species associated with urban habitats. Although voles, especially the common vole *Microtus arvalis*, were still the most important prey, mice constituted approximately 17% of all prey items, with the field mouse *Apodemus agrarius* being most frequent. Food niche breadth was wider in December than in March. Our results suggest that owls from Rzeszów hunt mostly in open habitats surrounding the city, where they can still capture their basic prey species. Yet, they can broaden their diet with species of murids associated with the mosaic urban and suburban habitats.

Keywords: owl pellets, *Asio otus*, diet, Rzeszów, *Microtus arvalis*, *Apodemus agrarius*, urban environment

INTRODUCTION

In the last decades we could observe intensified development of human-created, artificial environments. This destroyed natural habitats, forcing some species to abandon the area of human activity, but could also generate new ecological niches for many species that were flexible enough to sustain vital populations in the vicinity of humans (Luniak 2004). The long-eared owl (*Asio otus*) is known to cope well with human presence and frequently roosts near human settlements. This species is considered a feeding specialist. Its most important prey in Central Europe is the common vole *Microtus arvalis* (Birrer 2009). However, the diet of the long-eared owl varies in the degree of domination of this rodent and the occurrence of supplementary prey species (Czarnecki 1956). The diet composition was investigated in relation to

ambient temperature and precipitation (Rubolini et al. 2003), type of occupied habitat (Romanowski & Żmihorski 2008), and long-term fluctuations in prey abundance and availability (Korpimäki 1992; Tome 2003). However, the majority of European research was conducted in the central and western parts of the continent (Korpimäki 1992) in rural or forested areas. Relatively few authors investigated the diet composition of owls roosting in urban areas (Riegert et al. 2009; Kiat et al. 2008) and very few (such as Nilsson 1981; Tome 2009) have highlighted substantial seasonal variations in the diet of the long-eared owl. Consequently, there is an insufficient amount of information about the diet of owls roosting in the urban environment. The most important difference between farmland and the urban environment is that vole abundance is higher in the former (Čiháková & Frynta 1996, cited from Riegert et al. 2009). Thus vole-eating predators are forced to hunt outside the city and/or feed on alternative prey (Riegert et al. 2009). Some indications of a winter dietary adaptation to man-made environments have been reported (e.g. a dominance of the house mouse *Mus domesticus* and brown rat *Rattus norvegicus* or an increase in the contribution of birds to the diet) (Wijnandts 1984; Pirovano et al. 2000; Sándor & Kiss 2008). Although the diet of long-eared owls seems to be quite well-studied (partly because they use communal roosts in winter where it is easy to collect a sufficient number of pellets), their diet composition was mainly investigated in central or western parts of Poland (Czarnecki 1956; Harmata 1969; Sałata-Piłacińska & Tryjanowski 1998; Skierczyński 2003; Romanowski & Żmihorski 2008). Two studies were conducted in the south-east of Poland, but in an agricultural landscape (Kitowski et al. 2005; Wiącek et al. 2008). In the south-east, populations of potential prey species are different. For example, populations of the common vole are larger and very abundant occurrence is more frequent (Romankov-Zmudowska & Grala 1989).

The main aim of this study was to report on the diet composition of long-eared owls roosting communally in the urban environment of Rzeszów (SE Poland) in the winter season.

MATERIAL AND METHODS

The roost site, occupied by 12–15 owls during winter (October 2007 until April 2008), was located in the central part of the municipal cemetery (surface area 19 ha) in the eastern part of Rzeszów (SE Poland, 50.0436°N, 22.0428°E). From the north, the cemetery was bordered by cultivated arable fields, meadows and gardens, which stretched for about 1 km and further away were replaced by built-up areas of the northern part of the city. The eastern part of the cemetery was edged by meadows and abandoned gardens for about 1 km and further away they were replaced by monoculture farming. The southern and western parts of the cemetery were adjacent to built-up areas of the city, which spread for more than 6 km south and west.

The study was carried out during one winter season and pellets were collected twice, with a 3-month interval: at the end of December 2007 (221 pellets) and at the end of March 2008 (808 pellets). The pellets found were not older than 1.5 months. Standard methods for pellet analysis were used (Raczyński & Ruprecht 1974). Prey was identified on the basis of lower jaws, skulls, and teeth according to the identifica-

Table 1. Diet composition of the long-eared owl (determined according to prey remains in pellets) in Rzeszów during the cold season: December 2007 (221 pellets) and March 2008 (808 pellets). *N* = number of prey individuals; %*N* = percentage of prey individuals; *B* = biomass consumed; %*B* = percentage of biomass consumed. Food niche breadth calculated according to LEVINS (1968). Mean body mass of prey species according to JĘDRZEJEWSKA & JĘDRZEJEWSKI (2001)

Prey category/species	Mean body mass (g)	December 2007				March 2008			
		N	% *N*	*B*	%*B*	*N*	% *N*	*B*[g]	%*B*
Arvicolinae (total)		**339**	**76.3**	**6671**	**80.3**	**1296**	**84.7**	**24917**	**87.2**
Microtus arvalis	19	330	74.2	6270	75.5	1257	82.1	23883	83.6
Microtus sp.	21	4	0.9	84	1.0	8	0.5	168	0.6
Microtus subterraneus	17	2	0.5	34	0.4	28	1.8	476	1.7
Arvicola terrestris	130	2	0.5	260	3.1	3	0.2	390	1.4
Microtus agrestis	23	1	0.2	23	0.3	0	0.0	0	0.0
Murinae (total)		**104**	**23.3**	**1601**	**19.3**	**229**	**15.0**	**3527**	**12.3**
Apodemus agrarius	17	58	13.0	986	11.9	130	8.5	2210	7.7
Apodemus flavicollis	31	5	1.1	155	1.9	16	1.0	496	1.7
Apodemus sp.	19	12	2.7	228	2.7	13	0.9	247	0.9
Micromys minutus	8	29	6.5	232	2.8	68	4.4	544	1.9
Mus musculus	15	0	0.0	0	0.0	2	0.1	30	0.1
Aves	32	**1**	**0.2**	**32**	**0.4**	**3**	**0.2**	**96**	**0.3**
Others (total)		**1**	**0.2**	**1**	**0.01**	**3**	**0.2**	**24**	**0.1**
Sorex araneus	8	0	0.0	0	0.0	3	0.2	24	0.1
Insecta	1	1	0.2	1	0.01	0	0.0	0	0.0
Total		**445**	**100**	**8305**	**100**	**1531**	**100**	**28564**	**100**
Food niche breadth			1.70				1.42		

tion key by Pucek (1984). Based on prey remains, 1976 individuals were separated out and identified. Mammals were determined to the species level (N=1934) and, if not possible, to the generic level. The number of prey individuals was calculated on the basis of the most frequent skull element. The prey species were grouped into 4 categories: Arvicolinae (voles), Murinae (mice), Aves (birds), and Others (including *Sorex* sp. and Insecta). To calculate the biomass consumed, standard values of mammalian body masses were taken from Jędrzejewska & Jędrzejewski (2001). Food niche breadth was then calculated according to Levins' (1968) formula: $1/\Sigma p_i^2$, where p_i denotes the percentage contribution of a given prey group to the diet. Chi-square test with Yates correction was used to compare frequencies of prey items in the 2 samples.

RESULTS

The diet of long-eared owls in Rzeszów was composed nearly exclusively of small rodents (99%). Birds, shrews and insects constituted less than 1% of all prey. The dominant group were voles (Arvicolinae), both with regard to the number of prey individuals and biomass (Table 1).

Among the vole specimens identified to the species level, the common vole *Microtus arvalis* was the most important prey. Other species (the field vole *Microtus agrestis*, the European pine vole *Microtus subterraneus*, and the water vole *Arvicola terrestris*) were much less frequent. Murids remained the second important prey category. Among them, the field mouse *Apodemus agrarius* was the most frequent prey, with a higher frequency in December. Less frequent were the harvest mouse *Micromys minutus* and the yellow-necked mouse *Apodemus flavicollis*. Birds constituted only 0.2% of all prey individuals. Proportions of the major prey species (*Microtus arvalis, Microtus subterraneus, Apodemus agrarius, Micromys minutus, Apodemus flavicollis)* between the 2 samples differed significantly ($\chi^2 = 17.6$, df = 4, $P = 0.001$). When all prey was categorized as voles or mice (including unidentified *Microtus sp.* and *Apodemus sp.*), the proportions between the 2 samples also differed significantly ($\chi^2 = 17.5$, df = 1, $P < 0.0001$). Food niche breadth was wider in December than in March (Table 1).

DISCUSSION

The analysis of pellets collected in the cemetery in Rzeszów shows a strong domination of rodents in the diet of the long-eared owl. This result is similar to the results obtained by other authors investigating the diet of this owl species in Poland (Czarnecki 1956; Judziński 1978; Romanowski 1988; Sałata-Piłacińska 1995; Kopij 1998; Żmihorski 2005; Romanowski & Żmihorski 2008; Wiącek et al. 2008). Like in the other studied localities of the long-eared owl, the main component of its diet in Rzeszów was the common vole *Microtus arvalis*.

We found a relatively large number of murids in the diet of the long-eared owl from Rzeszów. Their remains constituted almost 17% of all prey items, with a higher frequency in December than in March. The field mouse *Apodemus agrarius* consti-

tuted more than half of all murids. In the study by Żmihorski (2005) in Jelonki (central Poland), this species constituted 32.2% of all prey items and was the only species of mice caught by owls in that region. Like in Rzeszów, the pellets were collected during winter and the owl's roost site was in the proximity of an urban area. Long-eared owls can hunt in edge habitats within urban areas, such as wastelands along streams, power-line openings, and railway track verges (Lövy 2007, cited from Riegert et al. 2009). In Poland, *A. agrarius* is a species typical of agricultural field-forest edges (Kozakiewicz et al. 1999). Additionally, studies on small mammals in cities revealed that this species is captured most frequently in urban habitats (Chudoba et al. 1961; Babińska-Werka et al. 1979; Piłacińska et al. 2004). The northern and eastern parts of the cemetery in Rzeszów are surrounded by arable fields and abandoned gardens, which together create a mosaic of habitats and therefore might host great numbers of field mice.

Significant differences were found between the 2 samples from the cemetery in Rzeszów. In December, the percentage contribution of voles to the diet was lower than in March, and the contribution of mice was higher. Similar results were obtained by other authors (Czarnecki 1956; Wijnandts 1984; Tome 1994; Rubolini et al. 2003; Romanowski & Żmihorski 2008). One of the explanations of these differences can be snow cover: when it is present, voles are much less available for avian predators than mice. This is because voles move more frequently under the snow, whereas mice prefer to move on the snow surface (Jędrzejewski & Jędrzejewska 1993). In Rzeszów in 2007, first snow appeared in mid-November (16 cm deep). Thanks to low ambient temperature (minimum temperature -14ºC), it covered the ground for some time. In March 2008, snow was almost absent (G. Pitucha, unpubl. data). Additionally, owls may shift their hunting activity into woods, partially afforested areas and forest-field edges, where snow is usually shallower (Canova 1989). Urban and suburban environment is composed mainly of edge habitats, where owls can hunt for alternative prey when snow is present. In our study, the snow cover was present in November and December, and the percentage of Murinae (especially of *Apodemus agrarius*, which prefers habitat edges) significantly increased in that period.

The frequency of birds in the diet of long-eared owls from Rzeszów was low. This contrasts with a study conducted in western Poland (Judziński 1978), where birds (including the house sparrow *Passer domesticus*) constituted 17.8% of all prey items. It is possible that the hunting area studied by the cited author was less abundant in common voles and the specialisation in bird hunting was a secondary effect. The same conclusion was suggested by Żmihorski & Rejt (2006). When there is snow cover, the frequency of birds in the owl's diet can be even higher, because the owls can shift their hunting areas into urban habitats, where the availability and density of house sparrow populations are higher (Winjands 1984). In Rzeszów, in spite of the proximity of a built-up area, birds were not an important prey. The low proportion of birds in the diet can indicate that owls did not hunt near buildings (Laiu et al. 2002) or that owls from Rzeszów were not specialized in hunting that kind of prey. Additionnally, the low number of birds in the diet can be also explained by the overall low winter abundance of birds in the area. Unfortunately, however, we lack data on the abundance of birds in Rzeszów in that period.

Food niche breadth was higher in December than in March (1.70 and 1.42, respectively). The observed slight increase in food niche breadth during the cold part of the year confirms the pattern recorded earlier in southern Europe (Tome 1994). It indicates that owls tend to broaden their diet and hunt for alternative prey when weather conditions are more severe.

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