ECOLOGIA BALKANICA
2020, Special Edition 3 pp. 129-138

Landscape Structure Impacts the Small Mammals as Prey of Two Wintering Groups of Long-eared Owls (Asio otus L.) from the Region of Silistra (NE Bulgaria)

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Abstract. We studied the diet of two wintering groups of long-eared owls (*Asio otus* L.) from the town of Silistra. During the winter months of 2013/2014, significant differences in the species composition and proportions of the main small mammals in owls' diet were recorded, due to differences in living conditions. A total of 1538 specimens were established, of which 1500 (97,5%) skeletal parts of small mammals, 36 bird specimens (2,3%) and two Coleoptera specimens. We collected 511 whole pellets in which 1183 specimens were identified; the other specimens were found in scattered pellets' parts. A total of 23 species of small mammals were identified: 5 species of Eulipotyphla, 3 species of Chiroptera and 15 species of Rodentia. Twelve of them were common for the two groups of wintering birds. Significant for the owls' diet were 8 species from the genera *Microtus* (3 species), *Apodemus* (3 species) and *Mus* (2 species). In the first territory (Danube Park), with primary importance were the openly living species – voles ($N_{(number\ of\ species)}$ = 54%, $B_{(biomass)}$ = 59%), and in the second (Forest Park Medzhidi Tabia) – forest, field and domestic species of mice (N = 56%, B = 48%). The recorded differences in the small mammal species composition and their percentage share were resulting from the features in landscape structure of the two regions studied, which showed a determining role for the diet of long-eared owls.

Key words: *Asio otus* pellets, Micromammalia, owls diet, Danube River coast.

Introduction

Long-eared owl (*Asio otus* Linnaeus, 1758) is a specialised predator feeding mostly on small mammals. The owls spend the winter in groups of up to 30–40 birds, preferring coniferous trees and choosing areas with good food supply (Glutz von Blotzheim & Bauer, 1994; Marks et al., 1999; Birrer, 2009; Mebs & Scherzinger, 2000). Researches on the long-eared owls' diet are extremely topical, given the multifaceted information we receive, both for its biological and ecological characteristics, and for a wide range of vertebrate animal preys, who are indicative for the state of the environment (Wijnandts, 1984; Korpimaki & Norrdah,

1991; Birrer, 2009). Through the analysis of the diet of the long-eared owl we obtain valuable data about the state of many rare or conservationally significant species of mammals and birds on the one hand (Simeonov, 1964; Simeonov & Petrov, 1986), and about the dominant species of small mammals of the particular region (Birrer, 2009) – on the other. Through dietary analyses, the regularities in the gradients of the environment and the importance of individual components determining the specificities in the communities of the preys can be established (Marti, 1973; 1976; Tome, 1994; 2000; 2003; Sharikov & Makarova, 2014; Tulis et al., 2015). Data from the winter months when owls gather at clusters of several dozen individuals, who excrete their pellets in the same place, are particularly valuable (Dziemian et al., 2012; Cecere et al., 2013). Such information for separate regions of Bulgaria is found in the works of Simeonov (1964; 1966), Simeonov & Petrov (1986), Milchev et al. (2003), Milchev & Ivanov (2016).

Landscape structure and microclimatic features have a determining importance for the living environment on which the species composition and distribution depend (Korpimaki & Norrdah, 1991; Tome, 2003; Aschwanden et al., 2005; Romanowski & Zmiehersky, 2008; Mori & Bertolino, 2015). In order to establish these patterns, it is necessary to compare different groups of owls at the same time, in the same region, but in areas with a different landscape structure. The aim of this study was to establish and compare the prey species composition of two groups of overwintering long-eared owls living in one region, but hunting and feeding in different landscapes. Such a research is carried out for the first time in Bulgaria. The objects of the survey are the food remains in owls' pellets from the region of the town of Silistra (NE Bulgaria).

Material and Methods

The food remains from two wintering groups of long-eared owls during the winter months of 2013/2014 from the region of the town of Silistra (Fig. 1) were collected once on 18–21 April 2014. The first roosting group of birds was located in the Danube City Park (N 44°07'04'' E 27°15'21'', 19 m). Birds inhabited several microhabitats with different tree species (cypresses, pines, ivy-covered large trees). The second group of wintering birds was on the ridge part of the Medzhidi Tabia Forest Park (N 44°06'08'' E 27°15'31'', 131 m), at 2 km distance from the first group. The pellets there were collected under a group of black pines (*Pinus nigra* J.F.Arnold), around 50–60 years of age and about 10–12 m in height, bordering an asphalt road.

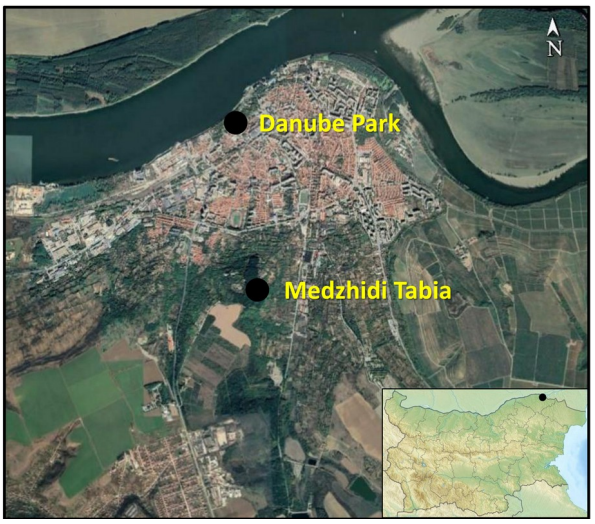

Fig. 1. Location of the two wintering *Asio otus* groups in the town of Silistra.

The collected material was cleaned and all bone remains, feathers and hairs from each pellet were separated individually. The materials from the disintegrated pellets were processed together, and bones and fragments of skulls and mandibles were separated from the post-cranial bones. The determination of the mammals was according to Peshev et al. (2004), Popov & Sedefchev (2003), Görner & Hackethal (1987) and the collection of the University of Forestry, Sofia. Young specimens of *Apodemus flavicollis* (Melchior, 1834) and *A. sylvaticus* (Linnaeus, 1758) were identified to a genus level, and in analysis of

the abundance and biomass of both species they were distributed proportionally, as the proportions of the adults. According to the latest information from Nedyalkov et al. (2019) and Nedyalkov (pers. comm.), in the region of Silistra both the common vole (*Microtus arvalis* (Pallas, 1778) and the southern vole (*M. rossiaemeridionalis* Ognev, 1924) occur. Since they are very hard to determine without chromosomal analyses, they were united in the analysis and discussion as *Microtus arvalis/ rossiaemeridionalis*. The determination of the house mouse (*Mus musculus musculus* Linnaeus, 1758) and steppe mouse (*M. specilegus* Petényi, 1882) for part of the individuals was also impossible, given the heavily broken skulls and the lack of completion between the skull and the mandible. Non-determinable individuals are proportionally distributed between the identified to species level ones.

Birds from the pellets were divided into four size-weight groups according to Prof. Z. Boev (pers. comm.): first size-weight class, with average biomass 8,5 g: Wren (*Troglodytes*) – Robin (*Erithacus*); second, with average biomass 41,2 g: Sparrow (*Paser*) – Hawfinch (*Coccothraustes*); third, with average biomass 97,5 g: Starling (*Sturnus*) – Thrush (*Turdus*), and fourth, with average biomass 210 g: Jay (*Garrulus*) – Magpie (*Pica*). Their number was determined by the remains of skulls, thoracic bones and limb bones, and the size class – by model skeletons corresponding to a given size class.

The abundances and biomass of the small mammal species and genera were calculated as a percentage of the total number of preys or biomass per region. Information about the biomass of the mass species comes from measurements of individuals from different regions of Bulgaria. For the indeterminable species (some voles and mice), the weight was averaged. Information from the literature (Popov & Sedefchev, 2003; Görner et al., 1987) has been used for the rare species. The individual species biomasses used are included in Table 1.

Results and Discussion

During the study of the two wintering groups of *Asio otus* in Silistra, a total of 1538 prey specimens were established, of which 1500 skeletal parts of small mammals from 23 species, 36 of birds and two pairs of Coleopteran elytra (Table 1). Small mammals made up 97,5% of all prey specimens, and 96% of the total biomass in the diet of the wintering owls. The established small mammals were: 5 insectivorous species (Eulipotyphla), 3 bat species (Chiroptera) and 15 species of Rodentia. They made up 58% of the potential prey species for the region, and 77% of the established prey species so far for the whole country (see Kodzhabashev et al., 2020). Five species were recorded for the first time as prey of the long-eared owl in Bulgaria (*Sorex minutus*, *Neomys anomalus*, *Barbastella barbastellus*, *Nyctalus noctula* and *Apodemus uralensis*), six species are protected, three species can be considered very rare (see Kodzhabashev et al., 2020). Rare and protected species were represented by a small number of specimens (from 1 to 3–6), making up 0,07–0,3% of all small mammal preys identified. With the same low ratios were all species newly established as preys of *Asio otus*. We collected 511 whole pellets, and the 1183 preys in them had a total biomass of 35393,5 g. The other specimens were found in scattered pellets' parts. The average number of preys per pellet was 2,32. The average biomass was 69 g, and the average weight per one prey was 29,9 g. These results are similar to those of Marti (1976).

In total, for the region of Silistra, the significant preys in owl diet were representatives of three genera of rodents: *Microtus* ssp., with 47% of the abundance and 51% of the biomass; *Apodemus* ssp., with 27% of the abundance and 26% of the biomass; *Mus* ssp., with 20% of the abundance and 15% of the biomass. United, these three genera had an abundance of 94% of all preys

Table 1. Content of the pellets collected in two hunting territories of *Asio otus* L. in Silistra, NE Bulgaria. Av.w. – average weight; B – biomass.

Prey species	Av.w.(g)	Silistra total (2016)			Danube Park			Medzhidi Tabia		
		No ex.	No ex. %	B %	No ex.	No ex. %	B %	No ex.	No ex. %	B %
Mammalia										
Sorex araneus Linnaeus, 1758	10	8	0.52	0.17	4	0.53	0.17	4	0.51	0.18
Sorex minutus Linnaeus, 1766	5	6	0.39	0.06	4	0.53	0.08	2	0.26	0.04
Neomys anomalus Cabrera,1907	12	1	0.07	0.03	1	0.13	0.05			
Crocidura suaveolens (Pallas, 1811)	5	9	0.59	0.1	5	0.66	0.11	4	0.51	0.09
Crocidura leucodon (Hermann, 1780)	10.5	3	0.2	0.07	1	0.13	0.04	2	0.26	0.09
Plecotus austiacus (Fischer, 1829)	11.5	1	0.07	0.02				1	0.13	0.05
Barbastella barbastellus (Schreber, 1774)	9.5	1	0.07	0.02				1	0.13	0.04
Nyctalus noctula (Schreber, 1774)	29	1	0.07	0.06	1	0.13	0.12			
Muscardinus avellanarius (Linnaeus, 1758)	27	3	0.2	0.17	3	0.39	0.34			
Dryomys nitedula (Pallas, 1778)	28.5	2	0.13	0.12				2	0.26	0.25
Micromys minutus (Pallas, 1771)	7	11	0.72	0.17	1	0.13	0.03	10	1.29	0.31
Apodemus agrarius (Pallas, 1771)	20	104	6.76	4.5	17	2.24	1.44	87	11.2	7.61
Apodemus uralensis (Pallas, 1811)	16.5	6	0.39	0.2				6	0.78	0.43
Apodemus sylvaticus (Linnaeus, 1758)	25	54	3.51	2.9	20	2.63	2.12	34	4.37	3.72
Apodemus flavicollis (Melchior, 1834)	35	221	14.4	16.7	69	9.08	10.3	152	19.5	23.3
Apodemus flavicollis/ sylvaticus	30	35	2.28	2.3	21	2.76	2.68	14	1.8	1.84
Mus spicilegus Petényi, 1882	23	149	9.69	7.4	67	8.82	6.55	82	10.5	8.25
Mus musculus (Linnaeus, 1758)	23	7	0.46	0.35	7	0.92	0.68			
Mus musculus/spicilegus	23	152	9.88	7.5	91	12.0	8.9	61	7.84	6.14
Rattus norvegicus (Berkenhout, 1769)	375	1	0.07	0.8				1	0.13	1.64
Rattus rattus (Linnaeus, 1758)	200	1	0.07	0.4	1	0.13	0.85			
Mesocricetus newtoni (Nehring, 1896)	100	1	0.07	0.2	1	0.13	0.42			
Arvicola amphibius (Linnaeus, 1758)	200	2	0.13	0.9	2	0.26	1.7			
Microtus arvalis/rossiaemeridionalis	36	570	37.1	44.2	317	41.7	48.5	253	32.5	39.8
Microtus subterraneus (Selys, 1836)	20	151	9.82	6.5	96	12.6	8.16	55	7.07	4.81
Total (mammals):		*1500*	*97.5*	*95.8*	*729*	*95.9*	*93.2*	*770*	*99.1*	*98.59*
Aves (size classes)										
Wren–Robin	12.5	6	0.39	0.16	5	0.66	0.27	1	0.13	0.06
Sparrow–Hawfinch	42.5	18	1.17	1.65	15	1.97	2.71	3	0.39	0.56
Starling–Thrush	90	12	0.78	2.33	10	1.32	3.82	2	0.26	0.79
Total (birds):		*36*	*2.34*	*4.16*	*30*	*3.95*	*6.8*	*6*	*0.78*	*1.4*
Coleoptera										
Dytiscus sp.	2	1	0.065	0.004	1	0.13	0.01			
Coleoptera *sp. g.*	2	1	0.065	0.004				1	0.13	0.01
Total (beetles):		*2*	*0.13*	*0.008*	*1*	*0.13*	*0.01*	*1*	*0.13*	*0.01*
Total:		**1538**			**760**			**778**		

and 92% of the total biomass. Similar results and distribution of the main groups of preys established Milchev & Ivanov (2016) for the region of Dobrich.

Our results showed that preys with biomass between 21 and 50 g predominated, both in relation to their abundance, and each species' biomass (Fig. 2). They were followed by those weighing between 11 and 20 g. The share of the very small and very large preys was negligible. This analysis confirmed the data about the diet of the long-eared owl in south-eastern Europe (Birrer, 2009), as well as the results obtained by Tome (1994), on the optimal dimensions of priority and significant small mammal preys.

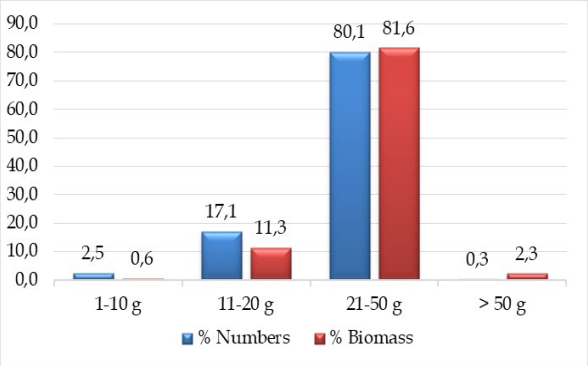

Fig. 2. Share of the different size-weight classes of the mammal prey in owls' diet.

We found 13 mammal species common to the two regions, including the 8 main for the owl's diet species (*M. arvalis*, *M. rossiaemeridionalis*, *M. subterraneus*, *A. flavicollis*, *A. sylvaticus*, *A. agraius*, *M. specilegus*, *M. musculus*), and the remaining 5 species (*S. araneus*, *S. minutus*, *C. suaveolens*, *C. leucodon*, *M. minutus*) had low abundance and biomass, i.e. they were of secondary importance. The other mammal species found had a small number of specimens, due to two main reasons – they are either difficult to capture, inaccessible and non-traditional (accidental) preys, or they are rare. The first group includes the rats (*R. norvegicus* and *R. rattus*), and the water vole (*A. amphibius*) always associated with the presence of water reservoirs. They are large, fast, strong and heavy, which is why they are most often presented with a small number of specimens and abundance between 0,1–0,3% and 3-4% (Simeonov & Petrov, 1986; Milchev et al., 2003; Milchev & Ivanov, 2016); in our research it was 0,2%. However, due to their relatively large mass, their share in the biomass in the owl's diet is significant (Simeonov & Petrov, 1986). The weight and size of these large preys are commensurate and even exceed those of the owl, which adults weigh from 227 to 326 g (Simeonov, 1990), and those of the brown rat are from 250 to 500 g (Popov & Sedefchev, 2003). The inclusion of these "heavy" preys in the diet biomass in their full mass is highly speculative and not entirely correct, given the ability of the owls to swallow the entire prey or to consume all its biomass. There are also no evidences if the predators return to the prey's corpse. Probably, a large proportion of the eaten specimens of these species are young, not reached the optimal size and weight for their species (Marti, 1976).

Accidental preys include amphiboitic and fossorial mammals. In our study, we found one water shrew (*N. anomalus*), whose presence is associated with the bordering Danube River. During the examination of the territory, fresh molehills and piles of dug-out soil were found, suggesting the activity of moles and mole-rats in the winter season. The European mole (*Talpa europea* L., 1758) and the lesser mole-rat (*Nannospalax leucodon* Nordmann, 1840) are potential owls' prey, but they are not traditional, given their hidden lifestyle and rare appearance on the surface, especially in the winter months. Another active in winter species is the squirrel (*Squirus vulgaris* L., 1758), which is dendrophilous and active during the day, hence it is an accidental owls' prey. It has been found as a prey just once in Bulgaria (Milchev et al., 2003). Near the Forest Park Medzhidi Tabia, within range of the owls' hunting territory, there

was an active colony of ground squirrels (*Spermophilus citellis* L., 1766). This species is also a potential prey, registered once for Bulgaria (Milchev et al., 2003), but in our study it was not found, probably due to its daily activity and winter hibernation. Similar is the case with the edible dormouse (*Glis glis* L., 1766), who has winter hibernation, but has been found repeatedly in owls' diet, although its abundance was only 0,7% (Simeonov, 1964, Simeonov & Petrov 1986). In our study, we found the hazel dormouse (*M. avellanarius*) (3 ex.) and forest dormouse (*D. nitedula*) (2 ex.), which can be taken as an exception and atypical behavior, given the biological characteristics of these animals during the winter. According to Peshev et al. (2004), all three species are in hibernation by the end of April, but the initial period is not firmly established. Given our knowledge of the periods of formation of the wintering groups of owls, we can assume either that dormice fall into hibernation after mid-October, or during the winter, when prolonged uncharacteristic warmings occur, they temporarily come out from a state of hibernation and fall in wintering birds' menu. As an exception, the forest dormouse might be pointed, because it is known it can interrupt its hibernation for short periods (Peshev et al., 2004).

The identified three bat species can also be considered accidental prey of wintering owl groups. So far, only the gray long-eared bat (*P. austriacus*) has been registered as a prey of wintering owls in Bulgaria (Milchev et al., 2003). The other two species, the common noctule (*N. noctula*) and the western barbastelle bat (*B. barbastellus*), were here established as prey for the first time in Bulgaria. Six bat species have been reported as owls' prey for the territory of northern Eurasia (Sharikov & Makarova, 2014) – two species for Slovakia (Obuch, 1998), and for the Mediterranean zone two species and *Pipistrellus* spp. are reported (Garcia et al., 2005). These long-time studies on wintering groups of owls showed a dependence of the number of bats caught from the specific climatic conditions. When prolonged warmings in winter occur, bats are activated and fall into the owl menu, and in the absence of temperature fluctuations (if such warmings are missing), bats disappear from owl's diet. According the authors, owls do not have certain preferences for specific bat species, but hunt those available in the airspace.

To the category of the rare species found in owls' pellets, we can name the western barbastelle bat, Romanian hamster (*M. newtoni*) and the Ural field mouse (*A. uralensis*). The first two species are protected by the Biological Diversity Act and included in the Red Data Book of Bulgaria, and the third species has no national conservation status, but it has not been confirmed for our fauna since 1972, when the last studies on its bio-ecology were carried out (see Kodzhabashev et al., 2020).

The differentiated analysis of the hunting areas of the two groups of wintering owls showed significant differences in the proportions of the main food components. There were also differences found in the species composition of the preys. The food remains collected from the first group of owls from the Danube Park included 760 preys: 729 mammal specimens of 19 species, 30 specimens of birds of three size classes, and one beetle (Table 1). The average number of preys in one pellet was 2,22 and the average biomass was 67,7 g. The average weight of one mammal prey was 30,93 g. From the second group of wintering owls found in the Medzhidi Tabia Forest Park, remains from 778 preys were found: 771 mammals of 17 species, 6 birds of the same three classes and one diving beetle of the family Dytiscidae. The average weight of one mammal prey was 29,24 g.

Literary data about the daily dose of food needed to satisfy the energy needs of one owl individual are highly contradictory, the daily ratios varying from 80 to 120 g (Simeonov & Petrov, 1986). Our results

showed that the daily ration limits vary between about 70 g (contained in one pellet) and 140 g (in two pellets). Given the average biomass of the preferred preys, 21–50 g, followed by these of 11–20 g. (Fig. 2), we can make different combinations of the eight main small mammal species preys. It is very likely that the preys in one pellet (2–4 specimens on average, depending on the individual mass), are the nutritional norm of one owl for a day. According to Marti (1976), *Asio otus* in Europe consumes 60 g per day at an average prey weight of 32,2 g. However, the diet is highly dependent on climatic conditions (temperature, snow cover, wind, etc.) and energy balance, which also determines the necessary calories for the normal functioning of all life processes (Wijnandts, 1984; Sharikov & Makarova, 2014).

In addition to the differences found in the average biomass and the number of preys in pellets from the two regions, we also observed differences in the species composition (Table 1), as well as in the abundance of the different prey species (Fig. 3, 4).

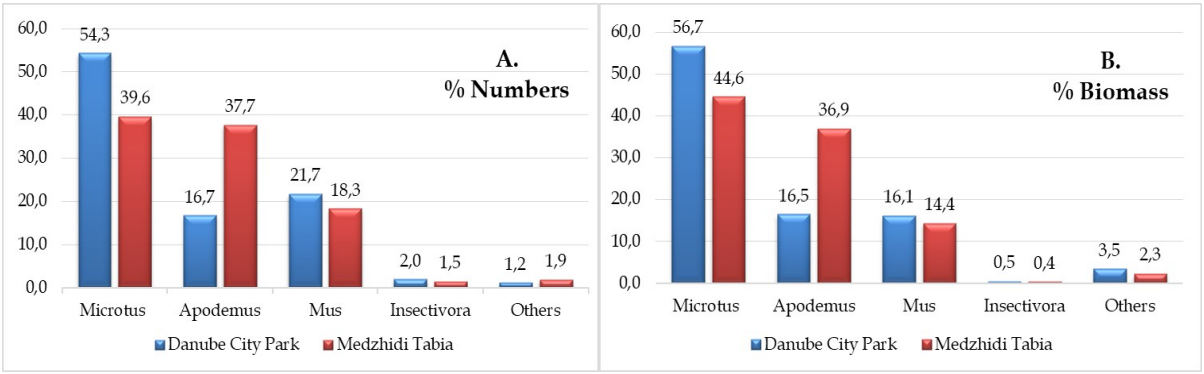

Fig. 3. Share of the most significant groups of preys:
A. Share in the total abundance; B. Share in the total biomass.

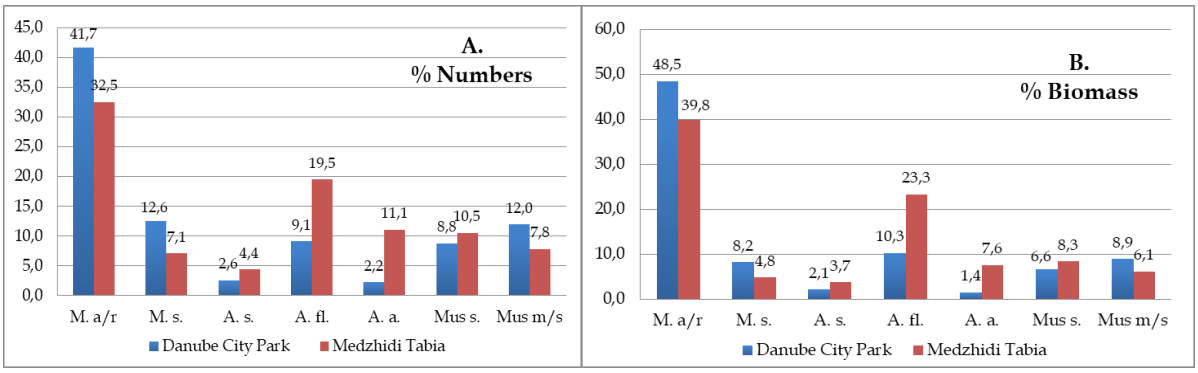

Fig. 4. Share of the most significant species of preys: M. a/r – *Microtus arvalis/rossiaemeridionalis*, M. s. – *M. subterraneus*, A. s. – *Apodemus sylvaticus*, A. fl. – *A. flavicollis*, A. a. – *A. agrarius*, Mus s. – *Mus specilegus*, Mus m/s – *M. musculus/specilegus*; A. Share in the total abundance; B. Share in the total biomass.

In the hunting territories of the owls in the Danube Park, the share of the voles made up 54% of the total numbers and 57% of the total biomass, and for the Forest Park Medzhidi Tabia these values were 40% and 45%, respectively (Fig. 3, 4). Just the opposite

was the share of forest and field mice (Fig. 3, 4). In the Danube Park, genus *Apodemus* had 17% of the total abundance and 17% of the total biomass; in Medzhidi Tabia the abundance was 38% and the share in the total biomass was 37%. The share of domestic mice of the genus *Mus* was similar for the two hunting regions, respectively: 22% of the numbers and 16% of the biomass in the Danube Park, and 19% of the numbers and 15% of the biomass in Medzhidi Tabia. The most significant difference in the diet of the two groups of wintering owls resulted from the main preys – voles and forest mice, which have different requirements for the specific environmental conditions and different behavior during the winter period. The results presented on Fig. 4 showed the significance of the main prey species. In both regions, dominant were the voles from the *Microtus arvalis/rossiaemeridionalis* group.

Habitats in the Danube Park, located next to the Danube River coast and bordering the urban environment, combined with compositions of watered lawns and groups of wood-shrub vegetation, can be divided into synanthropic (urban), semisynanthropic (forest park) and natural (coastal). The synanthropic landscape is extremely heterogeneous with a wide variety of micro-habitats, predetermining the rich species composition of small mammals. The landscape structure offers suitable conditions for open-living mesophilous and mesohygrophilous species. Regular mowing and presence of predominantly ornamental shrub and tree species with atypical (unknown to the native animals) seeds, are probably shaping an unsuitable environment for some of the forest dwellers, including *A. flavicollis* and *A. agrarius*. The presence of mesohygrophilous species, characteristic mainly of mountain habitats, is registered for both the Northern Dobrudzha (Murariu, 2005; Miu et al., 2018), and some plain regions of Bulgaria (Peshev et al., 2004) and Southern Dobrudzha (Simeonov, 1966; Milchev & Ivanov, 2016). As such species, *S. minutus*, *N. anomalus*, *M. subterraneus*, *B. barbastellus* can be classified. According to Miu et al. (2018), other typical mountain species such as *Myodes glareolus* (Schreber, 1780) and *Neomys fodiens* (Pennant, 1771) are also registered near the Danube Delta. In Bulgaria, *M. glareolus* is found at the sea level around the mouth of the Kamchchia River (Peshev et al., 2004), and *N. fodiens* – near Plovdiv (Markov, 1957) and Yambol (Simeonov & Petrov, 1986). Only in the Danube Park we found *N. anomalus*, *A. amphibius*, *M. avellanarius*, *R. rattus*, *M. musculus*, *M. newtoni*, and *N. noctula*. Their requirements are very different and can be grouped into four habitat complexes – synanthropic and eusynanthropic (for the domestic mouse and black rat), water and hygrophilic (for *N. anomalus* and *A, amphibius*), forest mesophilic with rich undergrowth (for *M. avellanarius*), and natural and cultural open, steppe-like areas with thick and deeply drained soil horizon (for *M. newtoni*). The main preys in the Danube Park were of the genus *Microtus*, representatives of the open habitats, but *M. subterraneus* is mesophilous, and the other two are xeromesophiles, preferring cultivated areas and agrocoenoses.

The hunting territories of the owls from the Forest Park Medzhidi Tabia were extremely diverse. Next to the hill where the park is located, lay many agricultural lands, pastures and small livestock farms, two micro dams and two small but permanent creeks powered by the micro dams. The forest habitats are old black pine and black locust plantations and semi-natural forests with numerous hollow trees, mostly walnuts. In this region only, we found *P. austriacus*, *B. barbastellus*, *D. nitedula*, *A. uralensis*, and *R. norvegicus*. Here we found the three forest mice species – *A. flavicollis*, *A. sylvaticus*, and *A. uralensis*, and the ratio between them was, respectively, 26: 6: 1. The predominance of forest and field mice (Fig. 4) is in accordance with the dominating forest habitats, fragmented by numerous mesophilic gullies, meadows and agricultural areas. The main preys with greatest

importance in the owls' diet in this area were *A. flavicollis* and *A. agrarius*, followed by the steppe mouse (*M. specilegus*).

The established in the Danube Park places for hiding during the day were groups of several tall false cypresses (*Chamaecyparis* sp.) or black pines with a height of 8–10 m, located next to very lively, roadside places. In the specific year 2013, the total number of owls counted on 26 December was 56. In the area of the Medzhidi Tabia, such places, established on 26 and 27 December, were different from where we collected the biological material and the counted birds were about 40, found amongst an old black-pine plantation.

During our visit, at 19 April 2014, when we collected the biological material, we found a shell of a freshly hatched owl egg, which indicated that the breeding period probably started at the beginning of March or even in the end of February. These data differ significantly from those given by Simeonov & Petrov (1986) and Simeonov (1990), who stated that the breeding period begins after mid-March. It is likely that the beginning of the breeding period depends on the specific climatic conditions of the current year. The observed trends of global climatic changes, with shortening of the periods with cold and snowy days during the winter, are likely to cause atypical biological reactions, disrupting the natural rhythm of the biological clock of small mammal species and their natural cyclic hibernation in the winter season.

Acknowledgements. Authors express their gratitude to Kalina Miteva and Iva Stamenova (both from the University of Forestry, Sofia) for their help with the separation of the bone fragments, to Prof. Dr. Vasil Popov (IBER – BAS) for the confirmation of the determined animals, and to Dr. Nedko Nedyalkov (National Museum of Natural History – BAS) for providing information.

References

Aschwanden, J., Birrer, S. & Jenni, L. (2005). Are ecological compensation areas attractive hunting sites for common kestrels (*Falco tinnunculus*) and long-eared owls (*Asio otus*)? *Jurnal of Ornithology, 146*, 279-286. doi: 10.1007/s10336-005-0090-9.

Birrer, S. (2009). Synthesis of 312 studies on the diet of the Longeared Owl *Asio otus*. *In* Johnson, D., Van Nieuwenhuyse, D. & Duncan, J. (Eds.): Proc. Fourth World Owl Conf. Oct-Nov 2007, Groningen, The Netherlands. *Ardea, 97*(4), 615-624.

Cecere, J., Bombino, S. & Santangeli, A. (2013). Winter Diet of Long-eared Owl *Asio otus* in a Mediterranean Fragmented Farmland. *The Wilson Journal of Ornithology, 125*, 655-658. doi: 10.1676/13-005.1.

Dziemian, S., Piłacińska, B. & Pitucha, G. (2012). Winter diet composition of urban long-eared owls (*Asio otus*) in Rzeszów (SE Poland). *Biological Letters, 49,* 107-114. doi: 10.2478/v10120-012-0010-7.

Garcia, A., Cervera, F. & Rodriguez, A. (2005). Bat predation by long-eared owls in mediterranean and temperate regions of southern Europe. *Journal of Raptor Research 39*(4): 445-453.

Glutz von Blotzheim, U. & Bauer, K. (1994). *Handbuch der Vögel Mitteleuropas*. Bd. 9. Wiesbaden, Germany: Akademische Verlagsgesellschaft.

Görner, M. & Hackethal, H. (1987). *Säugetiere Europas* (p. 371). Leipzig, Germany: Radebeul.

Kodzhabashev, N., Dipchikova, S. & Teofilova, T. (2020). Conservationally significant small mammals in the diet of two wintering groups of long-eared owls (*Asio otus* L.) from the region of Silistra (NE Bulgaria). *Ecologia Balkanica, Special Edition 3,* 116-127.

Korpimaki, E. & Norrdah, K. (1991). Umerical and functional responses of Kestrels, shorth-eared owls and long-eared owls to vole densities. *Ecology, 72*(3), 814-826. doi: 10.2307/1940584.

Marks, J., Cannings, R. & Mikkola, H. (1999). Family Strigidae (Typical Owls). *Handbook of the Birds of the World* (Vol. 5, pp. 76-242). Barcelona, Spain: Lynx Edicions.

Markov, G. (1957). *Insectivorous Mammals of Bulgaria*. Sofia, Bulgaria: BAS. (In Bulgarian).

Marti, C. (1973). Food consumption and pellet formation rates in four owl species. *Wilson Bulletin, 85,* 178-181.

Marti, C. (1976). A review of prey selection by the long-eared owl. *Condor, 78*, 331-336.

Mebs, T. & Scherzinger, W. (2000). *Die Eulen Europas* (pp. 396). Stuttgart: Franckh-Kosmos Verlag.

Milchev, B. & Ivanov, T. (2016). Winter Diet of Long-eared Owls. *Asio otus* (L.) in a Suburban Landscape of North-Eastern Bulgaria. *Acta zoologica bulgarica, 68*(3), 355-361.

Milchev, B., Boev Z. & Toteva, T. (2003). Diet composition of the Long-eared Owl (*Asio otus*) during the autumn-winter period in the northern park of Sofia. *Annual of Sofia University „St. Kliment Ohridski". Book 1, Zoology*, 49-56.

Miu, I., Chisamera, B., Popescu, D., Iosif, R., Nita, A., Manolache, S., Gavril, V., Cobzaru, I. & Rozylowicz, L. (2018). Conservation priorities for terrestrial mammals in Dobrogea Region, Romania. *ZooKeys, 792*, 133–158. doi: 10.3897/zookeys.792.25314.

Mori, E. & Bertolino, S. (2015). Feeding ecology of Long-eared Owls in winter: an urban Perspective. *Bird Study, 62*, 257-261. doi: 10.1080/00063657.2015.1013522.

Murariu, D. (2005). The state of the mammals (Mammalia) along the Danube between Garla mare and Calarash (Romania). *Travaux du Muséum National d'Histoire Naturelle, 48*, 327-445.

Nedyalkov, N., Koleva, V. & Raykov, I. (2019). Distribution and taxonomy of the Grey voles (Mammalia, Rodentia, subgenus *Microtus*) in Bulgaria. ARPHA Conference Abstracts 2: e46495. doi: 10.3897/aca.2.e46495.

Obuch, J. (1998). Zastúpenie netopierov (Chiroptera) v potrave sov (Strigiformes) na Slovensku. *Vespertilio, 3*, 65-74.

Peshev, C., Peshev, D. & Popov, V. (2004). *Fauna Bulgarica* (Vol. 27. Mammalia, pp. 632). Sofia, Bulgaria: BAS.

Popov, V. & Sedefchev, A. (2003). *Mammals in Bulgaria.* Sofia, Bulgaria: Geosoft. 291 p.

Romanowski, J. & Zmihorski, M. (2008). Effect of season, weather and habitat on diet variation of a feedingspecialist: a case study of the long-eared owl, *Asio otus* in Central Poland. *Folia Zoologica, 57*(4), 411-419.

Sharikov, A. & Makarova, T. (2014). Weather conditions explain variation in the diet of Long-eared Owl at winter roost in central part of European Russia. *Ornis Fennica, 91*, 100-107.

Simeonov, S. (1964). Materials about the food of the Long-eared Owl (*Asio otus* L.) from some Bulgarian regions. *Annual of Sofia University, 57*, 117-120. (In Bulgarian).

Simeonov, S. (1966). Forschungen über die Winternahrung der Waldohreule (*Asio otus* L.) in Nord-Bulgarien. *Fragmenta Balcanica, 23*, 169-174.

Simeonov, S. (1990). Owls, Order Strigiformes. In: Fauna Bulgarica. *Aves. Part I*. (Vol. 20, pp. 293-317). Sofia, Bulgaria: BAS. (In Bulgarian, English summary).

Simeonov, S. & Petrov, T. (1986). New materials about the food of the Long-eared Owl (A*sio otus* L.) during non-breeding period in Bulgaria. *Ekologia, 18*, 27-32. (In Bulgarian).

Tome, D. (1994). Diet comparison on the Long-eared Owl in Central Slovenia: seasonal variation in prey use. *Journal Raptor Research, 28*, 253-258.

Tome, D. (2000). Estimating individual weight of prey items for calculation of the biomass in the diet of long eared owl (*Asio otus*): is it worth of extra effort? *Folia Zoologica, 49*(3), 205-210.

Tome, D. (2003). Functional response of the Long-eared Owl (*Asio otus*) changing prey numbers: a 20-year study. *Ornis Fennica, 80*(2), 63-70.

Tulis, F., Baláž, M., Obuch, J. & Šotnár K. (2015). Responses of the Long-eared Owl *Asio otus* diet and the numbers of wintering individuals to changing abundance of the Common vole *Microtus arvalis*. *Biologia, 70*, 667-673. doi: 10.1515/biolog-2015-0074.

Wijnandts, H. (1984). Ecological Energetics of the Long-Eared Owl (*Asio Otus*). *Ardea, 55*(1–2), 1-92.

Received: 17.07.2020
Accepted: 13.12.2020