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DIET OF THE LITTLE OWL *ATHENE NOCTUA* (SCOPOLI, 1769) ON THE TERRITORY OF BEREHOVO DISTRICT (TRANSCARPATHIAN REGION)

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Objectives. The Little Owl is the most common owl in the Western Palearctic and its population is declining significantly in Europe. Therefore, conservation and study of this owl is an important issue in most European countries. Analysis of trophic patterns at the local level provides interesting and valuable information about the predator's eating habits. The owl's diet investigation allows us to analyze their potential adaptations to habitats with different levels of environmental transformation.

Materials and Methods. We studied nutrition of the Little Owl *Athene noctua*, in agricultural lands of Berehove district of Transcarpathian region in Ukraine. In total, 1446 pellets were collected at 15 pellet stations in 2002–2020 and 2506 prey items were identified. The prey items represented 18 vertebrate species (16 species of small mammals of three orders Rodentia, Soricomorpha, Carnivora, as well as reptiles of the family Lacertidae and birds of the order Passeriformes and arthropods.

Results. Vertebrates play a major role in feeding the Little Owl (over 99 % of total prey biomass in all of the studied sites). The common vole is the most common prey in the owl's diet (52.1 % of the total prey number and 67.5 % of the biomass of the prey caught), as well as a high proportion of mice of the genus *Apodemus* and *Sylvaemus*. The contribution of invertebrates to total prey biomass is insignificant (0.3 %). A large number of invertebrates were observed in the diet of the Owl in summer and were almost completely absent in winter.

Conclusions. According to our data, the Little Owl is a typical predator generalist in Transcarpathia. The 28 taxa found in the pellets show a wide range of food objects

in a relatively small area, and high level adaptations to habitats with different levels of environmental transformation (agrosystems and anthropogenic areas).

Keywords: the Little Owl, feeding, pellets, the common vole, agro-landscape, Transcarpathian region

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INTRODUCTION

The Little Owl *Athene noctua* (Scopoli, 1769) is the most common owl in the Western Palearctic, although it currently undergoes severe population declines in many European countries (Génot & Van Nieuwenhuyse, 2002; Hámori, Szél, & Winkler, 2017). Therefore, conservation and investigation of this owl have become important issues across Europe (Van Nieuwenhuyse, Génot, & Johnson, 2008; Zastavnyi, 1994). The Little Owl is a synanthropic (nesting, sedentary) species that has inhabited many suburban and urban territories throughout western Ukraine with areas suitable for reproduction and hunting (Fesenko & Bokotey, 2002; Fesenko & Bokotey, 2007; Strautman, 1963; Tatarinov, 1973). Studies of the owl's habitat requirements show that this species uses a variety of settlements: active and abandoned industrial areas, suburbs, and sometimes even historic city centers (Arcidiacono, Donati, & Mastrorilli, 2007). A study of trophic patterns at the local level provides essential and valuable information about the predator's eating habits. It is known that the Little Owl feeds mainly on vertebrates, but insects comprise a considerable portion of its diet (Génot, 2005). Such data are confirmed by publications of owl nutrition in Western Ukraine, but these data were based on small size samples and therefore require further investigation (Bashta, 1994; Cherkashchenko, 1970; Skilskyy, Khlus, Meleshchuk, & Smirnov, 2007). In Europe, in the northern parts of the range, the diet of the Little Owl is less diverse than in the southern parts, where habitat and climatic differences contribute to the diversity of food objects (Génot & Van Nieuwenhuyse, 2002; Mikkola, 1983). The decline in the number of owls in Europe is primarily associated with changes in farming methods (Kitowski & Pawlega, 2010; Romanowski, 1988). These changes affect the diet, as well as jeopardize finding nesting sites. The number of this species has also been decreasing in Transcarpathia over the past decade (L. L. Pokrytiuk, pers. comm). Since there are enough nesting places in this area, it is worth researching the nutrition spectrum of the Little Owl in Transcarpathia to identify the main feeding objects and check for their possible changes depending on the year, season and habitat. The impact of different types of environment on its diet should also be analyzed to assess the potential adaptations of the species to habitats with different levels of environmental transformation (agrosystems and anthropogenic areas).

MATERIAL AND METHODS

This study was conducted in Berehove district of Transcarpathian region in Ukraine. The Transcarpathian lowland is the eastern part of the Pannonian Basin. It lies southwest of the Carpathian Mountains. More than 70 % of the Transcarpathian lowland is plowed. A large area of agricultural land is occupied by buildings, roads, hayfields and pastures, gardens, vineyards. The forested areas comprise a small portion (10–15 %) of the territory (Marynych & Shyshchenko, 2005; Zastavnyi, 1994).

The diet of the Little Owl was studied using the pellet method. The pellets – leftovers of food items that cannot be digested and are thrown up by a bird – were collected during 2002–2020 under hunting grounds and directly under the nests of the Little Owl (tobacco dryers, farms, elevators). The overall sample of 1446 pellets (779 in the winter, 441 in the spring, 131 in the summer and 95 in the fall) has been collected and analyzed in the study area (**Table 1**).

Table 1. **Pellets collection point and seasons of *Athene noctua***

Таблиця 1. **Пункти і сезони збору пелеток *Athene noctua***

Year	No.	Season	Pellet collection point	No. pellets	Year	No.	Season	Pellet collection point	No. pellets
2002	1	SUM	Berehove (point 1)	3	2008	26	WIN	Badalovo	57
2005	2	SUM	Velyka Byihan (point 1)	8		27	WIN	Choma	143
	3	AUT	Mala Byihan	33		28	WIN	Chopivka (point 2)	8
2007	4	WIN	Deida (point 1)	85		29	WIN	Chopivka (point1)	12
	5	SPR	Berehove (point 1)	270		30	WIN	Deida (point 2)	9
	6	SUM	Chopivka (point 1)	4		31	SPR	Deida (point 2)	8
	7	SUM	Balazher	25		32	SPR	Deida (point 2)	2
	8	SUM	Chopivka (point 2)	1		33	SPR	Deida (point 3)	4
	9	SUM	Berehove (point 2)	6		34	SPR	Berehove (point 2)	13
	10	AUT	Deida (point 1)	8		35	SPR	Deida (point 2)	3
	11	AUT	Berehove (point 2)	7		36	SPR	Berehove (point 1)	101
	12	AUT	Deida (point 2)	8		37	SUM	Velyka Byihan (point 1)	84
	13	AUT	Deida (point 2)	2		38	WIN	Chopivka (farm 2)	8
	14	AUT	Berehove (point 2)	14	2019	39	SPR	Velyka Bakta	21
	15	AUT	Deida (point 3)	3		40	SPR	Balazher	14
	16	AUT	Berehove (point 2)	19		41	SPR	Fornosh	5
	17	AUT	Deida (point 2)	1		42	WIN	Berehove (point 1)	57
	18	WIN	Deida (point 2)	5		43	WIN	Deida (point 1)	16
	19	WIN	Deida (point 1)	8		44	WIN	Deida (point 2)	8
	20	WIN	Deida (point 3)	3	2020	45	WIN	Deida (point 3)	5
	21	WIN	Deida (point 1)	21		46	WIN	Velyka Byihan (point 2)	63
2008	22	WIN	Berehove (point 2)	25		47	WIN	Balazher	8
	23	WIN	Deida (point 3)	12		48	WIN	Velyka Byihan (point 2)	145
	24	WIN	Chopivka (point 2)	4		49	WIN	Deida (point 2)	25
	25	WIN	Berehove (point 2)	52	**In general**				1446

Comments: WIN – Winter; SPR – Spring; SUM – Summer; AUT – Autumn

Примітки: WIN – зима; SPR – весна; SUM – літо; AUT – осінь

The pellets of the Little Owl were collected in 15 different localities of Transcarpathia, which were divided into 4 groups for analysis:

- **inactive industrial and animal complexes** (represented by a large number of abandoned industrial buildings; many trees and shrubs of both deciduous and coniferous species, with a predominance of the former; the grass cover is high, only a few pastures or hayfields are preserved; there are often continuous blackberry thickets; sometimes small almost drained irrigation canals pass nearby);
- **active farms** (have a mosaic structure, with numerous farm buildings for livestock, pastures and intensive agricultural fields intersected by small canals);
- **village** (there is a large number of residential and technical buildings and homesteads; the grass cover is mostly very low due to constant mowing down; trees are mostly represented by fruit crops (*Malus domestica*, *Pyrus communis*, *Prunus domestica*, etc.) and a small number of conifers (*Picea abies* and *Thuja occidentalis*), almost no bushes; at a distance of 200–300 m from the nests there are small private fields with various crops);
- **continuous agro-landscape** (areas with solitary active or abandoned buildings surrounded by farm fields planted with monocultures; there are few trees and shrubs, mostly along the fields or roads).

Identification of the food items has been conducted relying on the morphology of fragments of the skull, jaws, teeth and dentition (for mammals and reptiles), feathers and skeletal remains (for birds), the structure and shape of limbs and other parts of the body for insects (Vinogradov & Argyropulo, 1941). Mammals were identified to species level, in some cases to genus (*Apodemus/Sylvaemus* sp. and *Mustela* sp.), birds – to order, reptiles – to family, insects – to class, sometimes family, genus, species. Identification of vertebrate remains was performed by I. Zahorodnyi, L. Romaniuk, O. Hnatyna and I. Dykyy, and invertebrate remains – I. Skyrpan. The biomass data were obtained from the Pucek (Romanowski & Żmihorski, 2009).

We used such definitions as “dominant” and “subdominant” analyzing the owl`s diet. The word “dominant” designates to a species that dominates in the diet of the bird, and “subdominants” are species (or group of species) whose share is ≥ 5 %.

RESULTS

The prey that has been identified from 1446 pellets include 18 vertebrate species (16 species of small mammals of three orders Rodentia, Soricomorpha, Carnivora, as well as reptiles of the family Lacertidae and birds of the order Passeriformes) and arthropods (**Table 2**). 2506 food items were identified in total: 1401 in the winter, 760 in the spring, 218 in the summer, and 127 in the autumn.

Based on the data obtained, small mammals are the most abundant (87 % of items, 99.3 % by biomass) in the diet of the Little Owl in all of the studied areas. The common vole *Microtus arvalis* is the most common in the diet of the Little Owl (52.1 % of the total prey number), but mice of the genus *Apodemus* (11.4 %) and the harvest mouse *Micromys minutus* (5.5 %) also constitute a fairly high proportion. Other rodent species, including atypical for the Little Owl feeding objects, such us the brown rat *Rattus norvegicus*, occurred in small numbers. In addition, five Eulipotyphla species were also found in the pellets, among which the lesser white-toothed shrew *Crocidura suaveolens* (5.2%) was the most common. The common shrew *Sorex araneus* and the Eurasian pygmy shrew *Sorex minutus*, and rare for this area the Mediterranean water shrew

Table 2. **Diet composition of the *Athene noctua* in the territory of Berehove district of Transcarpathian region in Ukraine**

Таблиця 2. **Спектр живлення сича хатнього на території Берегівського району, Закарпаття**

Year	Number / frequency of occurrence and biomass	*Apodemus agrarius*	*Sylvaemus tauricus*	*Sylvaemus sylvaticus*	*Mus musculus*	*Micromys minutus*	*Apodemus / Sylvaemus* sp.	*Rattus norvegicus*	*Microtus arvalis*	*Microtus agrestis*	*Myodes glareolus*	*Sorex araneus*	*Sorex minutus*	*Neomys anomalus*	*Crocidura leucodon*	*Crocidura suaveolens*	*Mustela* sp.	Aves	Lacertidae	Insecta	In general
	g	23.5	31	20	15.5	8	25.8	238	28.5	33.5	24.5	11	4.5	13.5	8	6	65	19	12.5	0.5	
2002	MNI	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	3
	MNI %	0	0	0	0	0	0	0	100	0	0	0	0	0	0	0	0	0	0	0	100
	MNI g	0	0	0	0	0	0	0	85.5	0	0	0	0	0	0	0	0	0	0	0	85.5
	MNI g %	0	0	0	0	0	0	0	100	0	0	0	0	0	0	0	0	0	0	0	100
2005	MNI	0	0	0	0	2	2	1	37	2	0	0	0	0	0	0	0	0	0	5	49
	MNI %	0	0	0	0	4.1	4.1	2	75.5	4.1	0	0	0	0	0	0	0	0	0	10.2	100
	MNI g	0	0	0	0	16	51.6	238	1055	67	0	0	0	0	0	0	0	0	0	2.5	1430
	MNI g %	0	0	0	0	1.1	3.6	16.6	73.8	4.7	0	0	0	0	0	0	0	0	0	0.2	100
2007	MNI	10	13	0	7	10	74	2	383	6	0	22	6	0	8	39	0	5	1	150	736
	MNI %	1.3	1.8	0	1	1.3	10	0.3	52.1	0.8	0	3	0.9	0	1	5.3	0	0.7	0.1	20.4	100
	MNI g	235	403	0	109	80	1909	476	10916	201	0	242	27	0	64	234	0	95	12.5	75	15078
	MNI g %	1.6	2.7	0	0.7	0.5	12.7	3.2	72.4	1.3	0	1.6	0.2	0	0.4	1.5	0	0.6	0.1	0.5	100
2008	MNI	14	17	5	12	26	123	6	434	10	1	40	19	6	26	85	2	1	5	114	946
	MNI %	1.5	1.8	0.5	1.3	2.8	13	0.6	45.9	1.1	0.1	4.2	2	0.6	2.8	9	0.2	0.1	0.5	12	100
	MNI g	329	527	100	186	208	3173	1428	12369	335	24.5	440	85.5	81	208	510	130	19	62.5	57	20273
	MNI g %	1.6	2.6	0.5	0.9	1	15.7	7	61	1.7	0.1	2.2	0.4	0.4	1	2.6	0.6	0.1	0.3	0.3	100
2019	MNI	14	6	0	0	23	12	1	137	0	0	2	3	0	0	4	0	0	3	22	227
	MNI %	6.2	2.6	0	0	10.1	5.3	0.4	60.4	0	0	0.9	1.3	0	0	1.8	0	0	1.3	9.7	100
	MNI g	329	186	0	0	184	310	238	3905	0	0	22	13.5	0	0	24	0	0	37.5	11	5259
	MNI g %	6.3	3.5	0	0	3.5	5.9	4.5	74.2	0	0	0.4	0.3	0	0	0.5	0	0	0.7	0.2	100
2020	MNI	23	28	1	0	77	76	0	311	0	1	2	4	0	2	2	0	1	0	17	545
	MNI %	4.2	5.1	0.2	0	14.1	13.9	0	57.1	0	0.2	0.4	0.7	0	0.4	0.4	0	0.2	0	3.1	100
	MNI g	541	868	20	0	616	1961	0	8864	0	24.5	22	18	0	16	12	0	19	0	8.5	12988
	MNI g %	4.2	6.7	0.2	0	4.7	15.1	0	68.2	0	0.2	0.2	0.1	0	0.1	0.1	0	0.1	0	0.1	100
Σ 2002–2020	MNI	61	64	6	19	138	287	10	1305	18	2	66	32	6	36	130	2	7	9	308	2506
	MNI %	2.4	2.5	0.2	0.8	5.5	11.4	0.4	52.1	0.7	0.1	2.7	1.3	0.2	1.4	5.2	0.1	0.3	0.4	12.3	100
	MNI g	1434	1984	120	295	1104	7405	2380	37193	603	49	726	144	81	288	780	130	133	113	154	55113
	MNI g %	2.6	3.6	0.2	0.5	2	13.4	4.3	67.5	1.1	0.1	1.4	0.3	0.2	0.5	1.4	0.2	0.2	0.2	0.3	100

Comment: MNI – minimum number of individuals

Примітка: MNI – MNI – мінімальна кількість особин

Neomys anomalus and the bicolored shrew *Crocidura leucodon* have also been found. It should be noted that representatives of *Mustela* sp. (2 individuals), which are very rare in the diet of the Little Owl, were found in 2008 in the samples collected in two locations. Birds were rare in the diet of the Little Owl and their contribution to its feeding was low (0.3 % of the total prey number and 0.2 % of the biomass of prey caught). They were found only in three observations. Reptiles of the family of true lizards (Lacertidae) were uncommon (0.4 % of the total prey number).

Vertebrates played a major role in feeding the Little Owl (over 99 % of total prey biomass in all of the sites under study) by biomass. Instead, the contribution of invertebrates was insignificant (0.3 %) by total biomass, although their remains were often found in pellets (5–33 % depending on season). The bird's diet includes relatively large insects, such as the European rhinoceros beetle *Oryctes nasicornis*, the great capricorn beetle *Cerambyx cerdo*, the European mole cricket *Gryllotalpa gryllotalpa*, ground beetles Carabidae, buprestidae Buprestidae, the predaceous diving beetles Dytiscus, the longhorn beetles Cerambycidae and the true weevils Curculionidae.

DISCUSSION

It is known that the Little Owl is a generalist whose diet is related to the number and availability of prey (Šálek, Riegert, & Křivan, 2010). This assertion has been confirmed by differences in food composition in various environments, as well as seasonal changes (Romanowski, 1988; Van Nieuwenhuyse *et al.*, 2008). In general, this species has well-defined latitudinal differences in the number of insects in the diet: there is a decrease in their content in the owl's nutrition from south to north, while there is an increase in the proportion of vertebrates (Angelici, Latella, Luiselli, & Riga, 1997; Arcidiacono *et al.*, 2007; Kayahan & Tabur, 2016). Our data show a strong dominance of vertebrates both in biomass and in numbers in the diet, in contrast to the Hungarian studies, where insects were the dominant prey in number during the breeding season (Lanszki, 2006). In Transcarpathia, the main food object of the Little Owl is the common vole (52.1 % of the total prey number and 67.5 % of the biomass of prey caught), which is identical to other data from the Central European study (Lanszki, 2006; Romanowski, & Żmihorski, 2009; Romanowski, 1988; Šálek *et al.*, 2010).

Birds are not the major prey item in the diet of the Little Owl (Lanszki, 2006; Romanowski, 1988). Yet, there is an increase in their proportions in the diet in certain seasons (Hounsome, O'Mahony, & Delahay, 2004). In our study, birds were found in only two places, which may be related to the individual hunting behavior of several birds or these observations are purely accidental. Most birds were identified only to an order (Passeriformes) and only a few to a species (the Great Tit *Parus major* and the European Goldfinch *Carduelis carduelis*). It should be noted that the birds were found only in winter (in the pellets from two localities, while they were completely absent from other localities). The absence of birds in the pellets collected from other localities may be explained by the sufficient number and availability of rodents in winter.

Amphibians are rare in the Little Owl's diet (Chenchouni, 2014; Lanszki, 2006; Romanowski, 1988) and their proportion depends on the area and their total number. We have never found them in pellets in all the years of research. This, in turn, indicates a sufficient number of small mammals in the area and the absence of necessity for owls to hunt unusual types of prey.

Reptiles play a significant role in the owl's diet only in the southern parts of Europe (Arcidiacono *et al.*, 2007; Mastrorilli, Sacchi, & Gentilli, 2001), and they are rare or absent in the central and northern regions. We have found 9 specimens of Lacertidae in pellets from our study area, most probably the sand lizard *Lacerta agilis*, but with a small contribution (0.4 % in number and 0.2 % in biomass).

Based on the analysis of pellets, we can presume that arthropods do not play a significant role in the diet of the Little Owl in Transcarpathia (12.3 % of the total prey number and 0.3 % of the biomass of the prey caught) (**Table 2**). The proportion of insects in pellets depends on the owl's habitat (Schmidt, 1998), but details of the impact of insects on the diet are scarce. Our study has shown that members of the Coleoptera order are dominant among insects, which is concurrent to the data of other researchers (Kitowski & Pawlega, 2010; Lanszki, 2006; Romanowski, 1988). Most species of insects identified in pellets are active at night or at dusk, which implies a daily foraging activity of the Little Owl (Šálek *et al.*, 2010).

No earthworms (Lumbricidae) were found in the diet of the Little Owl. However, a number of publications report a small proportion of worms in the bird's diet (Bacia, 1998; Blache, 2001; Grzywaczewski, Kitowski, & Scibior, 2006; Hounsome *et al.*, 2004; Romanowski & Żmihorski, 2009; Schipper, Wijnhoven, Baveco, & Van Den Brink, 2012).

J. Lanszki (Lanszki, 2006) notes the presence of plant components in pellets of the Little Owl, but we did not find them during our study. Plants get into the pellets by accident (for example, in the process of swallowing prey or from the stomachs of prey) and very rarely.

Seasonal changes. In Central and Northern Europe, owls have seasonal changes in diet due to significant changes in weather conditions during the year, which directly affect the amount and availability of prey (Jędrzejewski, Jędrzejewska, Szymura, & Zub, 1996; Romanowski, Altenburg, & Zmihorski, 2013). The diet of the Little Owl differed over four seasons in the proportion of prey of vertebrates and invertebrates (**Table 3**). The numders of vertebrates in the diet of the Little Owl in spring (81.8 % of the total prey number) and autumn (81.9 %) were quite similar, while the shares of prey in winter (94.2 %) and summer (70.2 %) were different. The common vole dominated in the owl's diet throughout the seasons (**Table 3**), but the largest proportion of the species was observed in the autumn-winter period (58.3 %; 56.9 %), while in summer it decreased two-fold (28.4 %). This is due to a significant increase in the number of species such as the common shrew, the lesser white-toothed shrew and insects during the summer season. Namely, the number of other prey species that are more available compared to voles (because they are easier to hunt) is growing at this time of year. At the same time, the number of voles is low in this period and gradually increases, gaining its peak in early fall. Representatives of Muridae occur rather evenly throughout all seasons, with the exception of the harvest mouse, the share of which is 34 times higher in the diet in winter than in other seasons. In our opinion, such an increase in the number of the harvest mouse in diet may be related to the fact that they became more noticeable due to the drying of leaves and grass and snowless winters in Transcarpathia. The high proportion of insectivores in the summer season is natural, as this is the period of peak abundance of insects that they feed on.

Large numbers of invertebrates are observed in the diet of the Little Owl in the summer and they are almost completely absent in winter. It is associated with a decrease in average temperatures (Génot & Van Nieuwenhuyse, 2002; Jaksić & Marti, 1981;

Table 3. **Seasonal variability of the diet composition of *Athene noctua***

Таблиця 3. **Сезонна мінливість спектру живлення *Athene noctua***

Season		Winter				Spring				Summer				Autumn			
Number / frequency of occurrence and biomass	g	MNI	MNI %	MNI g	MNI g %	MNI	MNI %	MNI g	MNI g %	MNI	MNI %	MNI g	MNI g %	MNI	MNI %	MNI g	MNI g %
Apodemus agrarius	23.5	42	3	987	3	17	2.2	399.5	2.6	2	0.9	47	1.2	0	0	0	0
Sylvaemus tauricus	31	45	3.2	1395	4.2	16	2.1	496	3.2	3	1.4	93	2.4	0	0	0	0
Sylvaemus sylvaticus	20	4	0.3	80	0.2	2	0.3	40	0.3	0	0	0	0	0	0	0	0
Mus musculus	15.5	5	0.4	77.5	0.2	8	1.1	124	0.8	5	2.3	77.5	2	1	0.8	15.5	0.6
Micromys minutus	8	120	8.6	960	2.9	9	1.2	72	0.5	5	2.3	40	1	4	3.1	32	1.2
Apodemus sp.	25.8	179	12.8	4618	13.9	70	9.2	1806	11.8	26	11.9	671	17.1	12	9.4	309.6	11.7
Rattus norvegicus	238	5	0.4	1190	3.6	2	0.3	476	3.1	3	1.4	714	18.2	0	0	0	0
Microtus arvalis	28.5	798	56.9	22743	68.4	371	48.9	10574	69.1	62	28.4	1767	45.2	74	58.3	2109	79.7
Microtus agrestis	33.5	6	0.4	201	0.6	7	0.9	234.5	1.5	2	0.9	67	1.7	3	2.4	100.5	3.8
Myodes glareolus	24.5	1	0.1	24.5	0.1	1	0.1	24.5	0.2	0	0	0	0	0	0	0	0
Sorex araneus	11	24	1.6	264	0.8	30	3.9	330	2.2	12	5.5	132	3.4	0	0	0	0
Sorex minutus	4.5	18	1.3	81	0.2	11	1.4	49.5	0.3	2	0.9	9	0.2	1	0.8	4.5	0.2
Neomys anomalus	13.5	3	0.2	40.5	0.1	3	0.4	40.5	0.3	0	0	0	0	0	0	0	0
Crocidura leucodon	8	15	1.1	120	0.4	17	2.2	136	0.9	3	1.4	24	0.6	1	0.8	8	0.3
Crocidura suaveolens	6	43	3.1	258	0.8	55	7.2	330	2.2	25	11.5	150	3.8	7	5.5	42	1.6
Mustela sp.	65	0	0	0	0	1	0.1	65	0.4	1	0.5	65	1.7	0	0	0	0
Aves	19	7	0.5	133	0.4	0	0	0	0	0	0	0	0	0	0	0	0
Lacertidae	12.5	4	0.3	50	0.1	2	0.3	25	0.2	2	0.9	25	0.7	1	0.8	12.5	0.5
Insecta	0.5	82	5.8	41	0.1	138	18.2	69	0.4	65	29.8	32.5	0.8	23	18.1	11.5	0.4
In general		1401	100	33264	100	760	100	15291	100	218	100	3914	100	127	100	2645	100

Laursen, 1981). The relatively large share (5.9 % in number) of insects in winter in the diet of the Little Owl in Transcarpathia is not typical for Central Europe, but is explained by relatively "mild" winters, compared to the rest of Ukraine. This can be also due to the fact that the bird often hunts in buildings (stables, pigsties, warehouses, etc), where invertebrates can be active and available in winter (Kitowski & Pawlega, 2010; Romanowski, 1988). In Southern Europe, the proportion of invertebrates during this period may be more than 90 % of all prey (Fattorini, Manganaro, Piattella, & Salvati, 1999). Other studies from Central and Eastern Europe, such as the Czech Republic (Mikkola, 1983), Belgium (Libois, 1981), Moldova (Mikkola, 1983), and Poland (Romanowski, 1988) also found invertebrates in the winter diet of the Little Owl.

Long-term changes. In contrast to the pronounced seasonal changes in the diet of the Little Owl, we did not observe the dominance of individual groups of food objects in between 2007, 2008, 2019, and 2020. The common vole dominates in number and biomass among all prey items of the Little Owl in almost all years (**Table 2**). The lesser white-toothed shrew and Insecta predominate partially in number but not in biomass.

The only exception is the representatives of mice of the genus *Apodemus*, which was the second subdominant among the food objects in the diet of the Little Owl in 2007–2008. Moreover, during 2019–2020, their place was taken by the rodent – the harvest mouse. The different change of feed between years is probably related to the population dynamics of this species, which can fluctuate depending on many factors, both biotic and abiotic (Andreassen, 2021; Hanski, Henttonen, Korpimäki, & Oksanen, 2001).

Territorial variability. In the studied areas of Transcarpathia, the majority of the Little Owl diet consists of small mammals (voles, mice, insectivorous) – 87 %. The main prey were voles (52.9 %), with the common vole being an absolute dominant. This data coincides with other research (Romanowski & Żmihorski, 2009), which found that the Little Owl shows a high food specialization on farmland in the vicinity of a large city (Warsaw, Poland). This research revealed that the major prey items of the owl were the common vole and its proportion in the diet was higher than described in the literature (Hámori, Winkler, & Cserkész, 2014; Kitowski & Pawlega, 2010; Romanowski & Żmihorski, 2009; Romanowski, 1988) in such habitats. The author explains this by food specialization of the Little Owl and the vole's life history (lives in colonies with a fast reproduction cycle (Jacob & Tkadlec, 2010)).

According to our results, the proportion of the voles was the highest on active farms (**Table 4**). The common vole, as expected, dominated among Arvicolidae, which is the most common rodent in European agroecosystems (Heroldová, Bryja, Zejda, & Tkadlec, 2007; Jacob, Manson, Barfknecht, & Fredricks, 2014). As for the short-tailed field vole *Microtus agrestis*, the largest proportion was found in the pellets from agricultural landscapes.

A big proportion of mice in the pellets of the Little Owl was found in the samples from inactive industrial / livestock complexes and among the agro-landscape. The yellow-necked mice *Sylvaemus tauricus* and the striped field mice *Apodemus agrarius* dominated in the Muridae family. The yellow-necked mice was preyed upon at inactive industrial/livestock complexes and among agro-landscapes, the wood mice *Sylvaemus sylvaticus* – among agro-landscapes, and the striped field mice – at inactive complexes and among agro-landscapes. The proportion of house mice remained the highest in observations from villages, which is quite expected as it is a synanthropic species. It was reported in some studies that the proportion of house mice in the owl's diet was

significant where there were many farms (Chenchouni, 2014; Marián & Schmidt, 1968; Romanowski, 1988). According to our studies, the share of house mice (0.5 %) in pellets was almost the same in active farms as in inactive animal complexes (0.3 %), but it was higher in agricultural landscapes (0.9 %) and in rural areas (1.2 %). Regarding the harvest mouse in the owl's diet among the studied habitats, its share was the highest in pellets from inactive complexes.

Table 4. **Territorial variability of the diet composition of *Athene noctua***
Таблиця 4. **Територіальна мінливість спектру живлення *Athene noctua***

Prey	Inactive industrial and animal complexes	Active farms	Village	Continuous agro-landscape
Microtus arvalis	49.3%	60.9%	49.8%	48.8%
Microtus agrestis	0.3%	0.5%	0.8%	1.4%
Myodes glareolus	0	0	0	0.5%
Apodemus agrarius	3.2%	1.4%	2.2%	3.3%
Apodemus / *Sylvaemus* sp.	13.3%	10.3%	8.2%	16.9%
Sylvaemus tauricus	3.8%	1.4%	2.1%	3.3%
Sylvaemus sylvaticus	0.1%	0.2%	0.1%	0.7%
Micromys minutus	11.8%	2.9%	3%	4.9%
Mus musculus	0.3%	0.5%	1.2%	0.9%
Rattus norvegicus	0.1%	0.5%	0.3%	0.7%
Sorex araneus	1.9%	3.4%	3.7%	0.5%
Sorex minutus	0.8%	2.1%	1.4%	0.7%
Crocidura leucodon	0.5%	2.2%	2%	0.7%
Crocidura suaveolens	3.7%	6%	6.8%	3.1%
Neomys anomalus	0	0.5%	0.3%	0%
Mustela sp.	0.2%	0	0.1%	0%
Aves	0	0.8%	0	0.5%
Lacertidae	0.5%	0.3%	0.3%	0.2%
Insecta	10.2%	6.1%	17.7%	12.9%
In general	100%	100%	100%	100%

Insectivorous mammals occur most often in the owl's pellets from active farms and in the countryside, where their share was 14.2 % and the lowes – 4.9 % – among agricultural landscapes. We found that the share of insectivores is rather higher in the owl's nutrition in Transcarpathia compared to studies from Central Poland (Romanowski,

1988), where they comprise only 0.13 %. The same trend is observed in studies within Central Hungary (Hámori *et al.*, 2014). Such a large number of insectivores in the owl's diet, in our opinion, can be explained by the fact that the share of mice (which are the second main food for birds in Transcarpathia) is lower in these areas. The low number of mice may be due to the small number of suitable habitats, the small forage base, as well as the constant pest control by humans (various poisons). Voles experienced less pressure because they live in homesteads at a certain distance from human settlements. On the contrary, living conditions in these areas are favorable for insectivores due to the lack of human pressure, mosaic landscapes, and, most importantly, the large quantity and variety of food (various insects, their larvae and worms), concentrated in these habitats due to a large amount of human and animal waste.

D. Hámori (Hámori *et al.*, 2014) points out that the Little Owl is a dietary generalist predator, whose diet depends upon the number of available potential victims and there is a difference in diet depending on the environment and habitats. In Transcarpathia in agricultural lands, the owl is also a dietary generalist predator but its diet consists mainly of the common vole. This data supports the results of similar studies in Poland (Romanowski & Żmihorski, 2009).

CONCLUSIONS

According to our data, the Little Owl is a typical predator generalist in Transcarpathia. Based on the data obtained, small mammals are the most abundant (87 % of items, 99.3 % by biomass) in the diet of the Little Owl in all of the studied areas. The common vole is dominant in the diet of the Little Owl (52.1 % of items, 67.5 % by biomass), mice of the genus Apodemus is subdominant (11.4 % of items, 13.4 % by biomass). The diet of the Little Owl in this area depends on the environment in which the birds live (type and intensity of agricultural processes). Changes in agriculture can affect prey and, accordingly, the size of the owl population. However, seasonal changes in the diet demonstrate that the Little Owl is highly adaptable and able to respond quickly to changes in the availability of certain types of food in the nesting area. These results provide valuable information not only about the environment and diet, but also are important for the conservation efforts applied to the Little Owl. We expect that our findings on the biological features of this species which holds agricultural importance provide a baseline for future studies, and support conservation programs.

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COMPLIANCE WITH ETHICAL STANDARDS

Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Human Rights: This article does not contain any studies with human subjects performed by any of the authors.

Animal studies: All institutional, national and institutional guidelines for the care and use of laboratory animals were followed.

AUTHOR CONTRIBUTIONS

Conceptualization, [I.Z.; L.R.; O.H.; L.P.; I.D]; methodology, [I.Z.; O.H.; L.P.]; validation, [I.Z.; L.R.; O.H.]; formal analysis, [I.Z.; L.R.; O.H.]; investigation, [I.Z.; L.R.; O.H.]; resources, [I.Z.; O.H.]; data curation, [I.D.]; writing – original draft preparation, [I.Z.]; writing – review and editing, [O.H.; I.D.]; visualization, [I.Z.]; supervision, [I.D.].

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ЖИВЛЕННЯ СИЧА ХАТНЬОГО *ATHENE NOCTUA* (SCOPOLI, 1769) НА ТЕРИТОРІЇ БЕРЕГІВСЬКОГО РАЙОНУ (ЗАКАРПАТСЬКА ОБЛАСТЬ)

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Вступ. Сич хатній є одним із найпоширеніших видів сов у західній Палеарктиці. Проте наразі відмічено значне скорочення популяції цього виду в Європі. Тому збереження та вивчення цієї сови є важливим питанням у більшості європейських країн. Аналіз трофічних структур на місцевому рівні дає цікаву та цінну інформацію про харчові звички хижака. Дослідження трофічного раціону сов даэ змогу проаналізувати їхню потенційну адаптацію до середовища проживання з різними рівнями трансформації навколишнього середовища.

Матеріали та методи. Дослідження живлення сича хатнього (*Athene noctua*) на території Берегівського району Закарпатської області України. Загалом протягом 2002–2020 років на 15 локалітетах було зібрано 1446 пелеток і виявлено 2506 об’єктів живлення, які включають: 18 видів хребетних (16 видів дрібних ссавців із рядів Rodentia, Soricomorpha та Carnivora, а також рептилій родини Lacertidae та птахів ряду Passeriformes) і членистоногих.

Результати. Хребетні відіграють основну роль у живленні сича (понад 99 % загальної біомаси здобичі на всіх досліджуваних ділянках). *Microtus arvalis* є найпоширенішою здобиччю у спектрі живлення сови (52,1 % від загальної кількості

здобичі та 67,5 % від біомаси виловленої здобичі), а також велика частка мишей роду *Apodemus* і *Sylvaemus*. Внесок безхребетних у загальну біомасу здобичі незначний (0,3 %). Влітку в раціоні сича спостерігалася велика кількість безхребетних, а взимку вони були майже повністю відсутні.

Висновки. За нашими даними, сич хатній – типовий хижак-генераліст на Закарпатті. 28 таксонів, знайдених у пелетках, демонструють широкий спектр харчових об'єктів на відносно невеликій території та високий рівень адаптації до місць проживання з різним рівнем трансформації середовища (агросистеми й антропогенні зони).

Ключові слова: сич хатній, живлення, пелетки, *Microtus arvalis*, агроландшафт, Закарпаття

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