



The food of the tawny owl *Strix aluco* in the Oder Valley in the Opole Voivodeship (south-western Poland)

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Abstract: The aim of this paper was to describe the diet of the tawny owl *Strix aluco* in the Oder Valley in the Opole Voivodeship, south-western Poland. Tawny owl pellets were collected in the years 1996-2024 from 22 sites, grouped into five distinct localities. In total 19 species of mammals were found: 4 species of Soricomorpha, 1 Chiroptera, 1 Lagomorpha, 12 Rodentia and 1 Carnivora. Among 1103 identified prey items (902 belonged to mammals), 77.1% belonged to Rodents, which played the most important role as a prey at every locality. *Microtus arvalis*, *Apodemus agrarius*, *A. flavicollis* and *Clethrionomys glareolus* were the most important prey species in the tawny owl's diet. *Crocodyrus suaveolens*, *M. arvalis*, *Mus musculus* and *A. agrarius* were more frequently caught by tawny owl in farmlands, whereas *A. flavicollis* and *C. glareolus* were more abundant in forest habitats. High domination of Arvicolidae with Muridae in the diet, together with very low share of soricomorphs and other group of mammals, may indicate a considerable degradation of once natural environment of the Oder Valley within this section, currently dominated with farmland monocultures.

Key words: owl pellets, owl diet, mammal fauna, Oder river, Odra, SW Poland, micromammalia

INTRODUCTION

Research on the content of food of birds of prey and owl, in addition to its basic aim, which is investigating the food preferences and nutritional needs of a species, also provides faunistically valuable information about the presence of different prey and changes in their availability in the environment. Analysis of the pellets produced by predatory birds in Poland leads to the discovery of many rare species of mammals they prey on that are otherwise difficult to detect in the field, such as the Soricidae, Gliridae, birch mouse *Sicista betulina* (Pallas, 1779) and bats; *viz.* Mikusek 1999, Źmihorski & Osojca 2006, Lesiński et al. 2013, Lesiński & Błachowski 2023. The results of research on the food of particularly opportunistic predatory species, such as the tawny owl *Strix aluco* (Goszczyński 1981), are a good indicator of the real species composition of small mammals in a given area (Romanowski et al. 2014, Lesiński et al. 2016, Lesiński & Kmieć 2023). Furthermore, the composition of local fauna of small mammals obtained by analysing the pellets of the tawny owl is even more accurate than obtained through other methods, including collecting specimens (Balčiauskienė 2005, Zawadzka & Zawadzki 2007). A major advantage of this non-invasive technique is that it provides a list of species that can be used in Polish Atlas of Mammals (Pucek & Raczyński 1983, Okarma et al. 2023).

Publication of data concerning the food of owls and faunal data obtained by analysing pellets allows for documenting spatial changes and changes over time in the fauna of small mammals (Goszczyński et al. 1993, Romanowski & Źmihorski 2009, Balčiauskas & Balčiauskienė 2022), which is particularly necessary in the case of valuable and protected areas and areas sensitive to degradation. Such areas include, in particular, large river valleys, which are extremely important to the functioning of natural systems and maintenance of biological diversity assets. They are also areas of the highest ecological importance in the context of landscape, distinguished by high biodiversity (Ward et al. 1999, Pedrolí et al. 2002), including high biodiversity of small mammals (Romanowski et al. 2023). Unfortunately, the large river valleys are highly endangered

areas, and due to the transformations they have undergone across most of Europe, they have lost their original character (Tockner et al. 2002, Nilsson et al. 2005). Consequently, small mammals, which are known for their quick responses to local disturbances and landscape changes, can be expected to respond by modifying both their species composition and diversity (Balčiauskas & Balčiauskienė 2022).

The Oder is the second-longest river in Poland. It delineates the ecological axis of the Opole Voivodeship and is its most significant ecological corridor (Wróbel 2014). The part of the Oder Valley in the Opole Voivodeship constitutes an ecological corridor of an international rank (Upper Oder EC 19m) and a nodal region with an international rank (Middle Oder Valley Area 17M) as part of the European Ecological Network EECNET- PL (Liro 1995).

Unfortunately, despite the undeniably high rank of the Oder Valley in the nation-wide and regional system of environmental protection, its natural value have been investigated very selectively, and information about small mammals is exceedingly sparse and, at this point, nearly historical. Very fragmentary data about the presence of individual species can only be found in Polish Atlas of Mammals Distribution (Pucek & Raczynski 1983), a study by Kopij (1992), Sałata-Piłacińska (1994) and publication about natural value of Zdieszowicki Forest ('Łęg Zdieszowicki') (Hebda & Wyszynski 2001). These publications usually describe the locations of the sites in very broad terms and do not provide the quantitative relationships between the species they describe.

In this paper, I present the species richness and diversity of small mammal communities along a large section of the Oder Valley in the Opole Voivodeship based on an analysis of pellets produced by the tawny owl *Strix aluco*.

MATERIAL AND METHODS

The Oder is the second-longest river in Poland. This study was conducted in the section of the Oder located in the Opole Voivodeship, with a total length of canalised river of 110 km and a surface area of the valley of approximately 390 km². In physico-geographical terms, the Oder runs in this region through the Silesian Lowlands (318.5) within two mesoregions, the Racibórz Basin (318.59) and the Wrocław Ice-Marginal Valley (318.52) (Kondracki 2000). Potential plant communities in the region include (Matuszkiewicz 1991) *Ficario-Ulmetum typicum* lowland riverside ash and elm forests, *Salici-Populetum* lowland riverside willow and poplar forests and *Galio-Carpinetum* and *Tilio-Carpinetum* mixed oak-hornbeam forests. Only small fragments of riverside forests have survived. The most widespread currently are the *Galio silvatici-Carpinetum* forests, which have two forms: humid and typical, and *Tilio-Carpinetum* forests. Willow thickets and communities of rushes can also be found on the banks and in the oxbows. The valley has been extensively transformed, with farmland occupying the highest percentage of its surface area (about 70%), and forests, which used to be characteristic of its landscape, occupying only about 8% (Wróbel 2014).

Paper presents diet of the tawny owl on the basis of pellet analysis, derived from 1996-2024. Pellets were collected from 22 sites. Each pellet collection site was attributed to farmland (O) or forest (F). The collection sites were grouped into five distinct localities in the Oder Valley in the Opole Voivodeship (south-western Poland), two from the southern part of Opole, and three from the northern part (Figure 1). The distance between the southernmost and northernmost study site covered an approximately 70-km section of the Oder Valley. The general characteristics of the localities are presented in Table 1. Locality 2 encompasses the entirety of the 'Łęg Zdieszowicki' Natura 2000 Special Area of Conservation (PLH160011). Localities 3–5 are located entirely within the 'Grądy Odrzańskie' Natura 2000 Special Protection Area (PLB020002).

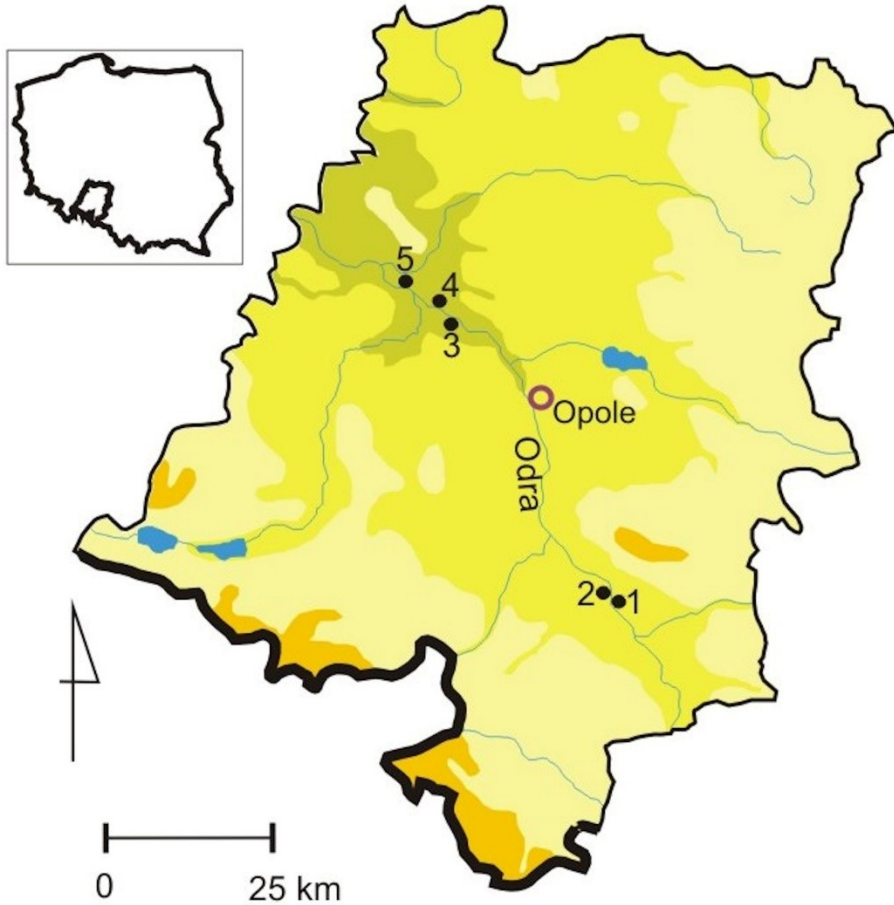


Fig. 1. Maps of the study area: Opole Voivodeship with the Oder River with 5 study localities (black dots).

Pellets were analysed using the standard dry method of dissection. Only the characteristic elements of the skeleton were used for identification: predominantly skulls and much less often long bones (humerus of the European mole *Talpa europaea* and amphibians). Identification to the species level of mammals was based on the key for mammal determination (Pucek 1984), supported by other, more detailed papers for the *Apodemus* (*Sylvaemus*) group: Ruprecht (1979).

I used chi-square test to determine if there were differences in frequency of given species caught by tawny owl between farmland and forest habitat. Calculations followed formulae in Statistica 12 software (StatSoft Inc. 2014).

Table 1. General characteristics of the 5 localities with the tawny owl pellet collection sites in the Oder Valley in the Opole Voivodeship. The squares in the geographic grids are given according to Okarma et al. (2023) in Polish Atlas of Mammals (PAM); O – farmland, F – forest; P/M – total number of prey/total number of mammals.

No.	Locality name with the square according PAM	Collection sites defined by coordinates and habitat type – O or F	General characteristics of locality with [years of study]	P/M
1.	Januszkowice [09Nj]	50.39367°N, 18.12850°E – O 50.39105°N, 18.12553°E – O 50.39072°N, 18.12198°E – O	Open valley. Crop fields, only small stretches of meadows and woodlots, proximity of built-up area. Pellets collected from the tawny owl nest-boxes hung on trees in the farmland, mostly during spring, less part during autumn; [2016–2024]	588/507
2.	Łęg Zdziechowicki [09Nj]	50.4044°N, 18.09094°E – F 50.39886°N, 18.10067°E – F 50.40896°N, 18.0879°E – F 50.38495°N, 18.10175°E – F	The largest forest complex in the Oder river valley south of Opole, predominantly oak-hornbeam, proximity of small villages. Pellets collected from the edge of forest, from the ground under cavity trees; mostly during spring, less part during summer-autumn; [1997–2024]	73/34
3.	Narok: Kolonia Narocka [08Mh]	50.76685°N, 17.7682°E – O 50.77095°N, 17.76085°E – F	Mixed forest-farmland area. Small forest complex in the Oder valley, predominantly oak-hornbeam surrounded by crop fields. Pellets collected from the loft of a building 200 m out of the forest and from the forest; during the spring and summer; [1997, 2020]	209/175
4.	Wielopole [08Mh]	50.80972°N, 17.72692°E – F 50.79641°N, 17.70065°E – O 50.8035°N, 17.71735°E – F 50.81528°N, 17.70852°E – F 50.79103°N, 17.72652°E – F 50.79771°N, 17.72974°E – O 50.79898°N, 17.69361°E – F 50.79375°N, 17.73435°E – F	Large forest complex, oak-hornbeam, surrounded by crop fields; proximity of small villages. Pellets collected mainly from the forest, from the ground under cavity trees, additionally from the abandoned buildings outside the forest. Material was collected throughout the year; [1996–2021]	91/73
5.	Stobrawa-Stare Kolnie-Rybna [08Md, 08Mg]	50.82743°N, 17.64295°E – F 50.83705°N, 17.65225°E – F 50.84701°N, 17.60995°E – F 50.83557°N, 17.64141°E – F 50.82444°N, 17.65468°E – F	The largest forest complex north from Opole in the Opole Region, predominantly oak-hornbeam, surrounded by crop fields and meadows. Pellets collected from the forest under cavity trees, from spring to summer; [1997–2005]	142/113

RESULTS

A total of 1103 prey specimens were identified, including 902 mammals as the most important group of prey in the tawny owl's diet, constituting approx. 82% of prey items (Table 2). Overall, 19 mammal species were found from five orders: Soricomorpha, Chiroptera, Lagomorpha, Rodentia and Carnivora. *Microtus arvalis*, *Apodemus agrarius*, *A. flavicollis* and *Clethrionomys glareolus* were the most important prey species in the tawny owl's diet in terms of the quantity of prey consumed: 24.9%, 20.0%, 10.6% and 6.6%, respectively. These four species predominated at all of the five analysed sites. A relatively more frequent species in two localities was *Mus musculus*, which reached a total share of 5.5% in the material.

Sorex araneus and *Crocidura suaveolens* were the most numerous collected soricomorphs. *S. araneus* with *Talpa europaea* were also the most regularly hunted, found in four of the five localities. *Neomys fodiens* was only caught in one locality (Januszkowice). *C. suaveolens* was caught in three localities; it was caught more frequently in farmland habitats, close to developed areas. Rodents, represented by 12 species, were the main prey in every locality. Gliridae, represented by a single species, *Muscardinus avellanarius*, was found at only one locality

(Januszkowice). Representatives of the other systematic groups: Chiroptera (*Pipistrellus pipistrellus/pygmaeus*), Lagomorpha (*Lepus europaeus*) and Carnivora (*Mustela nivalis*) were only sporadically caught (Table 2).

Table 2. The number of prey caught by the tawny owl in five localities in the Oder Valley between 1996 and 2024 in the Opole Voivodeship.

No.	Species	Localities					N Total	Share of all preys [%]	Share of mammal preys [%]
		1	2	3	4	5			
1.	<i>Talpa europaea</i> Linnaeus, 1758	1	2	2	1		6	0.5	0.7
2.	<i>Sorex araneus</i> Linnaeus, 1758	6		6	5	5	22	2.0	2.4
3.	<i>Neomys fodiens</i> (Pennant, 1771)	3					3	0.3	0.3
4.	<i>Crocidura suaveolens</i> (Pallas, 1811)	14		3		1	18	1.6	2.0
	Σ Soricomorpha	24	2	11	6	6	49	4.4	5.4
5.	<i>Pipistrellus pygmaeus/pipistrellus</i>			1			1	0.1	0.1
	Σ Chiroptera	0	0	1	0	0	1	0.1	0.1
6.	<i>Lepus europaeus</i> (young) Pallas, 1778		1				1	0.1	0.1
..	Σ Lagomorpha	0	1	0	0	0	1	0.1	0.1
7.	<i>Clethrionomys glareolus</i> (Schreber, 1860)	12	9	11	12	29	73	6.6	8.1
8.	<i>Arvicola amphibius</i> (Linnaeus, 1758)	13	3	1			17	1.5	1.9
9.	<i>Microtus arvalis</i> (Pallas, 1779)	178	2	66	15	14	275	24.9	30.5
10.	<i>Microtus agrestis</i> (Linnaeus, 1758)	3		2			5	0.4	0.6
11.	<i>Microtus subterraneus</i> (de Selys-Longchamps, 1836)	5	3	9		6	23	2.1	2.5
12.	<i>Rattus norvegicus</i> (Berkenhout, 1769)	2	1				3	0.3	0.3
13.	<i>Mus musculus</i> Linnaeus, 1758	37		21	3		61	5.5	6.8
14.	<i>Apodemus agrarius</i> (Pallas, 1771)	163	7	30	7	14	221	20.0	24.5
15.	<i>Apodemus flavicollis</i> (Melchior, 1834)	40	5	10	24	38	117	10.6	13.0
16.	<i>Apodemus sylvaticus</i> (Linnaeus, 1758)	8	1	5	4	1	19	1.7	2.1
-.	<i>Apodemus (Sylvaemus)</i> sp.	3		6	1	2	12	1.1	1.3
-.	<i>Apodemus</i> sp.					2	2	0.2	0.2
17.	<i>Micromys minutus</i> (Pallas, 1771)	11		2	1	1	15	1.4	1.7
18.	<i>Muscardinus avellanarius</i> (Linnaeus, 1758)	7					7	0.6	0.8
	Σ Rodentia	482	31	163	67	107	850	77.1	94.2
19.	<i>Mustela nivalis</i> Linnaeus, 1766	1					1	0.1	0.1
	Σ Carnivora	1	0	0	0	0	1	0.1	0.1
	Mammalia total	507	34	175	73	113	902	81.8	100
	Aves	54	8	34	9	5	110	10.0	-
	Reptilia (Lacertidae)	1		0			1	0.1	-
	Amphibia (Anura)	9	8	0			17	1.5	-
	Insecta	17	23	-	9	24	73	6.6	-
	Total	588	73	209	91	142	1103	100	-

As expected, in localities comprising large forest complexes, the forest-dwelling prey, such as *A. flavicollis* and *C. glareolus*, were caught more often. In contrast, in localities characterised more as a farmland habitat or a mixed, open-forest habitat, rodents typical for open areas were more numerous in the pellets, such as *M. arvalis* and *A. agrarius* (Table 2). The differences in species composition were strongly pronounced when comparing not the group of localities with the dominant type of habitat, but rather, the type of habitat where the pellets were collected. *C. suaveolens*, *M. arvalis*, *M. musculus* and *A. agrarius* were more frequent in farmlands with developed areas, but these differences were statistically significant only with respect to the last three species. Conversely, *A. flavicollis* and *C. glareolus* were more abundant in forest habitats (Table 3).

Table 3. Mammals hunted by tawny owl according to the type of habitat at the collection site. Statistical significance tested with the chi-square test: ** $P < .01$, *** $P < .001$).

No.	Species total	Forests		Farmland		Statistical significance
		<i>N</i>	Share of preys [%]	<i>N</i>	Share of preys [%]	
1.	<i>Talpa europaea</i>	3	1.7	3	0.4	
2.	<i>Sorex araneus</i>	7	3.9	15	2.1	
3.	<i>Neomys fodiens</i>	0	0	3	0.4	
4.	<i>Crociodura suaveolens</i>	1	0.6	17	2.4	
	Σ Soricomorpha	11	6.1	38	5.4	
5.	<i>Pipistrellus pygmaeus/pipistrellus</i>	0	0	1	0.1	
	Σ Chiroptera	0	0	1	0.1	
6.	<i>Lepus europaeus</i> (young)	1	0.6	0	0	
	Σ Lagomorpha	1	0.6	0	0	
7.	<i>Clethrionomys glareolus</i>	41	22.8	27	3.8	***
8.	<i>Arvicola amphibius</i>	3	1.7	14	2.0	
9.	<i>Microtus arvalis</i>	22	12.2	251	35.6	***
10.	<i>Microtus agrestis</i>	0	0	5	0.7	
11.	<i>Microtus subterraneus</i>	9	5.0	14	2.0	
12.	<i>Rattus norvegicus</i>	1	0.6	2	0.3	
13.	<i>Mus musculus</i>	3	1.7	58	8.2	**
14.	<i>Apodemus agrarius</i>	21	11.7	196	27.8	***
15.	<i>Apodemus flavicollis</i>	55	30.6	57	8.1	***
16.	<i>Apodemus sylvaticus</i>	6	3.3	13	1.8	
-.	<i>Apodemus (Sylvaemus) sp.</i>	3	1.7	9	1.3	
-.	<i>Apodemus sp.</i>	2	1.1	0	0	
17.	<i>Micromys minutus</i>	2	1.1	13	1.8	
18.	<i>Muscardinus avellanarius</i>	0	0	7	1.0	
	Σ Rodentia	168	93.3	666	94.3	
19.	<i>Mustela nivalis</i>	0	0	1	0.1	
	Σ Carnivora	0	0	1	0.1	
-	Mammalia total	180	100	706	100	

DISCUSSION

Diet composition of the tawny owl in the Oder Valley is comparable with other results from lowland Central Europe, rodents are the main prey component (Žmihorski & Osojca 2006, Zawadzka & Zawadzki 2007, Gryz et al. 2008, Žmihorski et al. 2008, Romanowski et al. 2014, Lesiński et al. 2016, Romanowski et al. 2023). Other groups of prey, such as birds, amphibians or insects, were less important. Species composition is typical for the forest-farmland mosaic, where such species as *C. glareolus*, *A. flavicollis*, *M. arvalis* are among the most frequently reported dominants (Goszczyński et al. 1993, Lesiński et al. 2013, Romanowski et al. 2014, Gryz & Krauze-Gryz 2016). The set of eudominant species differed depending on the type of dominant habitat at a locality. In a forested habitat: *A. flavicollis* with *C. glareolus*; whereas in a farmland or mixed open-forest habitat: *M. arvalis* and *A. agrarius* were the most numerous prey species collected, which is consistent with other studies: Goszczyński (1981), Gramsz (1991), Romanowski & Žmihorski (2009), Romanowski et al. (2014, 2023).

The number of 18 species of small mammals (excluding *Lepus europeus*) seems to accurately reflect the real state of this group of mammals (with the exception of bats) in the Opole section of the Oder Valley. As Žmihorski et al. (2011) have demonstrated, even a sample of 400 mammal specimens hunted by the tawny owl is sufficient to detect almost all species of mammals inhabiting a given area. The sample is high for the relatively uniform environment and extensive degradation of the Oder Valley in the Opole Voivodeship, where the share of farmland reaches as much as 70%, compared to the forests, which amount to about 8% (Wróbel 2014). A noticeably higher number of small mammals in the food of the tawny owl is observed

primarily in central and north-eastern Poland due to a high share of bats (Gryz et al. 2008, Lesiński et al. 2016, Lesiński & Błachowski 2023). Furthermore, the share of rare species of small mammals that are detectable through an analysis of pellets in Central Europe increases towards the north-east (Żmihorski et al. 2008).

The presence of a rare species among the collected material, the hazel dormice, is interesting. The hazel dormice is protected by law in Poland. Although the species is distributed throughout the country, it has relatively few localities in the Opole Voivodeship. Interestingly, the species seems to be truly absent from the section of the Oder Valley within the Stobrawski Landscape Park – not listed in localities 3–5. In this area, it has not been reported despite active search using photo cameras and trapping (Hebda et al., in prep.).

Data about the food of the tawny owl from the valleys of large rivers in Poland are very sparse. Gramsz (1991) analysed the diet of the tawny owl from a large riverside and oak-hornbeam forest located between Brzeg and Oława in the Oder Valley, which is about 20 km downstream from locality 5. The tawny owl hunted primarily 16 species of mammals in the area: 5 species of Soricomorpha and 11 species of Rodentia. Its basic food were *M. arvalis* and *C. glareolus*. Żmihorski et al. (2012) characterised a set of small mammals based on the pellets of the tawny owl from the Lower Oder Valley (north-western Poland). A majority of the material was collected from forests and near their edges. The researchers observed 19 species of small mammals: 5 species of Soricomorpha (14.7%), 3 bats (0.9%), 11 rodents (84.5%), with *A. flavicollis*, *C. glareolus* and *S. araneus* being the most numerous species, but Muridae being the most numerous group, accounting for a combined total of 52.7% all mammals. Extensive data based on the pellets of the tawny owl concerning small mammals of the Vistula Valley have been collected by Romanowski et al. (2023), who indicated 19 species of mammals: 5 Soricomorpha (7.95%), 1 Chiroptera (2.0%), 12 Rodentia (90.0%) and 1 Carnivora (0.05%). The most numerous species had more uniform shares than in other studies: *A. agrarius* 13.50%, *C. glareolus* 13.33%, *A. flavicollis* 11.66%, and *M. arvalis* 11.58%. The faunal complex of small mammals is similar to that obtained in the Opole Voivodeship, both in terms of the list of species and the share of primary prey. Differences in the species composition mostly concern the presence of *Microtus oeconomus* in the central and northern regions of Poland, for which a vast majority of the Opole Voivodeship lies outside its geographical range. In the Oder Valley, in the vicinity of Opole, only a small proportion of soricomorphs was observed. This results from a low share of large forest complexes in the valley, which are a typical environment for the soricomorphs, and where they reach a high percentage in the diet of the tawny owl (Żmihorski & Osojca 2006, Romanowski & Żmihorski 2009, Romanowski et al. 2014, Lesiński & Błachowski 2023). A very high share of rodents in the diet, primarily the Arvicollidae and Muridae, with a concurrent very low share of other groups of mammals, including soricomorphs, bats and the Gliridae, may indicate a considerable deformation of the ecosystem (Lesiński & Gryz 2011).

This study allows for a much better and up-to-date identification of the fauna of small mammals in the Oder Valley in the Opole Voivodeship, which is inhabited by complexes of small mammals that have only been researched in small detail. A lack of reference data prevents an analysis of changes in the distribution and population of each species. The only available information about the localities of small mammals along the Opole section of the Oder Valley (with the exception of bats) come from a few individual reports, often from villages located on the border of the valley, and do not provide precise locations or information about habitat (Pucek & Raczyński 1983, Kopij 1992, Sałata-Piłacińska 1994, Hebda & Wyszynski 2001). The Polish Atlas of Mammals by Pucek & Raczyński (1983) lists 13 sites of small mammals (excluding bats) in the Opole section of the Oder Valley from villages located on the border of the valley, including: Krapkowice [YR19], Opole [YS01], Stradunia [BA98], Koźle [BA97] and Popielów

[XS93]. The European ground squirrel *Spermophilus citellus* and the hamster *Cricetus cricetus* can be excluded from this list of species, as they have not been found in this part of the region for at least 50 years. A paper about the natural value of the Zdzieszowicki Forest lists only 6 species inhabiting the area, even though no research on this group has been conducted, and the observations were coincidental (Hebda & Wszyński 2001). The most extensive data can be found in a paper by Sałata-Piłacińska (1994); however, the data were collected in the 1970s, which makes it mostly historical in value. The paper includes data obtained through an analysis of the pellets of the western barn owl *Tyto alba* from its sites in Popielów, Cisek and Roszowicki Las, which are located near the Oder Valley. The paper lacks precise location data concerning the pellets, making it impossible to accurately compare them with the fauna of small mammals in the Oder Valley. However, this source of data was included as potentially relevant to the direct area of the Oder Valley. According to the paper, a total of 18 species are present across the three sites in the Oder Valley. Lastly, Kopij (1992) analysed material from the village of Żelazna (Dąbrowa Commune), located on the border of the Oder Valley (500 m from the riverbed), also produced by the western barn owl. He identified seven species of small mammals in the pellets (Table 4).

Table 4. Species of small mammals (excluding bats) reported in the Opole Voivodeship section of the Oder Valley.

No.	Species	Source of data				
		Pucek & Raczyński 1983	Kopij 1992	Sałata-Piłacińska 1994	Hebda & Wszyński 2001	This study
1.	<i>Talpa europaea</i>			+	+	+
2.	<i>Sorex minutus</i> Linnaeus, 1766	+		+		
3.	<i>Sorex araneus</i>	+	+	+	+	+
4.	<i>Neomys fodiens</i>	+	+	+	+	+
5.	<i>Crocidura suaveolens</i>		+	+	+	+
6.	<i>Cricetus cricetus</i> (Linnaeus, 1758)	+				
7.	<i>Spermophilus citellus</i> (Linnaeus, 1766)	+				
8.	<i>Clethrionomys glareolus</i>			+		+
9.	<i>Arvicola amphibius</i>		+	+		+
10.	<i>Microtus arvalis</i>	+	+	+		+
11.	<i>Microtus agrestis</i>			+		+
12.	<i>Microtus subterraneus</i>	+		+		+
13.	<i>Rattus norvegicus</i>			+		+
14.	<i>Rattus rattus</i> (Linnaeus, 1758)	+				
15.	<i>Mus musculus</i>	+	+	+		+
16.	<i>Apodemus agrarius</i>	+	+	+		+
17.	<i>Apodemus flavicollis</i>			+		+
18.	<i>Apodemus sylvaticus</i>			+		+
19.	<i>Apodemus uralensis</i> (Pallas, 1811)			+		
20.	<i>Micromys minutus</i>	+		+		+
21.	<i>Muscardinus avellanarius</i>	+		+		+
22.	<i>Sciurus vulgaris</i> Linnaeus, 1758	+			+	
23.	<i>Mustela nivalis</i>				+	+
Total:		13	7	18	6	17

Summarizing the above published data, with the exception of the European ground squirrel and the hamster, the presence of four species from the list has not been confirmed: pygmy shrew *Sorex minutus*, black rat *Rattus rattus*, red squirrel *Sciurus vulgaris* and pygmy field mouse *Apodemus uralensis*. The red squirrel very rarely falls prey to the tawny owl, which prefers smaller prey, usually weighing 10–50 g (Gramsz et al. 2005). The lack of the pygmy shrew, a common prey of the tawny owl, (Żmihorski et al. 2012, Romanowski et al. 2014, Lesiński et al. 2016, Lesiński & Błachowski 2023), can in general be explained by the very low forest

coverage in the Oder Valley, as the Soricidae prefer forested environments (Żmihorski & Osojca 2006, Romanowski & Żmihorski 2009, Lesiński & Błachowski 2023). The presence of the black rat in the Oder Valley is only a potentiality; unfortunately, the precise location of the site in Koźle mentioned in the Polish Atlas of Mammals (Pucek & Raczyński 1983) is unknown. It is possible that at the time, the species was found outside the Oder Valley. Furthermore, the *R. rattus* is likely extremely rare in Poland currently, as indicated by its distribution map included in the online version of the Polish Atlas of Mammals (Okarma et al. 2023). Lastly, the presence of the pygmy field mouse, indicated by Sałata-Piłacińska (1994) as inhabiting the neighbourhood of Popielowa, was not confirmed. Likewise, it is uncertain whether this species was collected at the time in the Oder Valley, and even if so, it was exceptionally rare: only a single specimen was found in the pellets.

The obtained results have provided valuable observations of small mammals in the Opole Voivodeship, which is a relatively poorly researched area of Poland in terms of the presence of mammals, as indicated by the fact that in the online version of the Polish Atlas of Mammals (Okarma et al. 2023), there are no sites of the most common species, such as the *C. glareolus*, *M. arvalis*, *A. agrarius* or *A. flavicollis*, listed in the UTM squares covering the Opole section of the Oder Valley. The obtained results fill this gap by providing information about the species composition of small mammals in the most important ecological corridor in the region and a poorly-researched area of Poland in terms of the fauna of small mammals.

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REFERENCES

- BALČIAUSKIENĖ L. 2005. Analysis of Tawny Owl (*Strix aluco*) food remains as a tool for long-term monitoring of small mammals. *Acta Zoologica Lituonica* 15: 85–89.
- BALČIAUSKAS L. & BALČIAUSKIENĖ L. 2022. Small Mammal Diversity Changes in a Baltic Country, 1975–2021: A Review. *Life* 12, 1887.
- GOSZCZYŃSKI J. 1981. Comparative analysis of food of owls in agrocenoses. *Ekologia polska* 29: 431–439.
- GOSZCZYŃSKI J., JABŁOŃSKI P., LESIŃSKI G. & ROMANOWSKI J. 1993. Variation in diet of Tawny Owl *Strix aluco* L. along an urbanization gradient. *Acta Ornithologica* 27: 113–123.
- GRAMSZ B. 1991. Pokarm puszczyka *Strix aluco* w lesie grądowym koło Oławy. *Acta Ornithologica* 26: 3–13.
- GRAMSZ B., KOŚCIÓW R. & ŻEGLIŃSKI G. 2005. Puszczyk *Strix aluco*. In: MIKUSEK R. (ed.), *Metody badań i ochrony sów*, pp: 114–124. Fundacja Wspierania Inicjatyw Ekologicznych. Kraków.
- GRYZ J. & KRAUZE-GRYZ D. 2016. Wpływ pory roku i dostępności gryzoni leśnych na skład pokarmu puszczyka *Strix aluco* w warunkach mozaiki polno-leśnej środkowej Polski. *Sylvan* 160, 1: 57–63.
- GRYZ J., KRAUZE D. & GOSZCZYŃSKI J. 2008. The small mammals of Warsaw as inferred from tawny owl (*Strix aluco*) pellet analyses. *Annales Zoologici Fennici* 45: 281–285.
- HEBDA G. & WYSZYŃSKI M. 2001. Fauna. In: MAKOWIECKI J., KOZIARSKI S. (eds), *Walory przyrodniczo-krajobrazowe Obszaru Chronionego Krajobrazu Łęg Zdzieszowicki*, pp: 41–43. *Studia i Monografie nr 293*. Uniwersytet Opolski. Opole.
- KONDRACKI J. 2000. *Geografia regionalna Polski*. Wyd. Naukowe PWN, Warszawa.
- KOPIJ G. 1992. Pokarm płomykówki *Tyto alba* na Śląsku Opolskim. *Ptaki Śląska* 9: 71–77.
- LESIŃSKI G. & BŁACHOWSKI G. 2023. Small mammals in the diet of the tawny owl *Strix aluco* in selected sites of the Biebrza Basin and Knyszyn Forest in north-eastern Poland. *Fragmenta Faunistica* 66 (1): 47–57.

- LESIŃSKI G. & GRYZ J. B. 2011. How protecting a suburban forest as a natural reserve effected small mammal communities. *Urban Ecosystems* 15: 103–110.
- LESIŃSKI G., JANUS K., NOWAK K. & PRUSZKOWSKA A. 2016. Drobne ssaki Bolimowskiego Parku Krajobrazowego i okolic na podstawie analizy diety puszczyka *Strix aluco*. *Parki Narodowe i Rezerваты Przyrody* 35, 4: 57–69.
- LESIŃSKI G. & KMIĘCIK P. 2023. Stanowiska drobnych ssaków na ziemi kłodzkiej wykryte podczas analizy diety sów w latach 2018–2022. *Przyroda Sudetów* 25: 205–226.
- LESIŃSKI G., ROMANOWSKI J., GRYZ J., OLSZEWSKI A., KOWALSKI M., KRAUZE-GRYZ D., OLECH B., PEŁOWSKA-MARCIK D. & TARŁOWSKI A. 2013. Small mammals of Kampinos National Park and its protection zone, as revealed by analyses of the diet of tawny owls *Strix aluco*. *Fragmenta Faunistica*. 56: 65–81.
- LIRO A. 1995. Koncepcja krajowej sieci ekologicznej ECONET – Polska. Wyd. IUCN, Warszawa, 18 pp.
- MATUSZKIEWICZ W. 1991. Potencjalna roślinność naturalna Polski. Mapa 1:300000, IGPZ PAN, Warszawa.
- MIKUSEK R. 1999. Ryjówka górską *Sorex alpinus* w zrzutkach ptaków drapieżnych i sów na Ziemi Kłodzkiej (Sudety Środkowe). *Chrońmy Przyrodę Ojczystą* 5: 94–98.
- NILSSON C., REIDY C.A., DYNESIUS M. & REVENGA C. 2005. Fragmentation and flow regulation of the world's large river systems. *Science* 308: 405–408.
- OKARMA H., BOGDANOWICZ W., RYCHLIK L. & ZALEWSKI A. 2023. Atlas ssaków Polski. Instytut Ochrony Przyrody PAN, Kraków. Available at: <https://www.iop.krakow.pl/ssaki>.
- PEDROLI B., DE BLUST G., VAN LOOY, K. & VAN ROOIJ S. 2002. Setting targets in strategies for river restoration. *Landscape Ecology* 17 (Suppl. S1): 5–18.
- PUCEK Z. 1984. Klucz do oznaczania ssaków Polski. PWN, Warszawa.
- PUCEK Z. & RACZYŃSKI J. 1983. Atlas rozmieszczenia ssaków w Polsce. PWN, Warszawa.
- ROMANOWSKI J., DUDEK-GODEAU D. & LESIŃSKI G. 2023. The Diversity of Small Mammals along a Large River Valley Revealed from Pellets of Tawny Owl *Strix aluco*. *Biology* 12,8: 1118. <https://doi.org/10.3390/biology12081118>
- ROMANOWSKI J., TARŁOWSKI A., LESIŃSKI G. & OLSZEWSKI A. 2014. Drobne ssaki Chojnowskiego Parku Krajobrazowego w pokarmie puszczyka *Strix aluco*. *Chrońmy Przyrodę Ojczystą* 70, 1: 63–67.
- ROMANOWSKI J. & ŻMIHORSKI M. 2009. Seasonal and habitat variation in the diet of the tawny owl (*Strix aluco*) in Central Poland during unusually warm years. *Biologia* 64/2: 365–369, Section Zoology.
- RUPRECHT A. L. 1979. Criteria for species determination in the subgenus *Sylvaemus* Ognev & Vorobiev, 1923 (Rodentia : Muridae). – *Przegląd Zoologiczny* 23: 340–350. [In Polish with English summary].
- SALAŁA-PILAĆIŃSKA B. 1994. Fauna ssaków Śląska w wyplawkach płomykówki *Tyto alba* (Scopoli, 1769). *Badania fizjograficzne nad Polską zachodnią* C, 41: 61–80.
- StatSoft Inc. 2014. STATISTICA (Data Analysis Software System), version 12. StatSoft Inc.: Tulsa, OK, USA.
- TOCKNER K. & STANFORD J. A. 2002. Riverine floodplains: Present state and future trends. *Environmental Conservation* 29: 308–330.
- WARD J.V., TOCKNER K., & SCHIEMER F. 1999. Biodiversity of floodplain river ecosystems: ecotones and connectivity. *Regulated Rivers* 15: 125–139
- WRÓBEL R. 2014. Antropogeniczne przeobrażenia krajobrazu polskiego odcinka doliny Odry w XX w. *Studia i Monografie* nr 513. Uniwersytet Opolski.
- ZAWADZKA D. & ZAWADZKI J. 2007. Feeding ecology of Tawny Owl (*Strix aluco*) in Wigry National Park (North East Poland). *Acta Zoologica Lituanica* 17: 234–241.
- ŻMIHORSKI M., BALČIAUSKIENĖ L. & ROMANOWSKI J. 2008. Small mammals in the diet of the Tawny owl (*Strix aluco* L.) in Central European Lowland. *Polish Journal of Ecology* 56,4: 693–700.
- ŻMIHORSKI M., GRYZ J., KRAUZE-GRYZ D., OLCZYK A. & OSOJCA G. 2011. The Tawny owl *Strix aluco* as a material collector in faunistic investigations: the case study of small mammals in NE Poland. *Acta Zoologica Lituanica* 21: 185–191.
- ŻMIHORSKI M. & OSOJCA G. 2006. Diet of the Tawny Owl (*Strix aluco*) in the Rominka Forest (North East Poland). *Acta Zoologica Lituanica* 16: 54–60.
- ŻMIHORSKI M., ROMANOWSKI J. & BOROWIECKI M. 2012. Drobne ssaki w pokarmie trzech gatunków sów w Dolinie Dolnej Odry. *Przegląd Przyrodniczy* 23,2: 77–85.

STRESZCZENIE

[Pokarm puszczyka *Strix aluco* w dolinie Odry w województwie opolskim (południowo-zachodnia Polska)]

W pracy przedstawiono skład pokarmu puszczyka występującego w dolinie Odry w województwie opolskim na podstawie analizy wypluwek. Wypluwki zebrano łącznie z 22 miejsc, zgrupowanych w 5 lokalizacjach różniących się strukturą użytkowania gruntów. Łącznie zidentyfikowano 1103 ofiary, z czego 902 należało do ssaków. W materiale zidentyfikowano 19 gatunków ssaków: 4 ssaki ryjówkoksształtne, 1 gatunek nietoperza,

1 zającokształtny, 12 gryzoni i 1 gatunek ssaka drapieżnego. 77,1% pokarmu stanowiły gryzonie, z czego najliczniejszymi gatunkami na wszystkich stanowiskach były: *Microtus arvalis*, *Apodemus agrarius*, *A. flavicollis* i *Clethrionomys glareolus*. W zależności od typu środowiska w którym wypluwki zbierano, *Crocidura suaveolens*, *M. arvalis*, *Mus musculus* i *A. agrarius* były najliczniejsze w krajobrazie rolniczym sąsiadującym z obszarami zabudowanymi, natomiast *A. flavicollis* i *C. glareolus* były najliczniejszymi ofiarami w środowisku leśnym. Do gatunków cennych przyrodniczo zalicza się wykazana na jednym stanowisku orzesznica leszczynowa *Muscardinus avellanarius*. Bardzo wysoki udział gryzoni w diecie, szczególnie myszowatych i nornikowatych, przy niskim udziale ssaków ryjówkowskich może świadczyć o znacznym przekształceniu środowisk typowych dla dolin rzecznych, i dominacji w krajobrazie nieodróżnionych użytków rolnych.

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