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The analysis of the diet composition of the barn owl *Tyto alba* (Scopoli, 1769) from the region of Brzeg, Opolskie Voivodeship (Poland)

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Abstract: Research on the diet composition of the barn owl *Tyto alba* was conducted near the town of Przecza in the area of Lewin Brzeski (Opolskie Voivodeship. On the basis of 1158 bone elements, 14 species of small mammals were found, including 4 insectivorous species (*Sorex araneus, Sorex minutus*, *Neomys fodiens*, *Cocidura suaveolens*), 5 vole species (*Microtus arvalis*, *Microtus agrestis*, *Arvicola terrestris*, *Myodes glareolus*, *Microtus oeconomus*) and 5 mouse species (*Mus musculus*, *Apodemus agrarius*, *Apodemus flavicolis*, *Apodemus sylvaticus*, *Micromys minutus*). The diet was dominated by 3 species: *Microtus arvalis*, *Sorex araneus* and the *Apodemus agrarius*. The conducted research clearly shows that the *T. alba* in the area of Przecza fed mainly with small mammals, while birds constituted only a small share in the total research material. The collected information is valuable for understanding the distribution of individual species, as well as for understanding the diet composition of the *T. alba*, and may also be useful in agriculture in order to implement protective measures.

Key words: Aves, Insectivora, Rodentia, food, Brzeg, Opolskie Voivodeship, Poland, biodiversity.

INTRODUCTION

The research on the diet composition of owls and diurnal predator birds has developed significantly since the second half of the 20th century (Hetmański *et al.* 2008). For this purpose, pellets analysis is used, which is one of the best methods for this type of research (Hetmański & Wołk 2007). This method is based on examining the undigested remains of the victims, which are defaecated by the birds in the form of airdrops (Wołk 1965). They

include bone elements, hair, insect shells and feathers. Apart from owls and other birds of prey, they are produced by kingfishers, storks, gulls, herons, swifts, etc. (Mikusek 2005). The analysis of the pellet allows obtaining information about the fauna of small mammals. It is a non-invasive method, and its advantage is the ability to collect data without catching the animals, which can be accompanied by stress or even death of the animals. In addition, it enables the identification of mammalian species that cannot be trapped for various reasons and the collection of considerable research material showing significant qualitative and quantitative variability. The analysis of the pellet is also used in studies on the dynamics of the population and the activity of small mammals (Hetmański & Wołk 2007). Determining the number of eaten victims allows us to illustrate their role in exterminating rodents that cause damage to farmlands and human economy (Wołk 1965).

The diet of owls and *Tyto alba* hasn't been analyzed to a full degree, a lot of data has been collected on the diet composition of the long-eared owl *Asio otus*, the tawny owl *Strix aluco* and the *T. alba*, due to their numerous occurrences and easy finding of research material (Romanowski & Żmihorski 2006, Grzywaczewski & Szczepaniak 2007). The *Tyto alba* are optimal in research on the fauna of small mammals (Hetmański & Wołk 2007), because they are a sedentary species that hunts in the vicinity of their nesting place. They leave a lot of pellet in buildings, churches, where they rest during the day, and the bone material contained in them is complete and well preserved.

Due to the intensive development of agriculture, the land structure is changing, which leads to changes in the fauna of small mammals. In some areas of Europe, the disappearance of Arvicolidae is observed, and thus the number of predator birds is decreasing. The endangered birds include, among others, *T. alba* and species of owls, mainly *Asio otus*, therefore, in conjunction with, research on the diet composition of owls and *T. alba* should be continued (Hetmański *et al.* 2008).

The aim of the conducted research was to determine the occurrence of small mammals and their species composition in the vicinity of Przecza, near the Lewin Brzeski, in the Brzeg county, in the western part of the Opolskie Voivodeship in Poland (Central Europe) and which of the small mammals predominate in the food of the *T. alba*.

The aim of the study was to determine the occurrence of small mammals and their species composition based on pellet analyses (1), and the dominance of small mammals in the diet of *Tyto alba*.

MATERIAL AND METHODS

Material collection site – the town of Przecza (N 50.758; E 17.680) is located on the left bank of the Nysa Kłodzka River, at the mouth of the Odra River and along the main communication routes. The collected research material comes from the Gothic church in Przecza. The church comes from the late Middle Ages; the turn of the 13th and 14th centuries, and is located in the central part of the village

The research material was collected from the church tower in Przecza during two field trips, which took place on January 23, 2010 and September 30, 2010. The obtained material was processed using cameral methods (preparation, material determination) according to Kłys and Marszałek (2008). The criteria for marking were: the shape of the skulls and mandibles, the shape and character of the dentition compared to a key (Pucek 1984). Diagnostic features for individual systematic groups were distinguished using the key for marking mammals of Poland (Pucek 1984). The data obtained in the course of the research was collected and compiled in tabular form, and then analyzed in order to obtain conclusions.

After dissecting the bone elements, they were isolated according to the date of collection and then the species belonging to the bone element on the basis of the key for marking Polish mammals (Pucek 1984). The results were analyzed. According to the method used, the number of individuals belonging to each species was estimated. The method of maxima was applied, i.e., the adoption of the most numerous results but not mutually exclusive for the final number of individuals of a given species (Kłys & Marszałek 2008).

RESULTS

There were 1158 skull elements dissected and identified. The obtained results are summarized in Table 1 and the estimated number of specimens is presented on the basis of the number of bone elements and their percentage broken down into orders and families (Table 2). The chart compares the number of bone elements with the number of individuals estimated on their basis (Kłys & Marszałek 2008). The main, solid, complementary and incidental food for *T. alba* were also determined according to the scheme (Mikusek 2005):

- Basic food – the share of the victim exceeds 20%
- Solid food – the share of the victim is in the range 5-20%
- Complementary food – the share of the victim is 1-5%
- Incidental food – if the victim's share does not exceed 1%

Table 1. Summary of the estimated number of individuals and their percentage share in the total material.
Tabela 1. Podsumowanie szacunkowej liczby osobników i ich procentowego udziału ogółem w materiale.

Species **Gatunek**	**The number of bone elements** **Liczba elementów kostnych**	**Estimated number of individuals** **Szacowana liczba osobników**	**Share [%]** **Udział [%]**
Sorex araneus Linnaeus, 1758	267	230	22,8
Sorex minutus Linnaeus, 1766	63	60	6
Neomys fodiens (Pendant, 1771)	13	13	1,3
Cocidura suaveolens (Pallas, 1811)	14	12	1,2
Crocidura Wagler, 1832	1	1	0,1
Microtus arvalis (Pallas, 1779)	252	235	23,3
Microtus agrestis (Linnaeus, 1761)	25	23	2,3
Arvicola terrestris (Linnaeus, 1758)	18	15	1,5
Myodes glareolus (Schreber, 1780)	8	8	0,8
Microtus oeconomus (Pallas, 1776)	1	1	0,1
unidentified Arvicolidae Gray, 1821	163	105	10,4
Mus musculus Linnaeus, 1758	34	34	3,4
Apodemus agrarius (Pallas, 1771)	88	88	8,7
Apodemus flavicolis (Melchior, 1834)	39	39	3,9
Apodemus sylvaticus (Linnaeus, 1758)	27	27	2,7
Micromys minutus (Pallas, 1771)	7	6	0,6
unidentified Muridae Illiger, 1811	96	73	7,2
Aves	42	38	3,8
∑	**1158**	**1008**	**100**

Table 2. Summary of the estimated number of individuals and their percentage share in the total material for orders and families.

Tabela 2. Zestawienie szacunkowej liczby osobników i ich procentowego udziału w materiale ogółem dla rzędów i rodzin.

Family Rodzina	The number of bone elements Liczba elementów kostnych	Estimated number of individuals Szacowana liczba osobników	Share [%] Udział [%]
Insectivora	358	316	31,3
Rodentia	758	654	64,9
Arvicolidae	467	387	38,4
Muridae	291	267	26,5
Aves	42	38	3,8
∑	**1158**	**1008**	**100**

DISCUSSION

The total number of bone elements prepared from the *T. alba* pellet is 1158. There are 7 types of bone elements, namely complete skulls, skulls with the left mandible, skulls with the right mandible, only the skulls, both mandibles, the left mandible and the right mandible. In the research material, the most numerous were complete skulls (603 skulls, which constitutes 52% of the total material), only the skulls (194, which constitutes 16.8% of the total material) and both mandibles (93-8%).

On the basis of 1158 dissected bone elements, the presence of 1,008 individuals was estimated (Tab. 1), of which 791 individuals were assigned to the species. It should be noted that this is only an estimate and due to the presence of incomplete skulls and loose mandibles in the research material, it is not possible to determine the actual number of individuals present in the study area.

The *T. alba* diet was dominated by small mammals, which together constituted 96.2% of all victims, while the remaining, a small part was represented by the order of birds (3.8%). The pellets of the *T. alba* contain the shells of insects: flies (Diptera), butterflies (Lepidoptera) or beetles (Coleoptera), which, however, appear very rarely (Hetmański & Wołk 2007), and no insect elements were found in the analyzed research material Wołk (1965) states that chitin shells, or its fragments found in pellet, could not have been eaten by an owl, but by its victim, so one should approach such statements with caution.

The *T. alba* diet also includes bats, which, like insects, are random food (Hetmański & Wołk 2007). Their percentage share in the vicinity of Toruń is 0.52% (Kasprzyk & Zalewski 1992), in the area of south-western Little Mazovia 0.27%, but usually does not exceed 0.1%. (Nikodem 1972). In the conducted research, no bone elements belonging to bats were found, perhaps *T. alba* in the study area did not specialize in capturing these animals. The percentage share of the estimated number of individuals shows that rodents (64.9%) dominate among micromammals including voles (38.4%) and mice (26.5%), while insectivores (31,35%) (Tab. 2).

In general, 14 species of small mammals, 4 species of insectivores, 5 species of mice and 5 species of voles were found in the research material. The dominant species in the food of the *T. alba* were the *Microtus arvalis* (23.3%), the *Sorex araneus* (22.8%) and the *Apodemus*

agrarius field mouse (8.7%) (Tab. 1). As you can see, the difference between the first two dominants is very small and it should be noted that these values were determined on the basis of the estimated number of individuals. It is possible that the shrew may dominate the food of the *T. alba*, and not the common voles, but it should be taken into account that among voles there are a large number of unmarked elements, including bone elements belonging to the common vole.

When determining the main food, it was found that the *Sorex areneus* and *Microtus arvalis* are the main food. This is understandable as these two species of mammals dominate the diet of the *T. alba* in the study area. The share of the *Sorex araneus* is (22.8%), and the *Microtus arvalis* (23.3%). The solid food included the *Sorex minutus* (6%) and the *Apodemus agrarius* (8.7%). The incidental food is the *Microtus oeconomus* (0.1%), the *Myodes glareolus* (0.8%) and the *Micromys minutus* (0.6%). The remaining species of mammals found themselves in complementary food, including the *Mus musculus.*

The presented data corelates with the data in the literature or shows little convergence. In northern Poland, small mammals also dominate the diet of the *Tyto alba*, and rodents (66.7%) are the most numerous in the food, followed by insectivores (33.2%). However, the proportion of voles in this case is lower and amounts to 23.9%, and predominates the proportion of mice (42.2%) (Hetmański & Wołk 2007), which is contrary to the research that was carried out (Tab. 2). The dominant species of small mammals in the diet of the *T. alba*, in northern Poland, were the *Sorex araneus*, then the *Mus musculus* and the *Microtus arvalis* (Hetmański & Wołk 2007), while in central-eastern Poland the house mouse, the common vole and the velvet shrew (Urbanek & Pyziołek 2007). The conducted research shows that the *T. alba* most often preyed on the *Microtus arvalis* and less often on the *Sorex araneus* and *Mus musculus*. Species of small mammals constituting the main food in the studied area: In the diet of the *T. alba*, the *Microtus arvalis* dominates in the area (23.3%) because, according to Nikodem (1972), it is a species abundant all over Poland, and its activity in the field coincides with that of owls. The large number of the *Sorex araneus* and its high activity makes it the most numerous species of insectivores (Sałata-Piłacińska 1977), which is confirmed by the conducted research. In addition, the *Sorex araneus* is the second dominant species in the studied area, its share is 22.8%.

Species of small mammals constituting solid food in the studied area: The *Apodemus agrarius* is the third most common species in the study area, its share in the research material is 8.7% and is similar to the result obtained by Kasprzyk & Zalewski (1992) near Toruń (7.17%), or Hetmański & Wołk (2007) in northern Poland (7.6%). The *Apodemus agrarius* inhabits, among others, meadows, arable fields, gardens, wet thickets (Pucek 1984). The *Apodemus agrarius* is the third most common species in the studied area, its share in the research material is 8.7% and, compared to other studies, it is the highest result, e.g. 3.35% (Nikodem 1972), 2-5% (Sałata-Piłacińska 1977), 7.17% (Kasprzyk & Zalewski 1992), 7.6% (Hetmański & Wołk 2007), 2.3% (Hetmański *et al.* 2008). The *Sorex minutus* is a less abundant species in the research material (6%), because, according to Nikodem (1972), it is a forest species, caught during migration, and therefore it appears only temporarily in open areas. The *Apodemus agrarius* inhabits, among others, meadows, arable fields, gardens, wet thickets (Pucek 1984).

Species of small mammals constituting complementary food in the study area:

The occurrence of *Mus musculus* in the diet of the *T. alba* differs depending on the region of the country (Sałata-Piłacińska 1977), but usually the *Mus musculus* is the main food of this owl and its share in the research material exceeds 20% (Kasprzyk & Zalewski 1992, Hetmański & Wołk 2007, Urbanek & Pyziołek 2007). The *Mus musculus* is associated

with human settlements, adjacent fields, orchards and gardens (Nikodem 1972). Additionally, the *Tyto alba* can hunt among buildings, especially in unfavourable weather conditions (Hetmański *et al.* 2008 after Altwegg *et al.* 2006), hence the presence of this species in the studied material. However, it is puzzling why the share of the *Mus musculus* is so small, only 3.4%. This may be related to changes in agriculture and the current character of buildings, which may lead to a decrease in the number of synanthropic species (Urbanek & Pyziołek 2007), or to seasonal changes in the species composition of prey. Perhaps the collected pellet came from the spring and summer period, when the *T. alba* food is dominated by the *Sorex araneus* and the *Microtus arvalis* (Hetmański & Wołk 2007). It is also possible that among the unidenfited elements belonging to the mice family, there are bone elements of the *Mus musculus*. The occurrence of *Apodemus sylvaticus* and *Apodemus flavicollis* is associated with forests, shrubs and parks (Nikodem 1972); therefore, they appear sparse in the food of the *T. alba.* Additionally, Sałata-Piłacińska (1977) states that the *Apodemus flavicollis* is less often caught than the *Apodemus sylvaticus*, because it is closely related to the forest and appears in the fields only during the harvest. In some areas it has not even been found (Kowalski & Lesiński 1986, Kasprzyk & Zalewski 1992). In the tested material, its share is 3.9% and is even higher than the share of *Apodemus sylvaticus* (2.7%). This may be related to the presence of forest complexes in the area of Przecza, belonging to Bory Niemodlińskie, as well as other forest areas (Banik 2005). *Neomys fodiens* are usually supplementary food (Sałata-Piłacińska 1977), which is confirmed by the conducted research. It is a species associated with water reservoirs, wet meadows (Pucek 1984), therefore its share in the studied material (1.3%) is quite small. Although *Crocidura suaveolens* lives in fields, orchards and gardens, and in the autumn, it appears in human buildings (Pucek 1984), it is a rare species in Poland (Sałata-Piłacińska 1977), which may result in its small number. The small share of *Microtus agrestis* (2.2%) in the *Tyto alba* diet explains its insular nature, low mobility and the fact that it is a forest species (Nikodem 1972).The last representative of the supplementary food in the diet of the *Tyto alba* is the European *Arvicola terrestris.* Its small share (1.6%) can be explained by the fact that it is an aquatic species, but also occurring in open areas, meadows and fields (Pucek 1984).

Species of small mammals constituting random food of *T. alba* in the study area:

In general, the *Myodes glareolus* is a common rodent found throughout our country (Pucek 1984), but it is typically forest species, associated with trees (Sałata-Piłacińska 1977), therefore it is sparse in the food of the *Tyto alba*, and its share is 0.8%.

The negligible share of *Micromys minutus* in the research material (0.6%) is due to the daily activity of this species (Sałata-Piłacińska 1977). The *Micromys minutus* can be found by the water, in the fields and in forests (Pucek 1984). The *Microtus oeconomus* shows the smallest share among small mammals in the study area. Only one individual of this species was found, because the research area is related to the border of the northern vole range (Pucek 1984).

The landscape of the studied area is shaped by arable fields, human settlements, developed meadows, therefore, the food of the *Tyto alba* is dominated by species of small mammals, characteristic for this type of environment. It is mainly the *Sorex araneus*, *Microtus arvalis*, *Mus musculus* and, to a lesser extent, *Apodemus agrarius* (Lesiński & Rusin 1996). In the conducted research, the *Mus musculus* has a surprisingly small share in the food of the *Tyto alba*.

The small share of forest species of small mammals in the research material is due to the fact that the *T. alba* hunts mainly in open areas and does not penetrate deep into forest complexes (Kowalski & Lesiński 1986). The occurrence of species associated with the

aquatic environment can be explained by the presence in the vicinity of Przecza ponds of Niemodlińskie, belonging to the Protected Landscape Area of Bory Niemodlińskie (Banik 2005), but the share of these species is still small.

The fauna of mammals in the presented studies is incomplete, because no species of mammals that appear in other studies were found, e.g. *Talpa europaea*, *Pitymys subterraneus*, *Rattus norvegicus*, Chiroptera (Kasprzyk & Zalewski 1992, Hetmański & Wołk 2007), but on the other hand, such species were found to not exist in the food of the *T. alba* in other areas, i.e. the forest mouse (Kowalski & Lesiński 1986) or the lesser white-toothed shrew (Kasprzyk & Zalewski 1992, Hetmański & Wołk 2007).

Such a different distribution of small mammals in the diet of this owl results from its food and environmental selectivity (Kowalski & Lesiński 1986). The *T. alba* hunts in open areas, a few km from its site, for the species of animals that exist in large numbers and with a similar lifestyle throughout the day (Sałata-Piłacińska 1977). In addition, the *T. alba* can use the increase in the number of a given species during the year (Hetmański & Wołk 2007).

The bone material was deposited at the Upper Silesian Museum in Bytom (ŚląskieVoivodeshipm, Poland).

These studies allow to determine which small mammals and other vertebrates are present in a given area, their numbers and species composition. The studies therefore provide information on the distribution of small mammals.

CONCLUSION

Research on the diet composition of the barn owl *Tyto alba* was conducted near the town of Przecza in the area of Lewin Brzeski (Opolskie Voivodeship. On the basis of 1158 bone elements, 14 species of small mammals were found, including 4 insectivorous species (*Sorex araneus*, *Sorex minutus*, *Neomys fodiens*, *Cocidura suaveolens*), 5 vole species (*Microtus arvalis*, *Microtus agrestis*, *Arvicola terrestris*, *Myodes glareolus*, *Microtus oeconomus*) and 5 mouse species (*Mus musculus*, *Apodemus agrarius*, *Apodemus flavicolis*, *Apodemus sylvaticus*, *Micromys minutus*). The diet was dominated by 3 species: *Microtus arvalis* 23,3%, *Sorex araneus* 22,8% and the *Apodemus agrarius* 8,7%. The remaining species of mammals found themselves in complementary food. The collected information is valuable for understanding the distribution of individual species, as well as for understanding the diet composition of the *T. alba*, and may also be useful in agriculture in order to implement protective measures.

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Streszczenie

Badania nad składem pokarmu płomykówki *Tyto alba* przeprowadzono w okolicach miejscowości Przecza w rejonie Lewina Brzeskiego (woj. opolskie). Na podstawie 1158 elementów kostnych stwierdzono 14 gatunków małych ssaków, w tym 4 gatunki owadożerne (*Sorex araneus*, *Sorex minutus*, *Neomys fodiens*, *Cocidura suaveolens*), 5 gatunków norników (*Microtus arvalis*, *Microtus agrestis*, *Arvicola terrestris*, *Myodes glareolus*, *Microtus oeconomus*) i 5 gatunków myszy (*Mus musculus*, *Apodemus agrarius*, *Apodemus flavicolis*, *Apodemus sylvaticus*, *Micromys minutus*) W diecie dominowały 3 gatunki: *Microtus arvalis* 23,3%, *Sorex araneus* 22,8% i *Apodemus agrarius* 8,7%. Pozostałe gatunki ssaków znalazły się w pokarmie uzupełniającym. Zebrane informacje są cenne dla zrozumienia rozmieszczenia poszczególnych gatunków, a także do zrozumienia składu diety *T. alba*, a także mogą być przydatne w rolnictwie do wdrażania działań ochronnych.

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