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COMPARATIVE ANALYSIS OF FOOD OF OWLS IN AGROCENOSES*

ABSTRACT: Food composition of three species of owls (*Strix aluco, Asio otus* and *Tyto alba*) has been analysed in an agricultural area with mass occurrence of common vole. The effect of various densities of this rodent on the food composition of owls has been examined. Also the seasonal variability of the diet and the variability due to environment are discussed. Specialization of owls in capture of voles and its consequences are discussed.

KEY WORDS: Cultivated fields, birds, owls, feeding habits.

Contents

1. INTRODUCTION

Studies on the food composition of owls were a part of more thorough investigations on the role of predators in agrocenoses (cf. Ryszkowski, Goszczyński and Truszkowski 1973, Goszczyński 1974, 1976, Truszkowski 1976). The studies on the three species of owls were conducted on the same area and at the same time, thus the material obtained described well the species differences as regards food composition. Parallel estimations of the density of small

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rodents, which are the basic food of these birds (G o s z c z y ń s k i 1977) allowed to determine additionally the food preference of owls and their reaction to varying densities of rodents.

2. AREA INVESTIGATED AND METHODS

The studies were conducted between 1970 and 1975 near Turew (52°04 N, 16°48 E) in Leszno province. The Kościan Plane, which was the investigated area, has the majority of fields. Forested areas (small forests and shelter belts) cover about 12% of the surface area. Common vole found mainly of alfalfa fields and meadows dominates in the rodent community. During mass appearances the common vole reaches the number of 1500 individuals per 1 hectare (R y s z k o w s k i, G o s z c z y ń s k i and T r u s z k o w s k i 1973). Detailed information on the investigated area can be found in papers by R y s z k o w s k i et al. (1971) and R y s z k o w s k i, G o s z c z y ń s k i and T r u s z k o w s k i (1973).

Pellets of barn owl *Tyto alba* (Scop.) were collected on attics of churches and buildings. Pellets of tawny owl *Strix aluco* (L.) and long-eared owl *Asio otus* (L.) were collected in places of roost site or under nests. Some of the pellets were also from nest boxes placed in shelter belts and small forests. Out of the pellets of tawny owl the total of 1600 individuals of vertebrates were distinguished, 5400 vertebrates – from pellets of long-eared owl and 3700 – from pellets of barn owl. Pellets were collected during the full cycle of changes in numbers of common vole and characterized well the food of owls on areas where this rodent appeared abundantly. Results of analyses are given in the form of weight percentage and frequency of occurrence of a given component in food. Knowing the prey number of a given species and mean weight of prey (estimated according to measurements on the area investigated), the biomass of a given species has been estimated in the diet. Total biomass of all species is assumed as 100, allowing thus to calculate the weight percentage of particular species.

In order to analyse the dietary overlap of three species of owls examined in periods of high and low densities of common voles and during the season, M o r i s o t a (1959) index modified by H o r n (1966), has been applied.

$$C = \frac{2 \sum_{i=1}^{n} x_i y_i}{\sum_{i=1}^{n} x_i^2 + \sum_{i=1}^{n} y_i^2}$$

where: C – dietary overlap in 0–1 range (1 means identical food composition), x_i, y_i – percentage of a given component in species compared or in the species examined in periods compared.

3. RESULTS

3.1. FOOD COMPOSITION

Food composition of owls is greatly affected by the agricultural character of the area examined. Thus the common vole – species dominant in the rodent community of agrocenoses – is the main food of the three species of owls examined.

Table I. Food composition of owls in Turew surroundings (weight percentage) for the period 1970–1975

Kind of food	*Strix aluco*	*Tyto alba*	*Asio otus*
Microtus arvalis (Pall.)	48.15	77.90	85.98
M. oeconomus (Pall.)	0.60	1.20	0.82
M. sp.	0.99	0.03	0.98
Pitymys subterraneus (de Sélys Longchamp)		0.06	
Clethrionomys glareolus (Schreb.)	5.70	0.22	1.34
Arvicola terrestris (L.)		0.25	0.15
Microtinae (vague)	0.11	0.03	0.14
Apodemus flavicollis (Melch.)	7.22	1.39	3.29
A. agrarius (Pall.)	1.13	0.73	0.45
A. sp.	6.15	2.29	4.29
Mus musculus L.	1.42	2.59	0.20
Micromys minutus (Pall.)	0.17	0.62	0.08
Rattus norvegicus (Berk.)	4.16	0.50	0.20
Murinae (vague)	0.59	0.07	0.20
Sciurus vulgaris L.	0.89		
Rodentia (vague)	0.30		
Talpa europea L.	1.35	0.15	
Sorex araneus L.	0.42	6.29	0.12
S. minutus L.	0.06	0.47	0.02
Neomys fodiens (Penn.)	0.03	0.40	0.01
Crocidura sp.	0.04	0.12	
Soricidae (vague)	0.02	0.08	
Chiroptera	0.09	0.07	
Aves	19.16	4.53	1.74
Rana sp.	1.20		
Lacerta sp.	0.06		

Average weight of this rodent in owl food is about 48% for the tawny owl, 78–86% for the barn owl and longeared owl (Table I). There is a statistically significant correlation between the density of common vole and its contribution to the food of tawny owl and barn owl ($0.001 > p$ and $0.01 > p > 0.001$, respectively). However, there is no statistically significant correlation in the case of long-eared owl ($0.6 > p > 0.5$).

Of the examined owl species the tawny owl reacts the strongest to changes in the density of common vole (Fig. 1). When the numbers of this rodent are very low the tawny owl switches onto buffer food: birds, small insectivorous mammals, bank voles and mice (*Apodemus* sp.). During the mass appearance of common vole the tawny owl hunts for this rodent first of all (Table II). The dietary overlap in periods of high and low densities of common vole is not high (0.56 as calculated for the kinds of food listed in Table II).

The contribution of common vole to the food of barn owl changes only slightly and rarely drops below 50% (Fig. 1). Insectivores are the main buffer food (Table II). Dietary overlap at high and low densities of common vole is considerable (0.76). The smallest fluactuations of the contribution of common vole to food have been observed in the case of long-eared owl. Common vole, independently of its numbers, forms 80–90% of food of this owl (Fig. 1) Similarity index of food composition in periods of high and low densities of common vole equals 1.

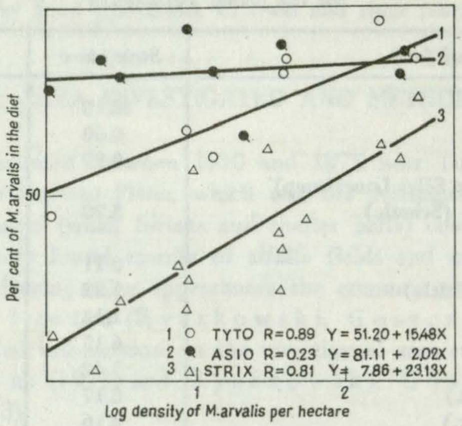

Fig. 1. Correlation between the weight percentage of common voles in the food of owl and the mean density of common voles per 1 ha of fields Density of voles after R y s z k o w s k i, G o s z c z y ń s k i and T r u s z k o w s k i (1973) and J. Truszkowski (unpublished data)

Table II. Food composition of owls at low (10 ind. · ha^{-1}) and high (100 ind. · ha^{-1}) densities of common voles (frequency)

Kind of food	Low density of voles			High density of voles		
	Strix aluco N = 371*	*Tyto alba* N = 973*	*Asio otus* N = 3393*	*Strix aluco* N = 837*	*Tyto alba* N = 612*	*Asio otus* N = 1458*
Microtus arvalis	23.4	47.1	87.9	72.8	88.4	93.8
Clethrionomys glareolus	7.8		1.1	4.4	0.2	0.5
Apodemus gen sp.	12.7	2.4	7.5	10.7	1.8	2.8
Other Muridae	8.9	9.3	0.7	2.5	4.4	0.5
Other Rodentia	1.6	1.5	1.1	0.4	0.3	0.9
Insectivora	2.7	35.5	0.3	1.7	3.4	0.6
Aves	37.2	4.2	1.4	7.5	1.5	0.9
Amphibia	5.7					

*Number of prey analysed.

Table III. Similarity of food composition (dietary overlap) of owls at extreme densities of the main prey – common vole

Density of voles	Dietary overlap for:		
	Strix aluco and *Asio otus*	*Strix aluco* and *Tyto alba*	*Tyto alba* and *Asio otus*
Low (< 10 ind. · ha^{-1})	0.44	0.50	0.73
High (> 100 ind. · ha^{-1})	0.96	0.97	1.00

At low densities of common vole the food composition of tawny owl differs from that of barn owl and long-eared owl. The two last species show great similarity (Table III). When the density of common vole is high and exceeds 100 individuals per 1 ha, the food of the three species is almost identical (Table III).

3.2. SEASONAL DIFFERENCES IN FOOD COMPOSITION

The sharpest seasonal fluctuations in food composition are typical of the tawny owl, because for the other two species seasonal differences are not great (Fig. 2). This confirms the already proved polyphagous feeding habits of tawny owl and the specialization of long-eared and barn owls in capture of voles.

In winter, and especially in spring, the differences in food composition between particular species are most distinct (Fig. 2). During these seasons the tawny owl and barn owl compensate the lack of common vole with other prey. It should be pointed out that the tawny owl has a greater range of buffer food than the barn owl (Fig. 2). Dietary overlap (for food indicated in Figure 2) in winter is: for *Strix aluco* and *Tyto alba* – 0.82, for *Strix aluco* and *Asio otus* – 0.78, for *Tyto alba* and *Asio otus* – 0.93. In spring the coefficients are respectively: 0.69, 0.62, 0.91. In summer and autumn differences in the food composition are very small (Fig. 2). During that time the density of common vole is the highest and intense agrotechnical treatments in fields at the time make the hunting easier for owls. They mainly catch the common vole. Coefficients of food similarity in summer and autumn are very high (from 0.96 to 1.0).

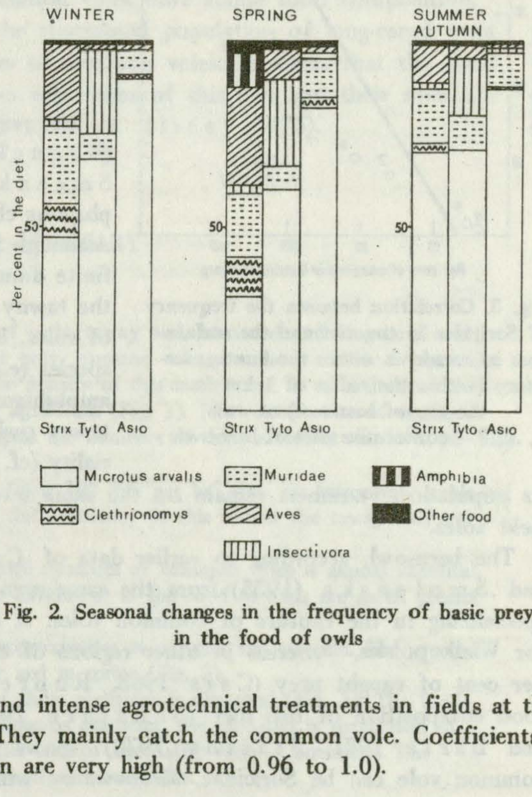

Fig. 2. Seasonal changes in the frequency of basic prey in the food of owls

3.3. HUNTING TERRITORY OF OWLS AND FOOD COMPOSITION

The dissimilarity of food composition of owls is greatly determined by the type of habitat in which the owls hunt. The tawny owl which hunts well among trees catches more frequently than barn and long-eared owls the bank vole (Fig. 2), i.e., a species typical for forested area. The tawny owl and barn owl which ferquently hunt close to farm buildings have a much higher weight percentage of house mice and brown rats (5.58 and 3.09%, respectively) than long-eared owl (0.40%), which hunts mainly on open field areas.

Even for the same species of owls the site conditions within the hunting territory cause the differentiation of food composition. Comparison of the contribution of Soricidae to the diet of barn owl from different sites surrounded by meadows (shrews do not occur on fields, and forests are not hunting territories for this species of owls) indicates that the intensity of catching prey on a given site is directly proportional to the surface area occupied by this site on the whole hunting territory of the owl (Fig. 3). Also in the case of other prey the relation is probably similar.

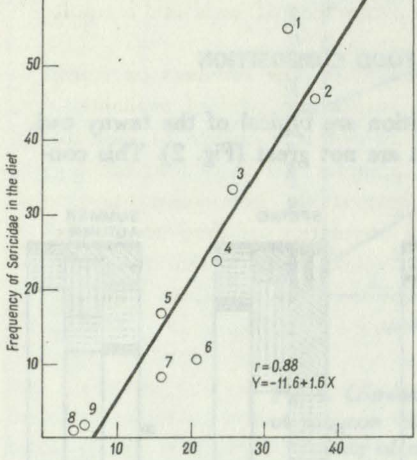

Fig. 3. Correlation between the frequency of Soricidae in the diet and the surface area of meadows within the hunting territory (within the radius of 1 km from the site of barn-owl) of owls
1, ..., 9 – consecutive sites of barn-owls

4. DISCUSSION

The paper confirms the literature data (Bogucki 1967, Hagn-Meincke 1967, Smeenk 1972 and others) on the polyphagous character of the tawny owl's diet. Although the common vole for years is a definite dominant in the community of rodents the tawny owl does not specialize in capture of voles, but rapidly changes to more available species (e.g., forest rodents, birds and even amphibians). This opportunistic character of tawny owl's diet connected with strong territoriality (cf. Southern 1970) explains why its population numbers remain on the same level despite the changes in numbers of field voles.

The barn-owl, according to earlier data of Czarnecki, Gruszczyńska and Smoleńska (1955) from the same area, has been considered as a species specializing in the capture of common voles. It seems to be a typical phenomenon for Wielkopolska, whereas in other regions of the country the vole is not even fifty per cent of caught prey (Cais 1963, Ruprecht 1971). The literature on the food composition of this owl (Schnurre 1967, Rothkopf 1970, Tyrner and Bărta 1971, Šťastny 1973) shows that the only prey alternative to common vole can be Soricidae. Meadows on which the barn-owl can catch shrews are very few in Turew surroundings. The specialization in the capture of common vole by this owl seems to be "forced", because it depends on the agricultural structure. In favour of such opinion is the fact that in Turew surroundings, wherever the hunting territory consists of meadow the contribution of Soricidae to the barn owl's diet is high.

The real specialization in the capture of common voles is in the case of long-eared owl. Authors analysing the food composition of this owl all agree as to the primary significance of common vole (Czarnecki 1956, Harmata 1969, Weber 1973 and others). No correlation between the density of common vole and its contribution to the food of long-eared owl can be explained by the fact that it can find out, even under conditions of low density, isolated colonies of common voles.

The diet of owls examined in some periods is almost identical and it could be expected that these birds compete for food. This is a delusion, because at high densities of common voles (in years of mass appearance) the pool of available prey is so high that the predators (also buzzards and predatory mammals) reduce only 10–20% of rodents (G o s z c z y ń s k i 1977). Thus the food convergences of owls are a result of quick functional reaction of the tawny owl and barn owl.

Still, real competition may occur under conditions of very low numbers of voles, because other predators also feed on this animal and reduce the pool of available prey. It seems that under such conditions the only way out is a change of diet to buffer food. At low numbers of common voles only predators (such as long-eared owl), highly specialized in capture of common voles have stable food composition. But probably only some individuals of the specialized population of long-eared owls can survive on an area with low numbers of common voles. It seems that the food specialization of long-eared owl affects on migrations of this owl and their numbers depend greatly on those of common voles (e.g., cf. I l i c e v 1975).

5. SUMMARY

During five years the food of three species of owls (tawny owl, barn owl and long-eared owl) has been investigated in agrocenoses. Among the prey, common vole prevails as the most numerous in agrocenoses (Table I). Correlation between the density of this rodent and its contribution to the food of barn owl and tawny owl is statistically significant (Fig. 1). The contribution of common vole to the food of long-eared owl remains, despite the numbers of this rodent, at the level 80–90% (Fig. 1).

In periods of high density of common voles (over 100 ind. per ha) they are intensively exploited by all owl species, whereas under conditions of the deficiency of this rodent the tawny owl and barn owl use buffer food (Table II).

The diet of species examined in periods of high densities of common voles is almost identical, whereas at very low numbers of this rodent the differences in the food of owls are much greater (Table III).

Food composition of owl species examined approximates in summer and autumn. The greatest differences among species are observed in winter and in spring (Fig. 2).

The effect of the environment on the diet of these predators is discussed (Fig. 3). The food of tawny owl on the area examined has a polyphagous character, the barn-owl is specialized in capture of voles, but it is "forced" because of the lack of alternative food – Soricidae. The long-eared owl is highly specialized in the capture of common voles.

6. POLISH SUMMARY

W okresie 5 lat badano pokarm 3 gatunków sów (puszczyka, płomykówki i sowy uszatej) w agrocenozach. Wśród ofiar przeważa najliczniejszy w agrocenozach nornik zwyczajny (tab. I). Korelacja między zagęszczeniem tego gryzonia a jego udziałem w pokarmie płomykówki i puszczyka jest statystycznie istotna (rys. 1). Udział nornika w pokarmie sowy uszatej utrzymuje się, bez względu na liczebność tego gryzonia, na poziomie 80–90% (rys. 1).

W okresach wysokich (powyżej 100 osobn. na ha terenu) zagęszczeń nornika jest on intensywnie eksploatowany przez wszystkie gatunki sów, natomiast w warunkach niedoboru tego gryzonia puszczyk i płomykówka wykorzystują pokarmy zastępcze (tab. II).

Dieta badanych gatunków w okresach wysokich zagęszczeń nornika jest prawie identyczna, podczas gdy w momentach depresji liczebnej tego gryzonia różnice w pokarmie sów są znacznie większe (tab. III).

Skład pokarmu badanych gatunków sów jest zbliżony w okresie lata i jesieni. Największe różnice między gatunkami stwierdzono w okresie zimy i wiosny (rys. 2).

Omówiono wpływ środowiska na dietę tych drapieżników (rys. 3). Na badanym terenie pokarm puszczyka ma charakter polifagiczny, płomykówka jest gatunkiem wyspecjalizowanym w chwytaniu nornika, ale specjalizacja ta jest wymuszona przez brak alternatywnego pokarmu – ryjówkowatych. Silną specjalizacją w wyłowie nornika charakteryzuje się sowa uszata.

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