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HABITAT PREFERENCE IN TERRITORIES OF THE RED-BACKED SHRIKE *LANIUS COLLURIO* AND THEIR FOOD RICHNESS IN AN EXTENSIVE AGRICULTURE LANDSCAPE

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Food richness of habitats influences their occupancy and influences both the numbers and breeding performance of birds. In 1999–2003, the percentage of habitat types in territories of the Red-backed Shrike *Lanius collurio* and their food richness were studied. Numbers and biomass of invertebrates were determined in four open habitats in the farmland of eastern Poland. Red-backed Shrikes preferred territories in meadows, pastures and fallows, and avoided arable land. The greatest number and biomass of animals 4–10 mm in length was found in meadows, the lowest in fallows and differences between these habitats were statistically significant. The highest number and biomass of animals longer than 10 mm was found in meadows, while it was the lowest in arable land. Statistically significant differences were found between meadows and pastures, meadows and arable land, pastures and arable land, and between arable land and fallows. The number and biomass of Coleoptera, Hymenoptera and Orthoptera in each habitat had the greatest influence on these differences. Habitat preference within the territories of Red-backed Shrikes thus corresponds with differences in the number and biomass of invertebrates occurring in these habitats.

Key words: Red-backed Shrike, *Lanius collurio*, farmland, habitat use

INTRODUCTION

Food richness is a feature of habitats which influences their occupation and shapes both the numbers and breeding performance of birds (WIENS 1984). Deterioration of feeding conditions is considered to be the main reason for the decrease in numbers of many species of the Western Europe agricultural landscape (FULLER 2000). This has been caused by the intensification of agricultural practices, e.g. by changing land use, mainly due to turning meadows and pastures into arable fields (FULLER *et al.* 1991). These changes, together with increased use of pesticides and mineral fertilisers, may lead to considerable depletion of the food base. An example are the case studies conducted in the UK on the Corn Bunting *Miliaria calandra*, which showed that its breeding success depended on the amount of potential food for nestlings, and was affected mainly by the structure of land use and application of pesticides (BRICKLE *et al.* 2000). Knowledge of the food base can be important also e.g. in bird conservation, because food availability in the breeding season is one of main factors limiting the breeding success of birds (MARTIN 1995, VERBOVEN *et al.* 2001, GRANBOM & SMITH 2006).

Agricultural practice in the farmlands of eastern Poland is far less intensive than in Western Europe (DONALD *et al.* 2002, USW 2005). The relatively good situation of birds in Poland's agricultural landscape should probably be connected with this factor (TRYJANOWSKI *et al.* 1999, DOMBROWSKI & GOŁAWSKI 2002). The aim of the present study was to identify habitat preferences in territories of the Red-backed Shrike *Lanius collurio* and to assess the food richness of selected habitats in an extensively managed agricultural landscape. The food composition of the Red-backed Shrike has been widely described. Invertebrates dominate, above all insects, which comprise 99% of prey. Most important among the insects are beetles, hymenopterans and orthopterans. (TRYJANOWSKI *et al.* 2003*a*, KARLSSON 2004, GOŁAWSKI 2006).

MATERIAL AND METHODS

Studies were conducted in agricultural landscape, 10–15 km to the north-east of Siedlce (E Poland). The study area consisted of 855 ha of extensively used farmland. Arable fields predominated in this area, mainly with crops of rye and potatoes. Meadows and pastures were drained and crossed by drainage ditches. Fallows usually formed small patches and often adjoined woodlands. Besides these open habitats, there were also woodlands and orchards. The structure of the land use did not change during the period of the study. The agricultural landscape of eastern Poland is characterised by a diverse mosaic of habitats. The use of pesticides and mineral fertilisers, and in consequence yield, is at least two times lower than in Western Europe (DONALD *et al.* 2002, USW 2005).

In 1999–2003, a total of 266 Red-backed Shrike nests were found. Around each nest, a hypothetical territory of 1.5 ha was delimited, as this mean size of a territory was known from other studies (CRAMP & PERRINS 1993, LEFRANC & WORFOLK 1997). The structure of the territory was drawn on a map at a scale of 1:100. The extent of meadows, pastures, fallows and arable land was delineated on the map, as well as other elements such as fences, transmission lines and tree stands. Next, using graph paper with a millimetre scale, the area of distinguished habitats was calculated with accuracy of 1 are in the field (100 mm^2 on the graph paper). The territories were depicted by only one person (AG), guaranteeing the same precision in drawing the sketches of the structure of the territories (BLOCK *et al.* 1987).

In 2003, the number of invertebrates in four types of habitats was determined. Open habitats, which were the feeding grounds of the Red-backed Shrike (meadows, pastures, fallows and arable land) were selected for controls. Arable land consisted of crops of cereals and potatoes. In each of these habitats, four sites 250–1500 m apart were selected within Red-backed Shrike territories, where invertebrates were caught with pitfall traps five times: on 27.05, 10.06, 23.06, 05.07, 15.07. These traps are used for catching invertebrates which move on the ground. Red-backed Shrikes hunt mainly prey moving on the ground surface (MOSKÁT 2001). The trap was a plastic cup with an entrance diameter of 6.5 cm and of depth 7 cm. In each site, 10 traps were placed every 2 meters in a row. Such an arrangement and number of traps are standard in entomological studies (e.g. NORMENT 1987, ZALEWSKI 1999). The traps were 1/3 filled with a mixture of water and dishwashing detergent, which decreased the water's surface tension and resulted in the quick drowning of the animals. Preservatives were not used, as the animals caught were identified the next day after capture. The traps were placed in successive sites between 7:30–9:00, and the animals were removed from them between 17:00–18:30. The same sequence of removing traps and collecting the material from them ensured that activity at the traps occurred at a similar time at each site. On average, trapped animals were removed over a time period of 9.5 hours at a given site. The material was collected only on days that were sunny or with little or no wind.

Trapped animals were classified by order and arbitrarily segregated by body length into two groups: 4–10 mm and longer than 10 mm. Animals smaller than 4 mm were omitted, as it has been found that longer animals almost exclusively comprise the red-backed shrike's food (HERNÁNDEZ 1993, LEFRANC & WORFOLK 1997). A separate category of "larvae" was distinguished among the trapped animals, including larval stages of all invertebrates, irrespective of the order they represented. To determine the mean biomass of Red-backed Shrike prey items, representatives of all taxa and classes of length were caught and weighed in 2003. These animals were trapped in the same sites where the potential food was obtained, and after killing them with ether they were weighed (up to 3 hours after catching) on a METLER AE 200 laboratory scale with an accuracy of 1 mg. The animals were not dried, therefore, as in other studies (ex. KUPER *et al.* 2000), a wet body mass was obtained. In total, 470 invertebrates from 13 taxa and the "larvae" category were weighed, which corresponded with the proportion of taxa from catches with pitfall traps.

Besides the rarest taxa: isopods, myriapods, earwigs, the remaining taxa were represented by at least 10 specimens of a given length class. The most abundant among the invertebrates caught were: beetles (95 individuals), followed by orthopterans (94 indiv.) and spiders (67 indiv.).

The number and biomass of invertebrates between the four types of habitats were compared using one-way ANOVA. When a statistically significant value of the test was obtained, the number or the biomass of prey was compared between habitats with the post-hoc Newman-Keuls test. The number and biomass of animals was logarithmically transformed. Statistics were calculated with the Statistica for Windows program, v. 6.0 (STATSOFT 2003).

RESULTS

Open habitats in a territory

In an average Red-backed Shrike territory (n=266), meadows comprised 41.5%, pastures 11%, fallows 8.5%, and arable land 39% of the area. Proportions of these habitats in the studied area were as follows: meadows 24%, pastures 2.7%, fallows 3.6%, and arable land 69.7%. Thus, in territories of the Red-backed Shrike there were 1.7-times more meadows than would result from their availability, 4.1-times more pastures and 2.4-times more fallows. Red-backed Shrikes clearly avoided arable land, as in that case this relation was 0.6. Differences between the area of available habitats and habitats present in territories were statistically significant (G-test, $G_3 = 21.0$, $p < 0.001$).

Table 1. Numbers and biomass of invertebrates in studied habitat types

Invertebrates	Numbers				Biomass (mg)			
	Meadows	Pastures	Arable	Fallows	Meadows	Pastures	Arable	Fallows
Length 4–10 mm	1264	1238	728	681	24371	21205	16531	13206
Longer than 10 mm	638	286	136	309	57839	29682	12738	34118

Food richness of habitats

In all habitats covered in the study, 3911 invertebrates of the first length class were caught, belonging to 10 orders and the "larvae" category. Their total biomass (wet body mass) was 75 313 mg (Table 1). Spiders and beetles were caught most often (Fig. 1), and they formed the largest proportion in the biomass of all taxa. The distinguished habitats differed also in the number of invertebrates from the first class of length, which were the potential Red-backed Shrike prey (ANOVA; $F_{3,76} = 3.2$, $p = 0.027$). The highest number of animals was caught on meadows, the lowest on fallows, and the difference between these habitats was statistically significant (post-hoc Newman-Keuls test, $p = 0.037$). The difference between habitats in terms of the biomass of prey had the same pattern (ANOVA; $F_{3,76} = 2.8$, $p = 0.044$, Fig. 2). Also in this case, a statistically significant difference occurred between meadows and fallows in the biomass of invertebrates (post-hoc Newman-Keuls test, $p = 0.029$). The greatest differences in numbers between habitats were found in spiders and beetles (Fig. 1).

In the second class of length, 1369 invertebrates from 8 orders and the "larvae" category were caught, and their total wet biomass was 134 377 mg (Table 1). The highest number of animals was caught in meadows, followed by fallows and

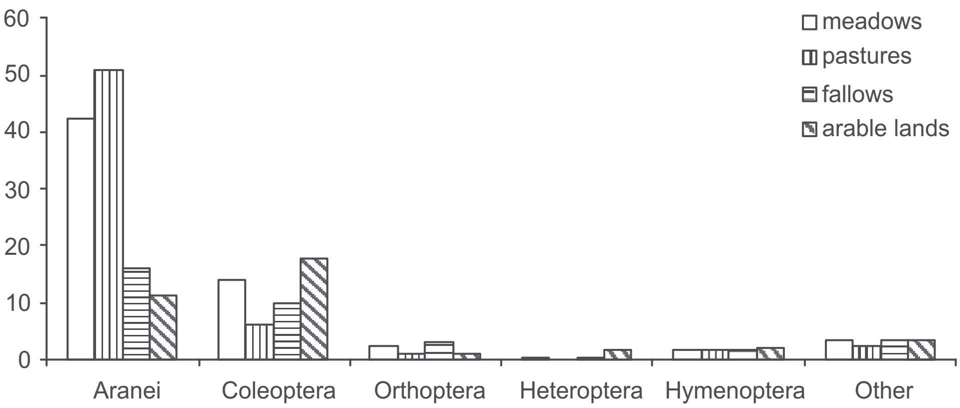

Fig. 1. Mean numbers of more important invertebrate taxa of 4–10 mm in length in four types of habitat

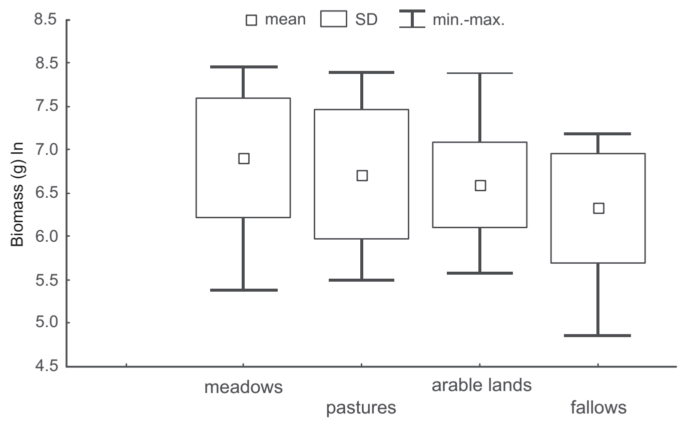

Fig. 2. Comparison of invertebrate biomass 4–10 mm in length in four types of habitat

pastures, while the lowest number – in arable land. The most numerous trapped animals were beetles and orthopterans (Fig. 3). In this length class, no spiders were found, which were the most abundant taxon in the first length class. The number of invertebrates from the second length class also differed between habitats (ANOVA; $F_{3,76} = 11.9$, $p < 0.001$). The highest number of animals was trapped in meadows, and the lowest – on arable land (Fig. 4). Statistically significant differences were found between the number of animals caught in meadows and pastures, meadows and arable land (post-hoc Newman-Keuls test, respectively, $p = 0.008$ and $p < 0.001$), pastures and arable land (post-hoc Newman-Keuls test, $p = 0.009$) and arable land and fallows (post-hoc Newman-Keuls test, $p < 0.001$). The biomass of invertebrates caught in these four types of habitats also exhibited statistically significant

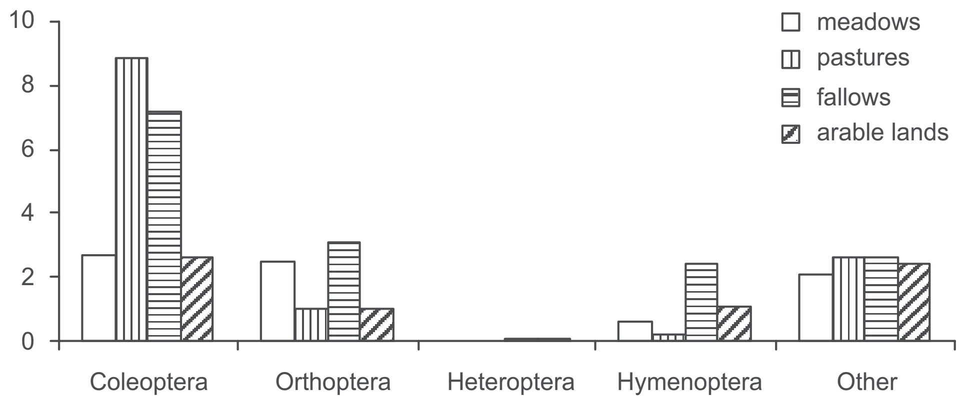

Fig. 3. Mean numbers of more important invertebrate taxa longer than 10 mm in four types of habitat

differences (ANOVA; $F_{3,76} = 10.4$, $p < 0.001$, Fig. 4), and statistical differences between habitats had an identical pattern as in the case of differences in the number of animals (in each pair-wise comparison of habitats – post-hoc Newman-Keuls test, $p < 0.050$).

DISCUSSION

In territories of the Red-backed Shrike, the area covered by meadows, pastures and fallows was larger than would result from their availability in the field. Only the area of arable land in territories was lower. A similar relationship between land of different uses and the number (density) of Red-backed Shrike has been presented in many papers. The positive influence of meadows and pastures on the numbers of this bird was emphasized by many authors (VAN NIEUWENHUYSE & VANDEKERKHOVE 1992, OLSSON 1995, VAN NIEUWENHUYSE 1998, KUŹNIAK & TRYJANOWSKI 2000, VANHINSBERGH & EVANS 2002). The negative influence of arable land on the occurrence of the Red-backed Shrike was also shown (VANHINSBERGH & EVANS 2002). However, such relationships did not occur in every case e.g. in Hungary no differences in densities of the Red-backed Shrike were found between 3 types of habitats: arable land, grasslands and fallows (FARKAS *et al.* 1997). Preference for grasslands is also known among other species of shrikes, for example, the Lesser Grey Shrike *Lanius minor* (WIRTITSCH *et al.* 2001), and Great Grey Shrike *Lanius excubitor* (TRYJANOWSKI *et al.* 1999). Preference or avoidance of certain habitats can be a consequence of e.g. their food abundance

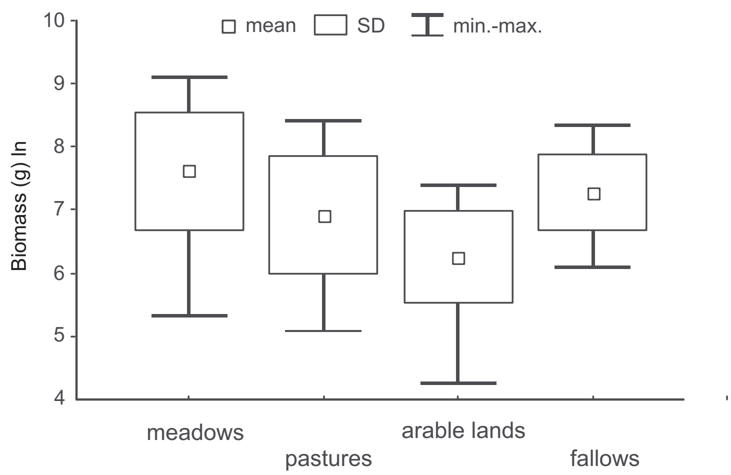

Fig.4. Comparison of invertebrate biomass longer than 10 mm in four types of habitat

or/and food availability. Considerable differences in the number and biomass of invertebrates were found among the habitats. These differences were in both of the distinguished classes of animal length; however they partly related to different habitats. In the first length class, the difference was between meadows and fallows, while in the second class, habitats were more varied. Decidedly, the lowest number of invertebrates was caught on arable land and they differed in both number and biomass in comparison with the remaining three types of habitat. This was mostly the effect of the numbers of beetles, hymenopterans and orthopterans.

Food of the Red-backed Shrike consists mainly of beetles and hymenopterans (OLSSON 1995, TRYJANOWSKI *et al.* 2003*b*, KARLSSON 2004), which was found also in the described area (GOŁAWSKI 2006). Red-backed Shrikes especially willingly catch longer prey (over 1 cm long) which may be connected with both their high nutritive value and the easier hunting of well seen and slow animals (BRODMANN & REYER 1999, LEPLEY *et al.* 2004). KUPER *et al.* (2000) relate a dramatic decrease in numbers of this shrike in the Netherlands due to the reduction of the number of large invertebrates. Thus, it seems that the second length class of animals distinguished hereby better reflects the food value of each habitat. In such a case, the most favourable area for this species should be pastures where large beetles are numerous, and fallows – due to the presence of hymenopterans and orthopterans. In contrast, the least abundant area of potential Red-backed Shrike prey is arable land, where the lowest numbers of beetles and orthopterans were noted. Besides potential prey abundance itself, its accessibility is of equal importance for birds (SOLARI & SCHUDEL 1988). Red-backed Shrikes hunt by spotting prey while it moves on the ground surface or flies. Hunting in flight has, however, a much higher energy expenditure, so that birds prefer collecting prey from the ground whenever possible (MOSKÁT 2001). Hunting animals dwelling on the ground surface is possible only when the vegetation is low enough for the shrike to see the prey. Therefore, pastures are a very important element of territories, as grazing cattle keep vegetation low. Probably the role of meadows, at least during hay mowing, is greater than would result only from the number and biomass of animals (mainly of beetles and hymenopterans) in this habitat (VAN NIEUWENHUYSE & VANDEKERKHOVE 1992, WIRTITSCH *et al.* 2001).

In summary, open habitats in the agricultural landscape differ in the number and biomass of invertebrates that inhabit them. The positive correlation of pastures, fallows and meadows in territories on the number of fledglings (GOŁAWSKI & MEISSNER 2007) confirms the important role of these habitats for the Red-backed Shrike. Besides, these habitats are undoubtedly important also for other species whose food is similar to the Red-backed Shrike diet, such as e.g. Great Grey Shrike and Hoopoe *Upupa epops*.

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