DOI:10.24394/NatSom.2014.24.305

Natura Somogyiensis	**24**	305-320	Kaposvár, 2014

Comparing small mammal faunas based on barn owl (*Tyto alba*) pellets collected in two different lowland landscapes

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SZŰCS, D., KITTI HORVÁTH, K. & HORVÁTH, GY. F.: *Comparing small mammal faunas based on barn owl (Tyto alba) pellets collected in two different lowland landscapes.*

Abstract: The composition of small mammal assemblages was analysed in two lowland landscapes (Drava floodplain, Győr basin) and was evaluated on three different spatial scales (meso-, microregions and local scale), based on barn owl pellets collected between 2006 and 2009. Altogether 273 pellet samples were collected from 41 settlements of the two regions during the four years of monitoring. The analysed 6978 pellets contained 17214 small mammal individuals. The distribution of the relative abundance of small mammal taxa was evaluated as well as the correlation of frequency order on a meso- and microregional scale in the comparison of the two lowland areas. The food niche parameters of barn owl were calculated on a local scale, regarding the breeding pairs. We investigated three null hypotheses: the distribution of species frequency values is homogeneous between two landscape areas (H_{01}); there are no significant differences in the rank of frequencies (H_{02}) in meso- and microregional scale; and niche parameters of the barn owl do not show difference between two landscapes (H_{03}). The first null hypothesis had to be rejected in several cases of small mammal taxa. The rank correlation of species frequency and the homogeneity test of total species pool of two investigated landscapes showed that the composition of small mammal fauna of the compared landscapes is basically the same, but the distribution of abundance was different between landscapes on both meso- and microregional scales. The statistical analysis of the niche parameters showed that the barn owl's niche breadth did not differ between the Drava floodplain and the Győr basin. However, the niche overlap within each of the two mesoregions was higher than between them, and thus we rejected the third null hypothesis. This provides a further evidence that besides the species-specific hunting strategy, the regional differences of the quantitative relations of small mammals is also reflected in the dietary composition of the barn owl.

Keywords: small mammal, relative frequency, spatial scale, landscape, Tyto alba

Introduction

The barn owl (*Tyto alba*) is the strigiform with the broadest worldwide distribution (BURTON 1984, TAYLOR 1994). Barn owl breeding density has been studied in different areas of central Europe (DE BRUIJN 1994, POPRACK 1996) and the Mediterranean region (FAJARDO 2001, SALVATI et al. 2002, MARTÍNEZ & ZUBEROGOITIA 2004), moreover it is a well-known fact that the population levels of this owl species correlates with cyclic fluctuations of small mammals (DE BRUIJN 1994, TAYLOR 1994). Thus the composition of its diet has been studied more extensively than in any other bird of prey (EVERETT et al. 1992).

ISSN 1587-1908 (Print); ISSN 2062-9990 (Online)

Owl pellet analysis is a useful indirect method for gaining additional insight into small mammal communities and distributions (BONVICINO & BEZERRA 2003, TORRE et al. 2004, SANTOS-MORENO & ALFARO ESOINOSA 2009). Although, there is no consensus among researchers that owls sample their prey randomly, partly due to the absence of knowledge about the real abundance of their prey (DE LA PEÑA et al. 2003). Despite of the selective predation (VON KNORRE 1973, DERTING & CRANFORD 1989, ASKEW 2007) and thus the potential bias of indirect sampling, the last decade's studies showed that investigation of barn owl's food composition is the most suitable method in the landscape-level analysis of small mammal data (DE LA PEÑA et al. 2003; ASKEW et al. 2006, 2007).

The studies based on the effects of changing agricultural landscape mosaic on the composition of the small mammal assemblages showed that the intensification of agriculture has negative effects on the density of rare and habitat-specialist species, while it favours habitat-generalist species, some of them being known to exhibit fluctuating density (DE LA PEÑA et al. 2003). LOVE et al. (2000) also demonstrated dietary changes of barn owl which emerged due to more intensive agriculture. BOND et al. (2004) investigated the effect of landscape parameters on the breeding success of barn owls. Their results showed that land cover was less heterogeneous at successful sites and unsuccessful nesting sites had significantly more improved grassland, suburban land and wetlands than successful sites.

Owl pellet analysis, being an indirect method is acceptable from a conservation aspect and is a relatively fast way of collecting large amounts of occurrence data. The collection and investigation of the barn owl's pellets is the most appropriate method for studying small mammal fauna (status survey, monitoring, estimation of species richness), because among the owl species occurring in Hungary this is the one with the widest selection of prey, and also its feeding ecology is well studied (KALIVODA 1999).

Barn owl pellet analysis in Baranya county has been carried out since 1985 (HORVÁTH 1994, 1995, 1998, 1999; HORVÁTH & MAJER 1995). At Győr-Moson-Sopron county extensive small mammal faunistic studies were performed by collecting and analysing pellets from several owl species (ANDRÉSI & SÓDOR 1981a,b, Jánoska 1992, 1993). Within both landscapes the subprogramme based on national owl pellet studies was started under the Hungarian Biodiversity Monitoring System (HBMS) program in 2000 and extended to cover the faunistic surveys of small mammals. As the result of that subproject, the data of owl pellet landscape-level analysis related to the monitoring of the upper section of Drava River was achieved on larger spatial scale. Differences between the compositions of the small mammal communities were evaluated depending on the landscape pattern of each section of the Drava (HORVÁTH et al. 2005). Although the synthesis of the results in this project has been not been achieved yet, data were suitable for comparing small mammal faunas of landscapes which were studied intensively on regional scale (eg. HORVÁTH et al. 2008).

The aim of this study is to compare the composition of small mammal assemblages of two lowland mesoregion landscapes (Drava floodplain and Győr basin), and evaluate the abundance of species on three different spatial scales (meso-, microregions and local scale). We investigated three null hypotheses: the distribution of species frequency values is homogeneous between two landscape areas (H_{01}), there are no significant differences in the frequency orders in meso- and microregional scale (H_{02}), and niche parameters do not show differences between the two lowland landscapes based on the characteristic dietary preference of the barn owl (H_{03}).

Material and methods

Locations of owl pellets

Barn owl pellets were collected between 2006 and 2009 in both landscapes. From 29 settlements of the three mesoregions in Drava floodplain 229 samples were collected, while from 12 settlements of the two microregions in Győr basin 44 samples originated. Altogether, 273 pellet samples were collected from 41 settlements of the two regions during the four years of monitoring. We selected 6-6 settlements in both regions, which were used for local analysis (i.e. breeding pair of a given settlement), because sufficiently large number of samples were available in these every year during the period of the examination. ArcView and ArcMap 10.0 programs were used for the thematic map of frequency distribution of featured species and affected settlements (Fig. 1).

Our studies involved two widely separated lowland regions in Transdanubia. The Drava plain was created by filling up with fluvial sediments, terrace formation and shedding of loess. The Baranya county section of the Drava river is widened, with sediments of sand and silty sand being characteristic. The Drava floodplain is the most Mediterranean part of our country due to the favourable precipitation and milder winter. However, the fundamental feature of the climate in the areas along the Drava is that the temperature rises towards the east, but the amount of precipitation decreases (MAROSI & SOMOGYI 1990). The Győr basin is a perfect plain, constituting the lowermost area of the Kisalföld plain region. Its surface is made up of alluvial cone plains (e.g. Rábaköz, Szigetköz, Mosoni plain) and former swamp- and marshlands (Fertő-Hanság basin) built by the Danube, Raba and their tributaries. The climate is moderately cool and dry.

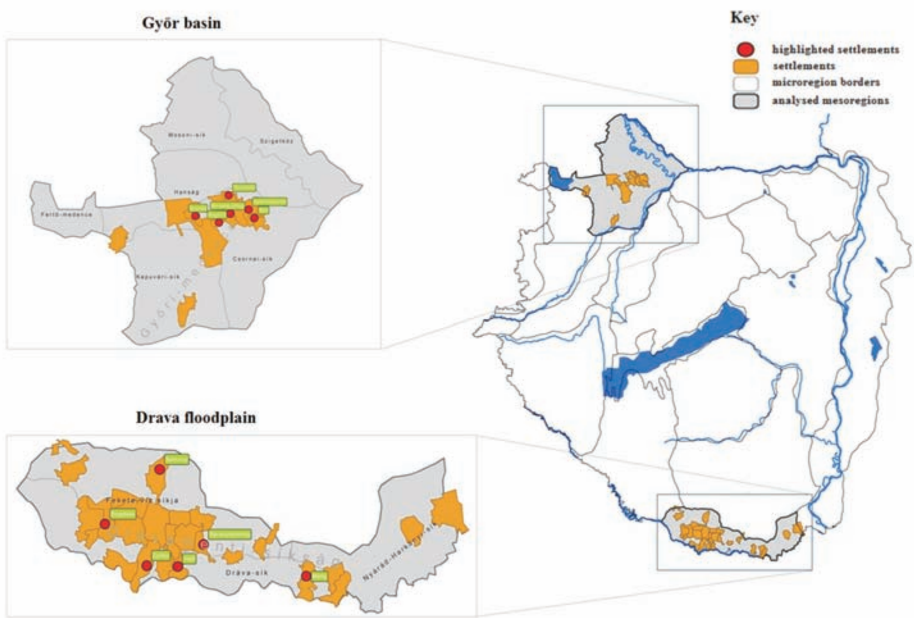

Fig. 1: Thematic map of localities (settlements) of the collected pellet samples; settlements that were used for local analysis are marked with green

Methods of owl pellet analysis

The collected material included whole pellets as well as pellet fragments/debris in many cases. This is important to note because prey lists were compiled based on whole pellets on the one hand and relying on whole pellets plus pellet debris on the other.

Taxonomic small mammal identification was done on the basis of skull characteristics and dentition (SCHMIDT 1967, ÁCS 1985, UJHELYI 1994). Neomys species (*Neomys fodiens* Pennant 1771, and *Neomys anomalus* Cabrera 1907) were differentiated by measuring the height of the corona-process of the mandible; if this was unfeasible, only the genus was identified (*Neomys* sp.). The wood mouse (*Apodemus sylvaticus* Linnaeus 1758), the yellow-necked wood mouse (*Apodemus flavicollis* Melchior 1834) and the pygmy field mouse (*Apodemus uralensis* Kratochvíl and Rosicky 1952) were categorised commonly as wood mice (*Apodemus* spp.) The house mouse (*Mus musculus* Linnaeus 1758) was differentiated from the gleaner mouse (*Mus spicilegus* Petényi 1882) on the basis of the length proportions of the upper and lower zygomatic arches (MACHOLÁN 1996, CSERKÉSZ et al. 2008). Consequently, the summarized list of small mammal taxa which was involved in our comparative statistical analysis consisted of 25 components.

Statistical methods

Mesoregional scale

The number of small mammal individuals was the basic data of pellet analysis. Because sample sizes were different, we used relative frequencies of taxa as derived data in our landscape level statistical analyses. The distribution of relative frequencies for each species was performed by G-test between two mesoregions. Based on data of total species list we investigated the hypotheses with homogeneity-test (χ^2) that the two samples derive from the same statistical population or not. We used detailed data of settlements to test the difference of small mammal abundance with non parametric Mann-Whitney-U test (ZAR 2010).

We calculated percentage overlap (Renkonen-index) to compare small mammal composition of the two landscapes. This index measures the percentage similarity of two assemblages (KREBS 1989):

$$P_{jk} = \left[\sum_{i=1}^{n} (\min . p_{ij}, p_{ik}) \right] \times 100$$

where n is the number of prey categories, p_{ij} and p_{ik} is the relative proportion of the i^{th} prey in two samples (*j* and *k*).

To compare the rank order of species frequencies, we used Spearman's rank correlation. This statistical method shows how much the ranking of frequencies are similar between two landscapes.

Microregional scale

By refining the spatial scale, it is possible to evaluate the small mammals' data of the detailed landscape-level with respect to microregions within mesoregions. In case of the Drava floodplain, the collected samples affected 3 microregions (Dráva-sík (DS), Fekete-víz síkja (FVS), Nyárád-Harkányi-sík (NHS)), while in the Győr basin only 2: Csornai-sík (CS), Kapuvári-sík (KS). We calculated the percentage overlap (P_{jk}) between each microregion (Renkonen-index) and also compared the rank order of small mammal taxa (Spearman's rank correlation). The relationship of abundance was tested by one-way analysis of variance (ANOVA) in both landscapes (microregions). In the case of one-way ANOVA test firstly, we examined variables for normality using Shapiro-Wilk test, and homogeneity of variances using Levene test. We used non-parametric Kruskal-Wallis median test when assumptions of ANOVA did not meet. When significant differences were detected in ANOVA or Kruskal-Wallis test, we employed LSD-test or Dunn's procedure for post hoc multiple comparisons (ZAR 2010).

Local scale

We calculated food niche parameters in each local sampling plot (settlements), which represented a breeding pair. We used Levine's measure (B_i) to define the niche breadth of barn owls in each settlement:

$$B_i = \frac{1}{\sum_{i=1}^{n} p_i^2}$$

where p_i is the proportion of individuals found in or using resource state *j*. The resource utilisation overlap of barn owl was calculated by Pianka's measure of niche overlap (O_{jk}) between two local sample pairs:

$$O_{jk} = \frac{\sum_{i}^{n} p_{ij} p_{ik}}{\sqrt{\sum_{i}^{n} p_{ij}^2 \sum_{i}^{n} p_{jk}^2}}$$

where p_{ij} and p_{ik} is the relative proportion of the ith prey in two samples (*j* and *k*) which mean breeding pairs of the involved settlements and *n* is the number of prey categories. We used independent *t*-test to compare means of niche breadth between two mesoregions. We employed one-way ANOVA with post hoc multiple comparison (LSD) to test the values of niche overlap within the Drava floodplain region and the Győr basin, and between the two landscapes.

Results

Evaluation of data in mesoregional scale

The analysed 6978 pellets contained 17214 small mammal individuals. According to the summarized data of the collected pellets samples during the four-year period, we defined the abundance and relative rate of small mammal taxa (Table 1). Species with relative frequency values over 1% regarding the rank of frequency were considered to be characteristic species in both mesoregions (Drava floodplain: S = 14, Győr basin: S = 12) (Fig. 2).

The common vole (*Microtus arvalis*) was eudominant in both landscapes, because this species is the main prey of the barn owl. Its frequency value constituted almost half of the total abundance in the Drava floodplain. The second in order was *Apodemus* spp. taxa (12.72%). The common shrew (*Sorex araneus*) had high proportion in the Győr basin and it was second in the order of dominance, so there were two dominant species

Table 1: Number of individuals and relative proportion of taxa determined in the two studied mesoregions

Species/taxa (code)	Drávamenti-floodplain		Győri-basin	
	n_i	p_i	n_i	p_i
Talpa europaea (TEU)	2	0.01	1	0.03
Sorex araneus (SAR)	626	4.49	880	28.30
Sorex minutus (SMI)	228	1.63	267	8.59
Neomys fodiens (NFO)	68	0.49	11	0.35
Neomys anomalus (NAN)	159	1.14	9	0.29
Neomys species (Nsp)	46	0.33	4	0.13
Crocidura suaveolens (CSU)	1057	7.58	67	2.16
Crocidura leucodon (CLE)	480	3.44	171	5.50
Myodes glareolus (MGL)	91	0.65	30	0.96
Microtus agrestis (MAG)	202	1.45	5	0.16
Microtus arvalis (MAR)	6038	43.28	922	29.66
Microtus oeconomus (MOC)	0	0.00	45	1.45
Microtus subterraneus (MSU)	45	0.32	14	0.45
Arvicola amphibius (AAM)	192	1.38	7	0.23
Rattus norvegicus (RNO)	84	0.60	19	0.61
Rattus rattus (RRA)	16	0.11	7	0.23
Rattus species (Rsp)	20	0.14	5	0.16
Apodemus agrarius (AAG)	1106	7.93	67	2.16
Apodemus sp. (Asp)	1774	12.72	258	8.30
Apodemus ind. (Aind)	562	4.03	55	1.77
Mus minutus (MMI)	271	1.94	109	3.51
Mus spicilegus (MSP)	284	2.04	50	1.61
Mus musculus (MMU)	113	0.81	19	0.61
Mus sp. (Mus)	409	2.93	86	2.77
Muscardinus avellanarius (MAV)	77	0.55	1	0.03
Total	**13950**	100	**3109**	100

in that landscape. The third one was the other Sorex species (pygmy shrew *Sorex minutus*) at Győr basin, as for the Drava floodplain it was the striped field mouse (*Apodemus agrarius*). After the third most frequent species, the dominance order showed large variety in both mesoregions. The recorded presence of the glacial relict root vole (*Microtus oeconomus*) in the area of the Fertő-Hanság National Park was considered to have low relative frequency (1.45%). The 45 identificated specimens provided proof about the presence of this strictly protected species in that landscape.

The homogeneity test (G-test) of the frequency distribution based on the summarized data of the two landscapes showed significant difference only for the two Sorex species (common shrew: G =19.28, P < 0.001; pygmy shrew: G = 5.19, P < 0.05). The significantly high value of the homogeneity test from the total species list (χ^2 = 2858,52 P < 0.001) meant that regarding frequency distribution, the composition of the revealed

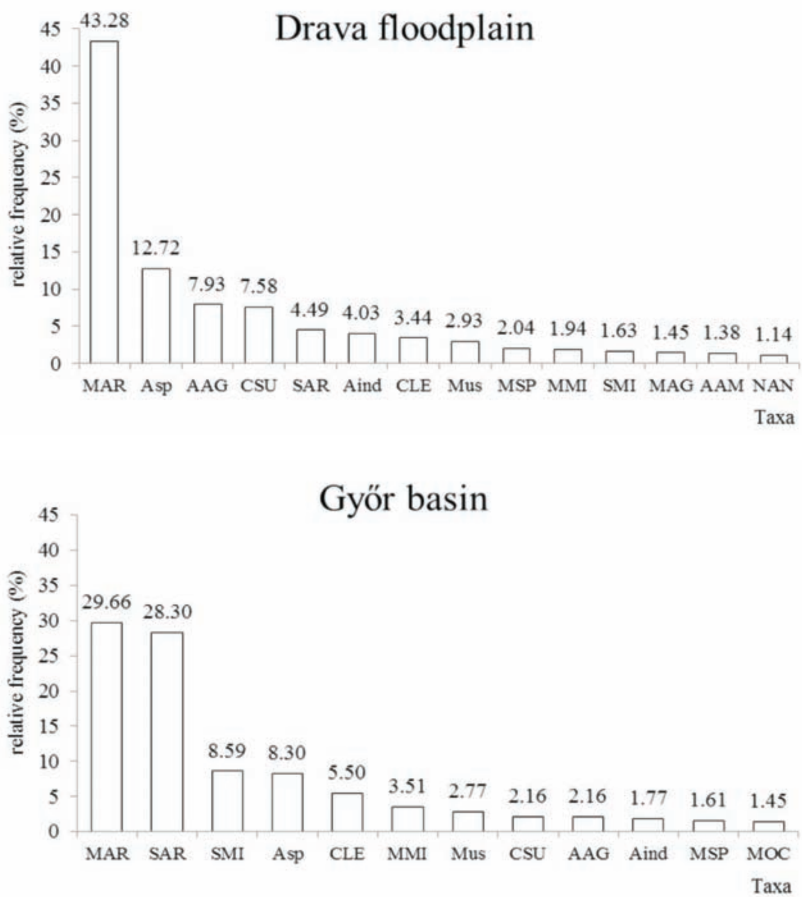

Fig. 2: Frequency histograms based on species data of the two mesoregions

small mammal assemblages was inhomogeneous, so there were significant differences in the frequency values of each species between the two mesoregions.

In the mesoregional spatial scale the statistical evaluation of small mammal abundances based on local detailed data (relating to breeding pairs) showed significant difference for 8 species (Table 2). The relative abundance of the four featured shrew species in two mesoregions showed that significant difference can be observed in the case of the common shrew and the Lesser white-toothed shrew (*Crocidura suaveolens*). As for the other two shrews, we have not received significant difference due to the overlap of confidence intervals (Fig. 3.). Clear difference can be seen in the case of root vole, on the diagram showing the abundance distribution of the low-frequency vole species, because it occurs only in the Fertő-Hanság area. Despite the fact that the field vole (*Microtus agrestis*) has similar habitat preference to that of the root vole, it occurred with lower relative proportion in the Győr basin than in the Drava floodplain, regarding pellets. Moreover, the European water vole (*Arvicola amphibius*) showed significant difference with high frequency in the Drava floodplain (Fig. 4). In terms of the relative abundance of mice species, only the striped-field mouse showed significant result (Fig. 5).

Table 2: Comparison of relative abundance values, based on highlighted local samples on the mesoregional scale (Mann-Whitney-U test)

Fajok/taxonok (kód)	z - érték	*P*
S. araneus	3.27	< 0.01
S. minutus	1.66	n.s.
N. fodiens	1.43	n.s.
N. anomalus	2.62	< 0.01
Neomys sp.	1.00	n.s.
C. suaveolens	3.35	< 0.001
C. leucodon	0.37	n.s.
M. glareolus	0.32	n.s.
M. agrestis	3.44	< 0.001
M. arvalis	0.34	n.s.
M. oeconomus	3.32	< 0.001
M. subterraneus	1.49	n.s.
A. amphibius	3.55	< 0.001
R. norvegicus	0.01	n.s.
R. rattus	0.42	n.s.
Rattus sp.	0.06	n.s.
A. agrarius	4.08	< 0.001
Apodemus sp.	1.13	n.s.
Apodemus ind.	2.02	< 0.05
M. minutus	1.42	n.s.
M. spicilegus	0.17	n.s.
M. musculus	0.26	n.s.
Mus sp.	0.37	n.s.

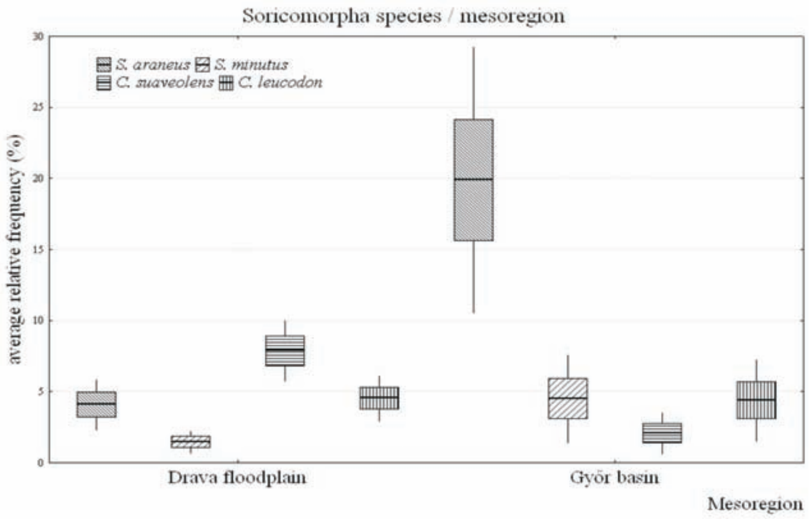

Fig. 3: Average frequency distribution of Soricomorpha shrews

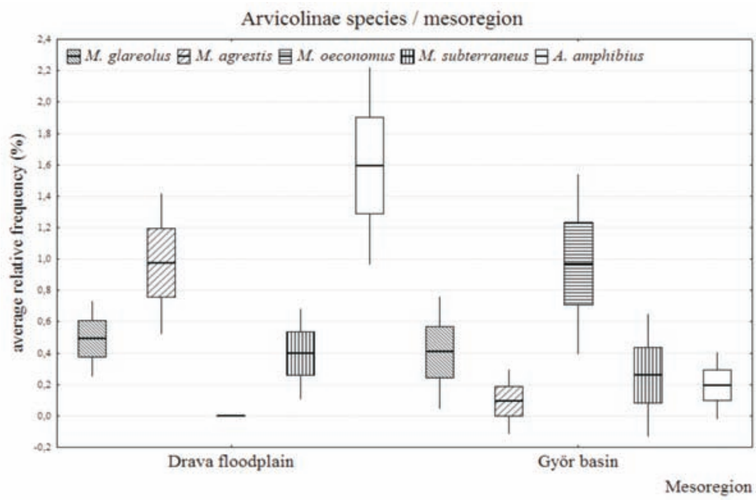

Fig. 4: Average frequency distribution of voles with low abundance

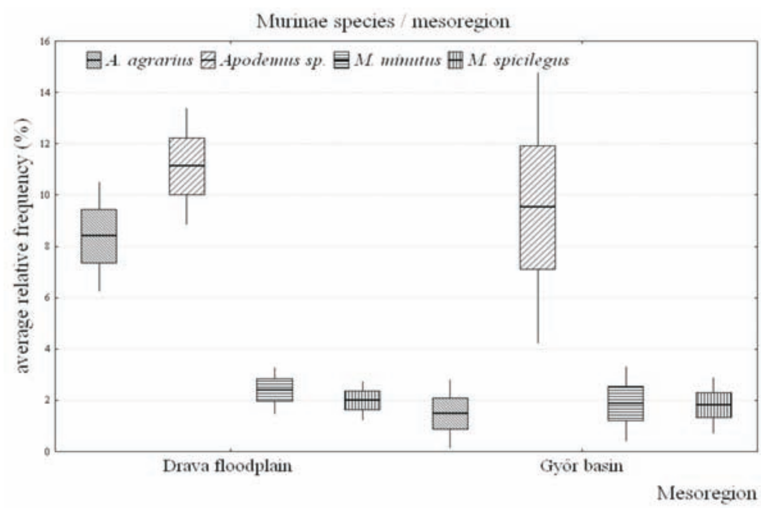

Fig. 5: Average frequency distribution of Murinae mice species

In addition, we summarized species belonging to one genus and also three small mammal taxa of shrews (Soricidae), voles (Arvicolinae) and mice (Murinae) and we examined the abundance of these prey groups. There was significant inhomogeneity in the case of the genus Sorex (G = 24.43, $P < 0.001$), the genus Apodemus (G = 4.29, $P < 0.05$) and the Soricidae family (G = 45.32, $P < 0.001$).

Comparative analysis of data on a microregional scale

The relative abundance of common shrew differed significantly between microregions (Kruskal-Wallis ANOVA: H = 14.20, $P < 0.01$) and thus the frequency of this species deviated in both spatial scales in the comparison of the two investigated landscapes.

According to post hoc Dunn-test, the proportion of this shrew was greater in a microregion of the Győr basin than in the two microregions of the Drava floodplain (CS vs. FVS: z = 2.83, $P < 0.05$; CS vs. NHS: z = 3.33, $P < 0.01$). In contrast, the relative frequency of the Lesser white-toothed shrew was significantly higher in the Drava floodplain (H = 17.09, $P < 0.01$.). The post hoc test showed that the abundance of this species was significantly different in the comparison of two microregions of the Drava floodplain and the Csornai-sík (DS vs. CS and FVS vs. CS: z = 3.19 - 3.23, $P < 0.05$). In the case of the field vole the Kruskal-Wallis ANOVA showed significant result (H = 13.79, $P < 0.01$) and difference of abundance was only reported by post hoc test between two microregions (FVS vs. CS: z = 3.03, $P < 0.05$). Furthermore, the European water vole had significantly higher relative abundance in the area of the Drava floodplain (H = 13.31, $P < 0.01$). Dunn-test results considerably differened between microregions as well as in the case of Lesser white-toothed shrew (DS vs. CS and FVS vs. CS: z = 2.93 - 3.06, $P < 0.05$). Because of the exclusive presence of the root vole in the Győr basin, the statistical result was evident (H = 23.24, $P < 0.05$) and Dunn-test showed difference in one microregion of both landscapes (FVS vs. CS: z = 2.86, $P < 0.05$). Due to the differences of geographical distribution, the stripe-field mouse has higher proportion in the Drava floodplain than in the Győr basin (ANOVA: F = 5.87, $P < 0.001$). The post hoc LSD-test demonstrated that abundance differed significantly in the case of four sample pairs (microregions) (DS vs. CS: $P = 0.0002$; DS vs. KS: FVS vs. CS: $P = 0.0011$; FVS vs. CS: $P = 0.0082$; FVS vs. KS: $P = 0.0161$). For the other species there was no significant result of ANOVA between microregional landscapes.

In addition, a faunistic assessment of shrews (Soricidae), voles (Arvicolinae) and mice (Murinae) was performed on this spatial scale. The proportion of three prey categories was shown in the map of the two mesoregions including the microregions (Fig. 6). Our results demonstrated that the Arvicolinae taxa had the largest share in the dietary composition, especially in the area of the NHS, where these species showed a distribution over 59%. However, in one of the microregions of the Győr basin shrews gave about 50% of the whole sample because of extensive wetlands in that area, while voles only occurred with the relative rate of 30%.

Significantly positive correlation was found between the frequency orders of each microregion by Spearman rank correlation analysis, which reflects the similarity of small mammal faunas on this spatial scale. The higher rank correlation value was

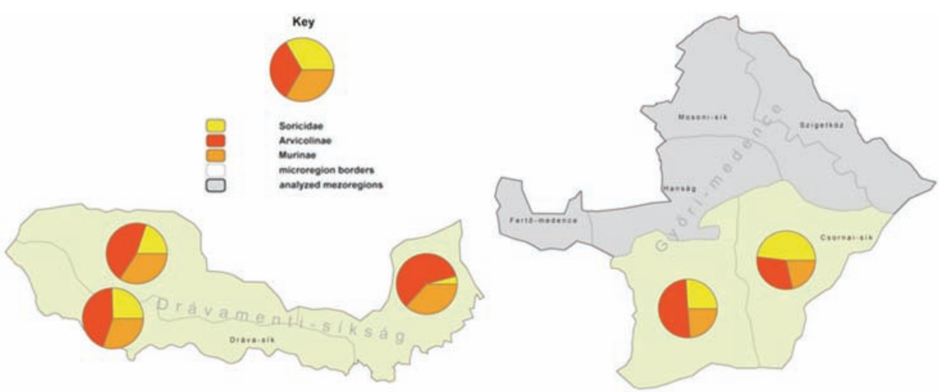

Fig. 6: Frequency distribution of three taxa in microregions within the two landscapes

Table 3: Results of ANOVA tests, based on relative frequencies of small mammal taxa with significant abundance

Faj/taxon	Kruskal-Wallis (H)	one-way ANOVA (F)	*P*
S. araneus	14.20		< 0.01
C. suaveolens	17.09		< 0.01
M. agrestis	13.79		< 0.01
M. oeconomus	23.24		< 0.05
A. amphibius	13.31		< 0.01
A. agrarius		5.87	<0.001
Apodemus genus		3.29	< 0.05
Neomys genus	14.48		< 0.01
Soricidae		2.90	< 0.05

between FVS and DS (RS = 0.96; $P < 0.001$), while we reported the lowest value in the case of two sample pairs (NHS vs. CS and NHS vs. KS: RS = 0.48 - 0.49, $P < 0.05$). However, the high values of homogeneity test also showed that the distribution of species frequencies was inhomogeneous in the comparison of the microregions ($\chi^2 = 160.07 - 2437.31$, $P < 0.001$). Based on the frequency distribution of small mammals, the percentage overlap was higher between landscapes which were in the same geographical region than in the comparison of two investigated mesoregions (Table 3). This result confirmed that the percentage overlap values between small mammal assemblages of landscapes increased as the spatial scale was refined.

Data analysis of local scale, based on niche parameters

The statistical evaluation of niche parameters on the local spatial scale showed that the niche breadth of the barn owl did not differ ($t = 0.35$, n.s.) in the comparison of the Drava plain and the Győr basin. The box plot diagram also illustrated the lack of statistical difference of the average niche breadth caused by the great overlap of the confidence interval (Fig. 7). Thus, there is high similarity in the food composition in both landscapes. Considering the faunistic data this is a realistic result, because the prey list of the two investigated landscapes deviated from only one species (root vole). Based on this result we did not reject the null-hypothesis for niche-breadth.

The value of niche overlap (O_{jk}) was significant between the three data groups (ANOVA: F = 11.29, $P < 0.01$) (Fig. 8). Due to the overlap of food composition between the breeding pairs of settlements in the regions, the value of niche overlap was significantly higher within the two mesoregions than between them (post hoc LSD-test: DS vs. DS-GYM: $P = 0.00064$, GYM vs. DS-GYM: $P = 0.00214$), so we rejected the third null hypothesis for niche overlap.

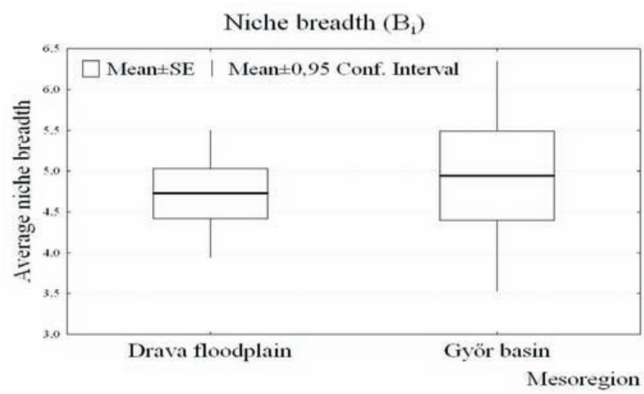

Fig. 7: Average niche breadth between two mesoregions

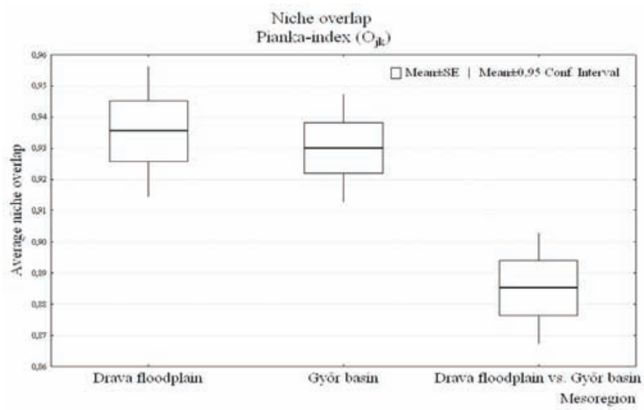

Fig. 8: Average niche overlap (Pianka-index) between three sample pairs

Discussion

In the framework of the National Biodiversity Monitoring System (NBMS) introduced recently in Hungary, special attention is focused on small mammal species (CSORBA & PECSENYE 1997, FODOR et al. 2007), since some of them are protected, they are important indicators of environmental changes and their populations have been thoroughly studied in many ecological aspects during the past 40 years (IERADI et al. 1998, SCHWEIGER et al. 1999, JORGENSEN et al. 2002, LEIS et al. 2008). As part of the NBMS, small mammal monitoring based on countrywide owl pellet collection is planned to be introduced in the form of a separate sub-project. Based on data of this project it is possible to compare and evaluate the composition of small mammal assemblages between landscapes of different spatial scales (HORVÁTH et al. 2005, 2008).

In recent years publications became more frequent evaluating the changes in structural elements of landscapes based on the abundance of prey detected from owl pellets BOSÉ & GUIDALI 2001, LA PEÑA et al. 2003, ANDRIES et al. 1994). LOVE et al. (2000) and ASKEW et al. (2006) reported further results about the diet of the barn owl. HORVÁTH et al. (2008) compared the abundance of small mammals of two geographically separated lowland areas (Drava Plain, Hevesi plane). This result showed that the species composition of small mammal assemblages did not differ significantly, but the frequency values of species and taxa categories as well the as temporal changes differed and shifted which related to structural changes and the usage of landscapes.

In this study we also examined two lowland geographical regions, but in this case we investigated three hypotheses based on the relationship of small mammal abundance on three spatial scales. According to the distribution of abundance, the first hypothesis was incorrect in the case of two Sorex species on a mesoregional scale, because their relative frequency was inhomogeneous between the two investigated landscapes. This result was caused by different landscape structures, because there are many marshland areas preferred by this shrew species in the Győr basin. In a previous study we demonstrated that the proportion of the two genera of shrews (Sorex, Crocidura) was significantly higher in the Drava Lowlands than in the Heves plain, but when the population of common voles collapsed, the owls altered their food selection in accordance with prey availability in both studied regions. In that study year, the relative frequency of shrews was higher in the Heves plain than in the Drava Lowlands (HORVÁTH et al. 2008). The two shrew genera (Sorex, Crocidura) which occurred with high abundance in the food composition of the barn owl showed different distribution patterns in the comparison of the Drava Lowland with the Győr basin. Sorex species were dominant in the Győr basin, in contrast the presence of Crocidura genus was higher in the Drava Lowland. Based on data of collected pellets form the Győr basin, the Lesser white-toothed shrew occurred with higher relative frequency in that region than the bicoloured white-toothed shrew, as presented in former pellet analyses (ANDRÉSI & SÓDOR 1987a,b). Our results disproved the assumption of SCHMIDT (1976) claiming that the bicoloured white-toothed shrew is dominant against the other shrew species in Western Hungary.

The results of this study confirmed that the refinement of the spatial scale provided more detail in the differences of frequency distributions, and gave a more accurate picture on distribution and frequency relations. We highlighted three species whose values of relative frequency differed significantly between two landscapes on the microregional scale. ANDRÉSI & SÓDOR (1987a,b) showed the presence of two postglacial relict voles (root vole and field vole) as an important faunistical result, occurring in the food composition of the barn owl with low abundance, mainly in wet and sedgy habitats. Owl pellet samples from the 1980's reported the presence of root vole in the area of Fertő Hanság. Based on data from pellets of the long-eared owl (*Asio otus*) and the short-eared owl (*Asio flammeus*) collected from two areas of Győr-Moson-Sopron county, a total of 20 root voles were found. In our study we detected only 5 specimens of field vole but root voles occurred with higher abundance (45 specimens). This result suggests that the field vole is rarer than the root vole in the area of the Fertő-Hanság, although the marshland areas of these landscapes mean potential habitats for the field vole. In contrast, based on pellet analysis and live trapping, this species is more common in the Kis-Balaton Landscape Protection Area whose composition and landscape structure is much similar to the Fertő-Hanság area (SCHMIDT 1967, HORVÁTH et al. 2004a, b). Results from the previous studies of owl pellets, it is known that 30-40 years ago the striped field mouse did not occur in pellets collected from areas of mesoregions located in the northern and north-western partsd of Lake Balaton. However, its presence was shown in the area of the Fertő-Hanság in 2008, which is an important faunistic data, because this species is able to spread expansively. During the investigated four-year period, the frequency distribution and the extent of locations based on collected pellets from the Győr basin confirmed the stable north-western expansion of this species.

According to our results the first null hypothesis had to be rejected in the case of several small mammal taxa. The rank correlation of species frequency and the homogeneity test of the total species pool of the two investigated landscapes showed that the composition of small mammal fauna of the compared landscapes is basically the same, but the distribution of abundance was different between the landscapes on both the meso- and the microregional scale. Environmental factors such as climate, vegetation cover, food supply and the presence of competitors modifies the fundamental niche of species in characteristic ecological environment, so the realized niche is formed by the presence of competitors. HERRERA & HIRALDO (1976) showed that the niche-range of owls separated in certain racial context, and they fulfill their energy demand form other components of food niche dimensions. The statistical analysis of niche parameters showed that barn owl niche breadths did not differ between the Drava plain and the Győr basin, because we studied only one owl species which is characterized by the same food composition due to its life-history strategy (prey preference and hunting strategy). However, niche overlap within each of the two mesoregions was higher than between the two, so we rejected the third null hypothesis.

ASKEW et al. (2007) reported that barn owls select habitats within their home-range based on the abundance of field voles and possibly shrews, which demonstrates the density dependent predation of this owl species. In theoretical aspect the response of vertebrate predators includes two components: the numerical and functional response showed by predators when facing fluctuating mammalian prey populations (JAKSIC et al. 1993, HONE & SIBLY 2002, HONE et al. 2007).

Besides, several studies have confirmed that the food composition of the barn owl as a typical farmland bird well-indicates the different land use which influences the distribution of prey through changing the composition and structure of landscapes (DE LA PEÑA 2003, ASKEW et al. 2006, GONZÁLES FISCHER 2012, HINDMARCH et al. 2012). Thus, the examination of barn owl food composition on different spatial scales is very important for understanding predator-prey relationship on a landscape level and for drawing correct conclusions from the results of owl pellet analysis as an indirect method.

Aknowledgements

Pellet-based small mammal monitoring was supported by Duna-Drava National Park Directorate and Fertő-Hanság National Park Directorate. Scientific students' associations and research of Dominika Szűcs was supported by the European Union and the State of Hungary, co-financed by the European Social Fund in the framework of TÁMOP-4.2.4.A/ 2-11/1-2012-0001 'National Excellence Program'. We want to thank László Bank, secretary of the Pécs Group of the Hungarian Ornithological Society for providing the pellet samples collected by the society. Moreover, thanks to all of the associates of Fertő-Hanság National Park who collected pellets in this region and to Gábor Takács ecological officer who co-ordinated these collections.

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