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Ornis Hungarica 2018. 26(1): 27–40.
DOI: 10.1515/orhu-2018-0002

Food-niche pattern of the Barn Owl *(Tyto alba)* in intensively cultivated agricultural landscape[×]

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Received: February 28, 2018 – Revised: June 13, 2018 – Accepted: June 15, 2018

Horváth, A., Morvai, A. & Horváth, G. F. 2018. Food-niche pattern of the Barn Owl *(Tyto alba)* in intensively cultivated agricultural landscape. – Ornis Hungarica 26(1): 27–40. DOI: 10.1515/orhu-2018-0002

[×]Presented at 1st Hungarian Owl Research Conference held in Pécs on 8th September 2017

Abstract This study investigated the dietary niche of the Barn Owl *(Tyto alba)* in an intensively farmed landscape, based on pellet samples from 12 nesting pairs containing 25 animal taxa and 1,994 prey items after the breeding season in 2016. Based on land use categories of the buffer area around each nest, three landscape types (agricultural, mosaic, urban) were considered, to analyse the diet composition and food-niche parameters. Niche breadth was calculated at the local and landscape level. Small mammals were the most frequent in the diet than other prey in each of the landscape types. The Common Vole *(Microtus arvalis)*, considered to be an important agricultural pest was the most numerous prey in all landscape groups. The trophic niche of Barn Owl varied between 0.69 – 0.86 at the local level, and the overall value of niche breadth was significantly higher in the urban than in the other two landscape types. Our results showed that the increase of Common Vole frequency lead to a decrease in niche breadth; significantly negative relationship was detected between these parameters. Despite differences in niche breadth, similarly high niche overlaps were detected by the randomisation test in the three landscapes. Our results suggest that the diet composition of Barn Owls, mainly their food-niche pattern, reflected prey availability in the comparison of the studied landscapes, which pointed out that it is necessary to examine the dietary difference of Barn Owls at the finer scale of land use.

Keywords: feeding ecology, niche breadth, pellet analysis, land use

Összefoglalás Jelen tanulmányban a gyöngybagoly *(Tyto alba)* táplálék-összetételét intenzíven művelt mezőgazdasági területen vizsgáltuk. A 2016-ban gyűjtött, 12 költőpártól származó köpetminta összesen 25 zsákmány taxon 1994 egyedét tartalmazta. Az egyes fészkelőhelyek körüli pufferterület tájhasználati kategóriái alapján három tájtípust (mezőgazdasági, mozaikos, urbán) különítettünk el, hogy vizsgáljuk a gyöngybagoly táplálék-összetételét és niche paramétereit. A niche szélességet a települések alapján lokális és tájszinten elemeztük. Minden egyes tájtípusban a kisemlősök domináltak a baglyok táplálék-összetételében, míg egyéb prédafajok alacsony gyakoriságban jelentek meg. Mindhárom településcsoport esetében a mezei pocok *(Microtus arvalis)*, mint jelentős mezőgazdasági kártevő volt a leggyakoribb zsákmány. A niche-szélesség lokális szinten 0,69 – 0,86 között változott, az összesített adatok alapján a niche-szélesség szignifikánsan nagyobb volt az agrárdominanciájú, mint a másik két településcsoport vonatkozásában. Eredményeink alapján a mezei pocok gyakoriságának növekedése a niche-szélesség csökkenéséhez vezetett, a két paraméter között szignifikáns negatív regressziót mutattunk ki. A niche-szélesség eltérésének ellenére, a randomizációs teszt alapján hasonlóan magas niche-átfedést mutattuk ki a három tájtípus összehasonlításában. Eredményeink azt sugallják, hogy a gyöngybaglyok táplálék-összetétele, főként a táplálék niche mintázat a vizsgált tájegységek összehasonlításában visszatükrözte a zsákmány-elérhetőséget, amely rámutatott arra, hogy a gyöngybagoly táplálék-összetétel különbségét a tájhasználat finomabb skáláján szükséges vizsgálni.

Kulcsszavak: táplálkozás ökológia, niche-szélesség, köpetanalízis, tájhasználat

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Introduction

Barn Owl *(Tyto alba)* as cosmopolitan nocturnal predator occurs worldwide in most open lands and farmlands (de Bruijn 1994, Taylor 1994, Charter *et al*. 2009, Frey *et al*. 2011) and its diet composition is influenced by the fluctuation of prey populations (Campbell *et al*. 1987, Taylor 1994, Bernard *et al*. 2010, Paspali *et al*. 2013), climatic factors (Clark & Bunck 1991, Avery 1999, Heisler *et al*. 2014), and change of land use and landscape composition (Rodríguez & Peris 2007, Milchev 2015, Veselovský *et al*. 2017).

Since the classical trophic niche studies of owls (Marti 1974, Herrera 1974, Herrera & Hiraldo 1976) the food-niche difference of Barn Owls has been investigated in several approaches such as through comparative intra- and interspecific feeding ecology (Herrera & Jaksić 1980, Capizzi & Luiselli 1998, Leader *et al*. 2010, Petrovici *et al*. 2013, Milchev 2016), trophic guild structure (Jaksić & Delibes 1987, Jaksić *et al*. 1993), long-term study of food composition (Marti 1988, 2010, Love *et al.* 2000), along different geographical regions (Jaksić *et al*. 1982, González-Fischer *et al.* 2011, Milana *et al.* 2016), and gradients (Leveau *et al.* 2006, Trejo & Lambertucci 2007, Hindmarch & Elliott 2015), as well as the impact of disturbances (Jaksić *et al.* 1997, Sahores & Trejo 2004) particularly dependence on growing agricultural activity and changes in farming practice (Love *et al.* 2000, de la Peña *et al.* 2003, Bontzorlos *et al.* 2005, Marti 2010).

Different results of Barn Owls' food-niche analyses have been demonstrated in agricultural ecosystems, and these depended on geographical regions and seasons. Niche breadth was different between seasons in Mediterranean areas (Pezzo & Morimando 1995, Bontzorlos *et al.* 2005), while the niche overlap was high in comparison between seasons (Pezzo & Morimando 1995), and between nest sites (Bosè & Guidali 2001). The food-niche breadth of Barn Owls varied significantly among the years but was not statistically different among seasons in a North American agricultural landscape (Marti 2010), although the seasonal difference of niche breadth was more detectable in temperate regions (Campbell *et al.* 1987, Taylor 1994, González-Fischer *et al.* 2011). Despite this seasonal variation, no correlation was observed between food niche breadth and latitude or longitude, but the prey selection of Barn Owls was associated with the rodent assemblages and responded to the abundance fluctuation of rodents along the gradients in South-America (Leveau *et al.* 2006, Trejo & Lambertucci 2007, González-Fischer *et al.* 2011). The relationship between density fluctuation of small mammals and diet composition was investigated in the Nearctic (Campbell *et al.* 1987, Marti 1988, 2010) and Palearctic range of the Barn Owl (Taylor 1994, Bernard *et al.* 2010). According to these studies, the variation of the Barn Owl's prey consumption was basically determined by high density open-field and agricultural pest rodents, such as species of *Microtus* in both distribution ranges of the Northern Hemisphere. The negative correlation between vole (*Microtus* spp.) frequency and food-niche breadth of the Barn Owl was demonstrated by long-term (Marti 1988, 2010) and other case studies (Milchev 2015, Hindmarch & Elliott 2015). Furthermore, the food-niche breadth of Barn Owl decreased significantly with the increase of mean prey weight (Marti 1988, Milchev 2015), and a significant positive regression was found between the sample size and niche breadth values (Milana *et al.* 2016).

Several studies suggested that the yearly and seasonal variations in the diet composition and thus the plasticity of the food-niche breadth of the Barn Owl reflected local resource conditions, especially the density fluctuation of small mammal preys and changes in the composition of the small mammal assemblages (Milana *et al.* 2016). The population and community attributes of this main prey groups of Barn Owls were determined by changes in the vegetation cover (Lovari *et al.* 1976, Marti 1988, Pezzo & Morimando 1995, Bontzorlos *et al.* 2005), land use and agricultural activity (crop rotation, frequency of mowing or harvesting) (Cooke *et al.* 1996, Askew *et al.* 2007).

In the present study we investigate the hypothesis that habitat variation at the local spatial scale influences the diet composition of Barn Owls, while according to alternative hypothesis, the prey consumption and niche breadth do not depend on the local environmental heterogeneity due to the dominance of intensively cultivated agricultural areas at the regional scale. Our objectives were: i) to evaluate the diet composition of Barn Owls and the relative abundance of small mammals, and ii) to investigate difference of food-niche breadth at the local and landscape scale and niche overlap between three distinguished landscape types within the intensively cultivated agricultural area.

Material and methods

Study area and sample collection

The study was conducted in the intensively cultivated south-eastern part of Transdanubian region in South Hungary (572.3 km²) in Baranya county (45°53′ N, 18°20′ E) *(Figure 1)*. The climate of this region is characterising by the Mediterranean influence with the high number of sunny hours, the relative low fluctuations of temperatures and mild winters. In the present study pellets and prey remains were collected from 12 Barn Owl pairs from the sampling sites at the end of the breeding season in 2016. As a result of a successful artificial nest box program in this county the collection of pellet samples was implemented from active next boxes in each locality. Landscape compositions were assessed using Google Earth (2013) and landscape elements were analysed within a 1 km radius around each nest site because this corresponds to an area that approximates the home range (3 km²) of a Barn Owl during the breeding season (e.g. Taylor 1994, Hindmarch *et al.* 2012, Kross *et al.* 2016). Three groups of the nesting sites (4 sampling localities/group) were distinguished based on landscape composition: 1) agricultural landscape (AL), 2) mosaic landscape (ML), and 3) urban landscape (UL). The following land-use types were identified and digitized, then the percentage of these categories were calculated: 1) agricultural field (annual and perennial crops); 2) extensive land use (grassland, pasture, orchards, vineyards); 3) wetland (including river banks, streams, artificial lakes, fishponds); 4) forest (all forest habitats), and 5) urban (all built-up surfaces) areas *(Table 1)*.

Pellets were processed by the dry technique when the individual pellets were broken down by hand and prey items were identified to the lowest possible taxonomical level. Small mammals were identified based on skeletal parameters (features of skull, mandible and teeth),

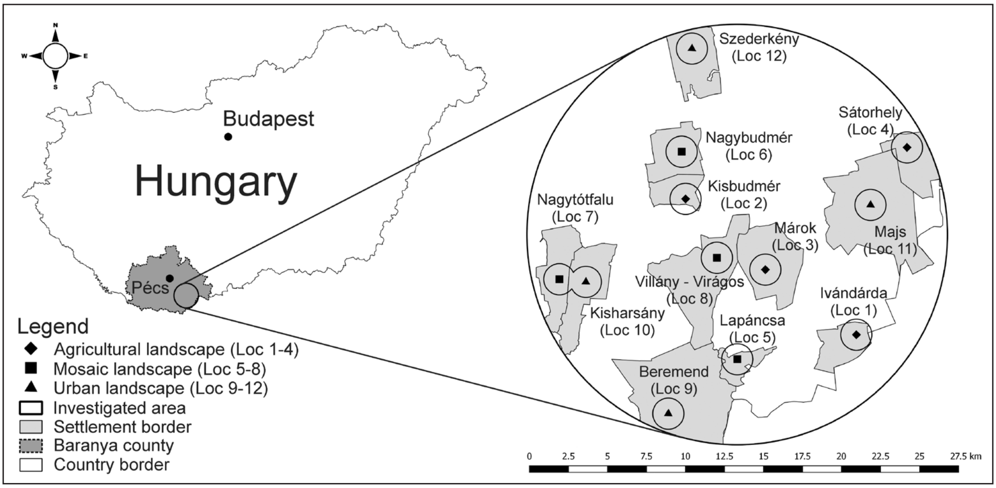

Figure 1. Study area in the South-Transdanubian region, Hungary, showing the location of Baranya county and 12 nesting pairs within the examined landscape. Code numbers (Loc1-12) besides settlement names correspond to those in Table 3.

1. ábra A vizsgált terület Dél-Dunántúlon, Magyarországon, feltűntetve Baranya megye és a 12 költőpár elhelyezkedését a vizsgált tájegységen belül. A településnevek melletti (Loc1-12) kódszámok a 3. táblázatban szereplő kódolásnak felelnek meg

following published literature (März 1972, Yalden 1977, Yalden & Morris 1990). Three different *Apodemus* species as the Wood Mouse *(Apodemus sylvaticus)*, the Yellow-necked Wood Mouse *(A. flavicollis)* and the Pygmy Field Mouse *(A. uralensis)* were categorized commonly as *Apodemus* spp. When the Striped Field Mouse *(A. agrarius)* was not separable from the *Sylvaemus* group (*Apodemus* spp.) the individuals were determined as 'unidentified *Apodemus*'. The sibling species of the genus *Mus* were determined according to Macholán (1996) and Kryštufek and Macholán (1998). In addition, birds were identified by their skulls, bills, feet, pelvises and feathers, and frog (Anura) by their skulls and bones of the postcranial skeleton. If major skeletal elements were missing, prey items were identified to genus (small mammals, birds), to order (frogs), and to class (birds) level.

Table 1. Mean proportions and value ranges (%) of land use categories in three distinct landscape types

1. táblázat A tájhasználati kategóriák átlagos aránya és érték-intervalluma (%) a három elkülönített tájtípusban

Landscape	**Agricultural**		**Mosaic**		**Urban**	
Land use	Mean ±SE	Range %	Mean ±SE	Range %	Mean ±SE	Range %
agricultural field	72.20 ±1.27	69.04-75.19	58.35 ±5.26	46.45-70.19	31.48 ±6.16	16.86-45.35
extensive land use	7.08 ±3.12	0.43-13.53	16.85 ±8.02	5.07-39.47	19.15 ±6.97	10.96-39.99
wetland	1.13 ±0.55	0.42-2.75	1.71 ±1.10	0-4.59	0.47 ±0.40	0-1.66
forest	7.85 ±3.84	1.67-18.95	13.99 ±3.15	4.91-18.77	13.20 ±2.97	4.33-16.87
urban areas	11.74 ±3.69	4.31-21.96	9.10 ±0.63	7.33-10.18	35.70 ±8.67	18.86-56.1

Prey numbers were estimated as the minimum number of individuals (MNI) which we determined according to the same anatomical parts of bones for small mammals (Klein & Cruz-Uribe 1984, McDowell & Medlin 2009, Torre *et al.* 2015, Tulis *et al.* 2015) and skulls, mandibles and long bones for birds. The percent frequency of occurrence (MNI%) was calculated for the total number of prey found in all the pellets at the three different landscape categories.

Statistical methods

First, we evaluated the difference of the relative abundance (MNI%) of small mammals among the separated landscape types. The arithmetic mean MNI% is presented with standard error. To test the hypothetic relationship between niche breadth and Common Vole *(Microtus arvalis)* frequency, linear regression method was used. These statistical analyses were performed using Statistica 8.0 software (StatSoft, Bedford, UK).

The food-niche breadth of Barn Owls was calculated by the Freeman-Tukey index (*FT*) from data of each nesting pair at the local scale and from the overall data of three different landscapes using the relative frequency of occurrence of food items which were identified in the pellets:

$$FT = \sum_{i=1}^{R} \sqrt{p_i a_i}$$

where *FT* is Smith's measure of niche breadth (Smith 1982), p_i is the proportion of individuals found using resource *i*, and a_i is the proportion of resource *i* of the total resources (*R*) found in a given summarized pellet sample. Smith's niche breadth is a standardized measure, as it takes resource availability into account (Devictor *et al.* 2010). The value of this index varies from 0 (minimal) to 1.0 (maximal) and it is relatively insensitive to selectivity for rare resources and to evaluate the significant difference of niche breadth, 95% confidence interval of *FT* values was calculated which measures the uncertainty of estimates (Krebs 1999).

To evaluate the food niche overlap of the Barn Owl among different landscapes, the Pianka overlap index ($O_{12,}$ Pianka 1974, Krebs 1999) was calculated:

$$O_{12} = O_{21} = \frac{\sum_{i=1}^{n} p_{2i}\, p_{1i}}{\sqrt{\sum_{i=1}^{n}(p_{2i}^2)\sum_{i=1}^{n}(p_{1i}^2)}}$$

where p_i is the frequency of the i^{th} item in the diet. This index ranges between 0 (no overlap) and 1 (complete overlap). The significance of the overlap was tested using randomization procedures in R v. 3.3.2 (R Development Core Team 2016), using the "EcoSimR" packages (Gotelli *et al.* 2015). The statistical tests were considered significant at the level $P \leq 0.05$ as standard in all analyses (Sokal & Rohlf 1995).

Results

The diet composition and feeding range was analysed from a total of 890 pellets from which 258 whole pellets were collected in agricultural, 424 in mosaic and 208 in urban landscape. Based on all samples of 12 nesting Barn Owl pairs, 25 animal taxa and 1,994 prey items were identified from the pellets examined during the nesting period in 2016 *(Table 2)*. Small mammals were more frequent among Barn Owl food types (AL: 98.30% ±1.04, ML: 99.93% ± 0.07, UL: 99.40% ± 0.40) while the proportion of other prey categories was very low in each landscape type (AL: 1.70% ± 1.04, ML: 0.07% ± 0.04, UL: 0.60% ± 0.39). Rodents (AL: 90.98% ±2.73, ML: 88.27% ±1.88, UL: 91.76% ±1.43) were more represented within the small mammals than shrews (AL: 7.31% ± 3.04, ML: 11.66% ± 1.82, UL: 7.36% ± 1.73) in the case of each landscape. The proportion of rodents was quite the same in the landscapes while this value of shrews was higher in mosaic than in the other two landscapes *(Table 2)*.

The Common Vole *(M. arvalis)* was the most abundant prey in each of the localities of the three landscape types (AL: 55.95% ± 9.49, ML: 45.72% ± 4.67, UL: 43.30% ± 6.09). Despite the predominance of the Common Vole which basically determined the percent frequency of voles (Arvicolinae), the amount of mice (Murinae) as an important alternative prey group was higher in the case of some sampling localities within rodents. At the species level, the percent distribution of the Striped Field Mouse was higher in the area dominated by built-up surfaces (8.63% ± 0.81) than in the agricultural land (3.75% ± 1.71) but the abundance of this species was similar between the urban and mosaic landscapes (7.53% ± 0.77) *(Table 2)*.

The calculated Freeman-Tukey index (*FT*) indicated that the niche breadth of the Barn Owl varied in different intervals within each separated landscape *(Table 3)*. The range of niche breadth of nesting pairs (localities) was greater in the agricultural land while narrower in the mosaic and urban landscapes which were confirmed by the 95% confidence interval of minimum and maximum values of *FT* index. The lack of overlap indicated a significant difference between the minimal and maximal values of niche breadth in the case of the agricultural landscape. In contrast, the same narrower range of food-niche breadth was showed by the overlap of 95% confidence interval of terminal values in the case of other two landscapes *(Table 3)*. Based on results of each nesting pair, a significant negative linear regression was detected between the local abundance of common vole and food-niche breadth ($R^2 = 0.659$, $F = 19.39$, $P < 0.01$) *(Figure 2)*.

The value of overall niche breadth at the landscape level was significantly higher in the urban than in the agricultural and mosaic landscapes while there was no significant difference between agricultural and mosaic landscapes due to an overlap of 95% confidence interval *(Figure 3)*.

Despite the difference of overall niche breadth values which was observed between urban and another two landscapes, significantly higher food-niche overlap indices were presented by the randomization procedure in the comparison of all the considered landscapes than the obtained mean values from simulations *(Table 4)*.

Table 2. Diet composition of the Barn Owl in the three considered landscapes (MNI: minimum number of individuals, MNI%: percentage frequency of occurrence)

2. táblázat A gyöngybagoly táplálék-összetétele a három figyelembe vett tájegységben (MNI: minimum ismert egyedszám, MNI%: az előfordulási frekvencia százalékos értéke)

Landscape	**Agricultural**		**Mosaic**		**Urban**		**Total**	
Taxa	MNI	MNI%	MNI	MNI%	MNI	MNI%	MNI	MNI%
Soricidae	40	8.03	118	12.25	52	9.76	210	10.53
Sorex araneus	1	0.20	11	1.14	6	1.13	18	0.90
Sorex minutus	1	0.20	2	0.21	2	0.38	5	0.25
Neomys fodiens	2	0.40	14	1.45	4	0.75	20	1.00
Neomys anomalus	3	0.60	13	1.35	8	1.50	24	1.20
Neomys sp.	3	0.60	2	0.21	3	0.56	8	0.40
Crocidura suaveolens	14	2.81	47	4.88	14	2.63	75	3.76
Crocidura leucodon	16	3.21	29	3.01	15	2.81	60	3.01
Arvicolinae	314	63.05	476	49.43	233	43.71	1023	51.30
Myodes glareolus	0	0.00	6	0.62	3	0.56	9	0.45
Microtus agrestis	2	0.40	1	0.10	0	0.00	3	0.15
Microtus arvalis	301	60.44	456	47.35	216	40.53	973	48.80
Microtus subterraneus	6	1.20	3	0.31	8	1.50	17	0.85
Arvicola amphibius	5	1.00	10	1.04	6	1.13	21	1.05
Murinae	142	28.51	364	37.80	236	44.28	742	37.21
Rattus norvegicus	0	0.00	0	0.00	3	0.56	3	0.15
Rattus sp.	4	0.80	12	1.25	22	4.13	38	1.91
Apodemus agrarius	16	3.21	74	7.68	48	9.01	138	6.92
Apodemus spp.	65	13.05	150	15.58	109	20.45	324	16.25
Apodemus indet	26	5.22	59	6.13	20	3.75	105	5.27
Micromys minutus	6	1.20	18	1.87	1	0.19	25	1.25
Mus spicilegus	10	2.01	20	2.08	13	2.44	43	2.16
Mus musculus	2	0.40	13	1.35	10	1.88	25	1.25
Mus sp.	13	2.61	18	1.87	10	1.88	41	2.06
Gliridae	0	0.00	3	0.31	4	0.75	7	0.35
Muscardinus avellanarius	0	0.00	3	0.31	4	0.75	7	0.35
Other prey	2	0.40	2	0.21	8	1.50	12	0.60
Birds	2	0.40	0	0.00	7	1.31	9	0.45
Amphibians	0	0.00	1	0.10	1	0.19	2	0.10
Insects	0	0.00	1	0.10	0	0.00	1	0.05

Table 3. Freeman-Tukey index of niche breadth of Barn Owls at a local scale (for each considered nesting pair)

3. táblázat A gyöngybagoly niche szélességének Freeman-Tukey index értékei lokális skálán (minden figyelembe vett költőpár esetén)

Landscape	**Agricultural**		**Mosaic**			**Urban**		
Code/nest	*FT*	95% CI	Code	*FT*	95% CI	Code	*FT*	95% CI
Loc1	0.789	0.730 – 0.841	Loc5	0.777	0.744 – 0.808	Loc9	0.837	0.797 – 0.872
Loc2	0.687	0.621 – 0.749	Loc6	0.712	0.672 – 0.750	Loc10	0.794	0.733 – 0.848
Loc3	0.855	0.782 – 0.914	Loc7	0.773	0.720 – 0.822	Loc11	0.825	0.766 – 0.877
Loc4	0.770	0.724 – 0.812	Loc8	0.789	0.735 – 0.838	Loc12	0.799	0.742 – 0.850

CI: Confidence Interval

Table 4. Pianka's food niche overlap (O) (below the diagonal) of Barn Owls among landscapes. Above the diagonal are the type I errors of each comparison, obtained by 1000 random permutations in EcoSim R

4. táblázat A gyöngybaglyok tájegységek közötti Pianka-féle niche átfedés (O) értékei (az átló alatt). Az átló felett az EcoSim R-ben 1000 random permutáció alapján kapott I. típusú hiba értékei minden összehasonlításban

Landscape	**Agricultural**	**Mosaic**	**Urban**
Agricultural	1.000	< 0.001	< 0.001
Mosaic	0.987	1.000	< 0.001
Urban	0.954	0.983	1.000

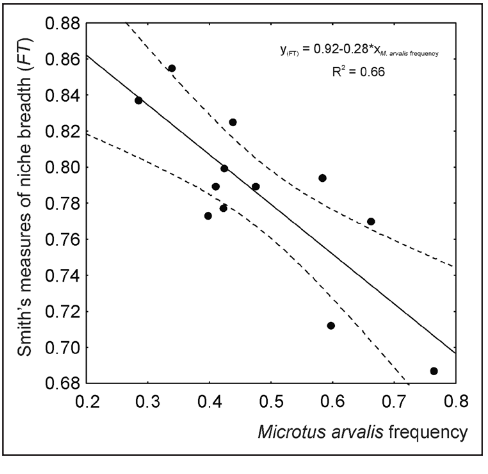

Figure 2. Linear regression between common vole frequency and niche breadth

2. ábra A mezei pocok gyakoriság és a niche szélesség közötti lineáris regresszió

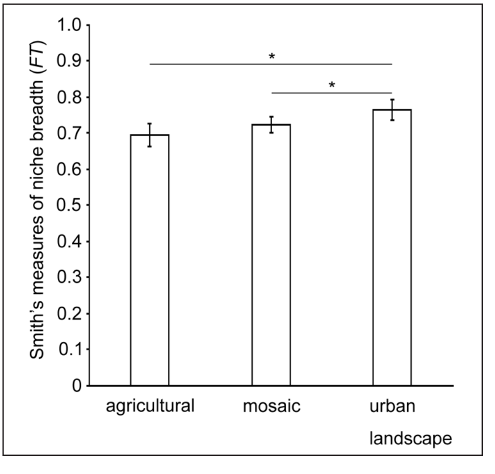

Figure 3. Values of Smith's measures of niche breadth (±95% confidence interval) at landscape level

3. ábra A Smith-féle niche szélesség érté-ke (±95% konfidencia intervallum) táj szinten

Discussion

The feeding habit analysis of Barn Owls from regurgitated pellets is an appropriate method to understand the impact of land use and agricultural practice on the diet composition (Love *et al.* 2000, Burel *et al.* 2004), especially on the change of small mammal assemblages in areas dominated by different human activity and land use (de la Peña *et al.* 2003, González-Fischer *et al.* 2011, Massa *et al.* 2014, Torre *et al.* 2015). The results of the present study demonstrated that the prey consumption of the Barn Owl showed less variation within the boundaries of the larger and intensively cultivated agricultural area. Similar low variability of Barn Owls' diet was reported by some studies in different habitats (González-Fischer *et al.* 2011) or during long-term study periods (Marti 2010) in agro-ecosystems, as opposing the greater seasonal variability of food compositions (Bontzorolos *et al.* 2005, González-Fischer *et al.* 2011, Paspali *et al.* 2013). Similar to other studies, our result confirmed that small mammals are the dominant prey group in the diet of the Barn Owl, and this owl species is characterized as a typical small mammal specialist (Bosè & Guidali 2001, Trejo & Lambertucci 2007, Milchev 2015, Torre *et al.* 2015). The percent frequency of Striped Field Mouse as a generalist species was significantly higher in the urban landscape. With respect to the relative proportion of this species, our results are consistent with other studies which described the Striped Field Mouse as a permanent but non-dominant prey in the Barn Owl's food composition in the southern part of the Transdanubian region (Horváth *et al.* 2005, Purger 2014, Szép *et al.* 2017). Some studies have also pointed out that this rodent species is rather a supplementary component than a crucial or important alternative prey in the diet of Barn Owls (Ruprecht 1979, Milchev 2015). Moreover it is known that Striped Field Mouse is a well spreading species due to its mobility (Spitzenberger & Engelberger 2014), thus its distribution range has expanded north in the Transdanubian region of Hungary over the last forty years (Bihari 2007) and it was detected in some parts of Austria and Slovakia (Herzig-Straschil 2004, Obuch *et al.* 2016, Tulis *et al.* 2016). Despite the distribution of this species in Slovakia, it did not occur in the diet of the Barn Owl in an intensively used farmland (Veselovský *et al.* 2017). The Striped Field Mouse prefers fields, meadows, wastelands and it is also found in different forests, woodlots patches, in urban and suburban mosaic habitats (Andrzejewski *et al.* 1978, Gliwicz 1980, Liro & Szacki 1987, Kozakiewicz *et al.* 1999, Łopucki *et al*. 2013, Pieniążek *et al*. 2017) and it is well adapted to heterogeneous agricultural landscapes (Gentili *et al*. 2014). Its frequency of occurrence is associated with landscape complexity (Fischer *et al*. 2011). According to our results the greatest proportion of Striped Field Mouse in pellet samples of urban land reflected the relatedness of this species with urban and suburban habitat patches.

We found that the Common Vole was the most abundant prey in each of the landscape types considered, the same predominance having been reported by other studies in central Europe (Goszczyński 1977, Horváth *et al.* 2005, Kitowski 2013, Petrovici *et al.* 2013, Purger 2014, Veselovský *et al.* 2017). Despite this general predominance, the significant heterogeneity of overall proportion values proved that the consumption frequency of common voles was higher in the agricultural than in the urban landscape. As shown by the heterogeneous percent frequency distribution of common voles and total *Microtus* genus among different landscapes, and the higher relative frequency of both prey categories in agricultural lands, our results agree with those reported in other studies conducted in different geographical regions of Europe (Taylor 1994, de la Peña *et al.* 2003, Milchev *et al.* 2006, Milchev 2015, Obuch *et al.* 2016), and in North-America (Smith *et al.* 1972, Colvin & MacLean 1986, Marti 1998, 2010, Hindmarch & Elliott 2015). In contrast, the higher frequency of mice (*Apodemus* or *Mus*) as an alternative prey type was detected principally in European Mediterranean regions (Pezzo & Morimando 1995, Bontzorolos *et al.* 2005, Rodrígez & Peris 2007) while in other studies, the predominance was detected in case of either mice or *Microtus* voles which was the consequence of different prey availability depending on landscape composition and farming practice (Love *et al.* 2000, Bosè & Guidali 2001, Bontzorolos *et al.* 2005). In North-America, Lyman (2012) reported that mice *(Peromyscus)* dominated the agricultural prey fauna, whilst voles (*Microtus* spp.) were the dominant prey group in the pellet samples of non-agricultural lands which was related with the conversion of land use. In addition, Kross *et al.* (2016) found that mice *(Mus, Reithrodontomys)* were the most frequently consumed prey item in the Barn Owl's diet, although voles were consumed by the greatest proportion of nesting pairs. This study pointed out the importance of land use gradient both for pest control and for the breeding success of Barn Owls.

The analysis of the Barn Owl's niche breadth showed that its value at the landscape level was significantly higher in the urban than in the agricultural and mosaic landscapes. Our results are in accordance with other studies conducted in Europe (e.g. Milchev 2015, Veselovský *et al.* 2017), in South-America (Leveau *et al.* 2006, Gonzalez-Fischer *et al.* 2011, Teta *et al.* 2012), and in North-America (Marti *et al.* 1988, 2010) which reported that the dominance of small mammals, particularly the high frequency of an available and profitable prey in the diet, explained the low values of niche breadth. Our results confirmed that the food niche breadth of Barn Owls was significantly higher in an urban landscape, caused by the decrease of predominant *Microtus* voles as main prey items (Hindmarch & Elliott 2015) and by the increase of commensal rodents (rats, house mice) as alternative prey which are associated with human activities (Salvati *et al.* 2002, Teta *et al.* 2012, Hindmarch & Elliott 2015). Hindmarch and Elliott (2015) found that the consumption of predominantly smaller rats increased significantly with increased urbanization within the hunting area of the Barn Owl. Clark and Bunck (1991) pointed out that the increase of these commensal or exotic species' frequency over time indicate the impact of human landscape transformation on the environment of Barn Owls. Despite the different overall niche breadth, based on randomization procedure we detected larger niche overlap between the landscapes considered. This result is consistent with other studies which described very high niche overlap in a comparison of seasons (Pezzo & Morimando 1995), nest sites (Marti 1988, Bosè & Guidali 2001), and subsequent years at the same site (Marti 1988, 2010).

According to our results, the regression analysis between percent frequency of Common Voles and niche breadth proved a significant negative relationship. This result is consistent with other studies according to which the higher frequency of voles (*Microtus* spp.) in the diet affects the evenness component of food-niche, that is, the increase in the frequency of voles leads to a reduction of prey evenness hence to a narrowing of the niche breadth (Marti 1988, 2010, Hindmarch & Elliott 2015, Milchev 2015).

Our findings suggest that the diet composition of Barn Owls, mainly their food-niche pattern, reflected prey availability in the comparison of the studied landscapes, which pointed out that it is necessary to examine the dietary difference of Barn Owls at the finer scale of land use.

Acknowledgments

The Barn Owl pellet analysis in 2016 was carried out with the support of the Hungarian Biodiversity Monitoring System and Duna-Dráva National Park Directorate. Thanks to László Bank, secretary of the Baranya County Group of BirdLife Hungary for providing the pellet samples. Finally, we would like to thank the two anonymous reviewers for many helpful comments.

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