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Diet composition of the scops owl (*Otus scops*) in central Romania

Potrava výrika lesného (*Otus scops*) v strednom Rumunsku

Hana LATKOVÁ, Attila K. SÁNDOR & Anton KRIŠTÍN

Abstract: Insect diversity correlates negatively with increasing management intensity of grasslands and with latitude. We supposed that similar patterns might be found in the diet spectra of insectivorous birds. The diet composition of the insectivorous scops owl was studied by analysing the prey remnants collected from 21 nests during 2008–2009 in an extensively cultivated rural area in the centre of the owl's distribution range in Central Romania. Altogether 831 prey items belonging to 45 prey taxa were identified. Similarly to the other parts of the scops owl range, orthopterans were high dominant prey items (86.8%) – especially bush-crickets Tettigoniidae (78.6%). In food samles were found also beetles (Coleoptera, 5.7%) and rarely spiders Araneidea, moths Lepidoptera, mantids Mantodea, Hymenoptera and Neuroptera (<1.5%). Vertebrates were rarely represented by rodents (2.5%) and passerines (1.3%). The following diagnostic prey species were identified in 20 nests using the MDFM method: bush-crickets *Tettigonia viridissima*, *Decticus verrucivorus*, *Metrioptera bicolor* and other species of the family Tettigoniidae, the beetle *Onthophagus* spp., the cricket *Gryllus campestris* and other unidentified beetles Coleoptera g. sp. Furthermore, the scops owl's diet in different parts of its range was compared. As expected, there were more Orthoptera and generally more prey taxa in food in the range centre than at its northern limit.

Abstrakt: Diverzita hmyzu negatívne koreluje so stúpajúcou intenzitou obhospodarovania trávnatých plôch a so zemepisnou šírkou. Predpokladali sme, že podobný model môže fungovať aj v prípade potravného spektra hmyzožravých vtákov. Zisťovali sme potravné zloženie hmyzožravého výrika lesného skúmaním potravných zvyškov z 21 hniezd v rokoch 2008–2009. Sledované lokality sa nachádzajú v extenzívne využívanej vidieckej krajine v centre areálu rozšírenia, v strednom Rumunsku. V potrave sa zistilo spolu 831 kusov koristi patriacich do 45 taxónov. Podobne ako v ostatných častiach areálu výrika, rovnokrídlovce (Orthoptera) boli v potrave vysoko dominantné (86,8 %), a to hlavne druhy čeľade Tettigoniidae (78,6 %). V potravných vzorkách boli nájdené tiež chrobáky (Coleoptera, 5,7 %), zriedkavejšie pavúky Araneidae, mory Lepidoptera, modlivky Mantodea, blanokrídlovce Hymenoptera a sieťokrídlovce Neuroptera (<1,5 %). Stavovce boli zriedkavo zastúpené hlodavcami (2,5 %) a spevavcami (1,3 %). Pomocou metódy MDFM boli v 20 hniezdach identifikované ako diagnostické druhy nasledujúce: kobylky *Tettigonia viridissima*, *Decticus verrucivorus*, *Metrioptera bicolour* a ďalšie druhy čeľade Tettigoniidae, chrobáky *Onthophagus* spp., svrčky *Gryllus campestris* a ďalšie neidentifikovateľné chrobáky (Coleoptera g. sp.). Okrem toho sme porovnali potravné zloženie výrika lesného v jednotlivých častiach jeho areálu. Ako sme očakávali, v centre areálu sme zistili viac rovnokrídlovcov a všeobecne viac taxónov koristi v potrave výrikov ako na severnej hranici jeho rozšírenia.

Key words: insectivorous owls, foraging ecology, Orthoptera

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Introduction

Insect diversity correlates negatively with increasing management intensity of grasslands (e.g. Marini et al. 2009) and with latitude (Rohde 1992). We supposed that similar patterns might be found in the diet diversity of insectivorous birds. The scops owl (*Otus scops* Linnaeus, 1758) is an obligatory insectivorous migrating owl species. A marked decline in its population is currently reported from most parts of its distribution range. Romania with the centre of the species breeding range is probably the only country where the scops owl shows a positive population trend. The population estimates in

1990–2002 were 25,000–40,000 pairs (BirdLife International 2004). For this reason, one might expect sufficient food supplies and suitable habitats for this species in that region. However, there is a lack of research on its ecology from the past. Even the basic data on the species distribution are not complete, which is also apparent in the latest version of the "Atlas of Breeding Birds in Romania" (Munteanu 2002). Lack of data is the case in most of the countries of SE Europe.

The scops owl has a quite narrow ecological valence. As such, it depends on specific conditions of well-preserved rural landscape with large insects available as food resources. This owl can therefore be considered as a suitable indicator of biodiversity and landscape diversity (Sergio et al. 2005). Its territories in semi-open habitats are characterised by rich diversity of insect species, especially Orthoptera (Krištín & Sárossy 2002). In Italy, the species' territories also host significantly more species of moths, reptiles, amphibians and birds (Sergio et al. 2006, 2008).

Diet composition and foraging ecology was studied in the centre of the owl's range, where the species is currently declining (e.g. Bavoux et al. 1993, Marchesi & Sergio 2005), and also at the northern range limit with relatively stable populations (Šotnár et al. 2008, Muraoka 2009). All results indicate large Orthoptera species as the most important component of the scops owl's diet, more than in the case of other European owl species (Herrera & Hidalgo 1976).

Large areas of grasslands and pastures showing "High Natural Value" as scops owl's foraging habitats can still be found in Transylvania. Thanks to the traditional farming with low intensity cultivation lasting for centuries, the diversity of species and habitats has remained preserved there.

Hence we expected the composition of the scops owl's diet to be more diverse in its range centre and in the south than at the northern limit. Similarly we expected differences between the various habitats. We addressed the following questions: (i) what is the diet composition at the range centre in Central Romania? (ii) are there differences in the diet composition within the species range? (iii) does the composition of prey species correlate with habitat structure in the owl's territories?

Material and methods

Study area and species

The study area is situated in the central part of Transylvania (Central Romania, Fig. 1), partly in the Special Protected Area named "Deaurile Târnavelor-Valea Nirajului" (code ROSPA0028, south from the town of Târgu Mureş). It is located in the valley of the NirajRiver (2–4 km wide) and in its smaller side valleys (350–550 m a. s. l.). The local rural landscape is cultivated in the traditional way and it is characterized by small-sized fields (cultivated mostly manually) and grazed grasslands forming a mosaic of various habitats. The scops owl crude density reaches 37.0–46.3 breeding pairs / 100 km^2 there, and the ecological density 43.4–54.2 breeding pairs / 100 km^2 (Latková 2011). The diet composition was studied in a grassland area with orchards, scattered trees and shrubs, in vineyards, cemeteries and in extensively-used agricultural land (Fig. 1).

The 21 breeding territories are dominated by grasslands (55.0 ± 18.7%), trees and shrubs (24.2 ± 12.5%), less frequent were fallows (9.4 ± 10.2%), alfalfa (3.7 ± 6.6%), crop (3.0 ± 6.1%), maize fields (2.0 ± 4.7%), cultivated vineyards (1.3 ± 3.2%) and others (1.5 ± 2.6%) (with surface <1%: roads, gardens, settlements and reed stands).

Data collection

The diet composition was studied in nests located in wooden nest boxes in 2008–2009. Prey remnants and pellets were collected from 21 nests (11 in 2008, 15 in 2009; Fig. 1), just before or immediately after the chicks fledged out. In five cases, the nests were occupied in both years of our study. In 2008, we supplemented our data with a stomach analysis of a dead scops owl female killed by *Strix aluco*. However, this sample was not included in the MDFM analyses. The prey species in the remnants were identified using a Nikon stereomicroscope (magnification 6–25×). The abundance was calculated based on characteristic body parts (mainly legs, mandibles, heads and ovipositors).

Habitat analysis was carried out on plots of 250 m radius (19.63 ha) surrounding owl nests (Denac 2009). Landscape components were surveyed directly in the field and redrawn later in ArcView 3.2 using current orthophoto maps.

Density of patches (ha^{-1}) in each owl territory was used for description of habitat fragmentation. The expression "patch" should be understood as a part of the Earth's surface, distinguishable according to its appearance (Odum 1977).

Data analysis

Absolute (n) and relative (n%) abundance of prey items

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was used for quantitative evaluation of the food composition. Abundance of prey taxa was evaluated using the method working with marked differences from the mean – MDFM (Obuch 2001). The differences between theoretical and real abundances may be positive (+) or negative (-). The species with marked differences from the mean are considered as "diagnostic". From the total of 21 studied nests, one of them was excluded from analyses as it contained only one item of prey. Samples from 20 nests were ordered according to their similarity with the diagnostic species with positive values, organized in clusters (Tab. 3). The "ZBER" computer database, version 2.8 (Šipöcz 2004) was used for data analyses.

Results

Altogether 831 prey items belonging to min. 45 taxa (from 4 classes, 9 orders and 23 families) were identified in the scops owl's food in Central Romania. The dominant food fractions were represented by insects (94.6%), especially Orthoptera (86.8%). Furthermore, the following insect classes were found in food samples: Coleoptera (5.7%), Lepidoptera (1.0%), Mantodea (0.3%), Hymenoptera (0.2%) and Neuroptera (0.1%). In these prey remains, in small percentages, we also found spiders (Araneidae, 1.5%), and vertebrates such as Rodentia (2.5%) and passerines (1.3%) (Tab. 1).

Tettigoniids (78.6%) dominated in all studied nests (R_x=100 $\%_{max}$ – 40 $\%_{min}$). Three bush-cricket species were the most abundant: *Tettigonia viridissima* (53.3 ± 31.4%), *Decticus verrucivorus* (4.6 ± 2.2%) and *Pholidoptera griseoaptera* (2.9 ± 1.2%). The field cricket *Gryllus campestris* (5.3 ± 5.0%) was identified as the most abundant cricket species in the owl´s food. Prey species with crepuscular activity were highly preferred.

In addition to MDFM analyses, in the stomach of one dead specimen (found on June 15) *T. viridissima* (2 females and 3 nymphs) and *Barbitistes constrictus* (1 female) were found.

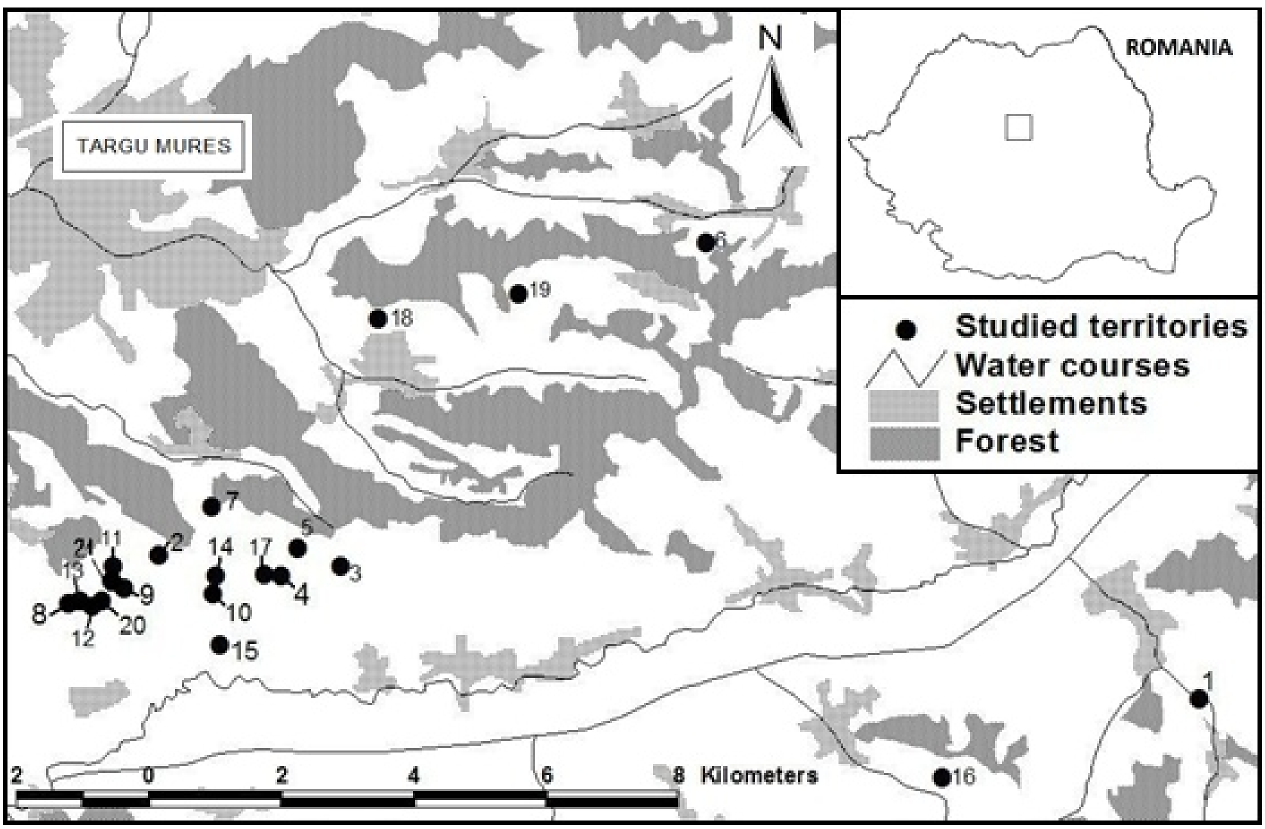

Fig. 1. Studied territories of scops owl (no. 1–21) in Central Romania and their localisation within Romania (UTM 50×50 km).
Obr. 1. Sledované teritóriá výrika lesného (č. 1–21) v strednom Rumunsku a ich poloha v rámci Rumunska (UTM 50×50 km).

Tab. 1. Absolute (n) and relative (n%) abundance of prey taxa in the diet of scops owl in central Romania (21 nests and one stomach content)
Tab. 1. Absolútna (n) a relatívna (n %) abundancia koristi v potrave výrika lesného v strednom Rumunsku (21 hniezd a 1 obsah žalúdka)

taxa / taxón // year / rok			**2008**	**2009**	**n**	**n%**
number of nests / počet hniezd			**11**	**15**		
Arachnida		Araneidae sp.	4	2	6	0.7
		Araneus sp.	5	2	7	0.8
Insecta	**Neuroptera**	*Mantispa* sp.		1	1	0.1
	Orthoptera	Tettigoniidae g. sp.		26	26	3.1
		Barbitistes constrictus	1		1	0.1
		Isophya sp.	1	2	3	0.4
		Polysarcus denticauda		2	2	0.2
		Ruspolia nitidula	3		3	0.4
		Decticus verrucivorus	19	19	38	4.6
		Metrioptera bicolor	9	25	34	4.1
		Metrioptera roeselii		3	3	0.4
		Pholidoptera griseoaptera	12	12	24	2.9
		Tettigonia sp.		75	75	9.0
		Tettigonia viridissima	416	27	443	53.3
		Tettigonia caudata	1		1	0.1
		Gryllus campestris	1	43	44	5.3
		Melanogryllus desertus		6	6	0.7
		Gryllus sp.		1	1	0.1
		Gryllotalpa gryllotalpa		3	3	0.4
		Acrididae g.sp.	2	12	14	1.7
	Mantodea	*Mantis religiosa*	2	5	7	0.8
	Coleoptera	unidentified	6		6	0.7
		Cerambycidae g.sp.		1	1	0.1
		Prionus coriarius	1	2	3	0.4
		Lucanus cervus	1		1	0.1
		Carabidae g.sp.	2	1	3	0.4
		Carabus sp.	2	3	5	0.6
		Pterostichus sp.		1	1	0.1
		Curculionidae g.sp.	1	1	2	0.2
		Scarabeidae g.sp.	1	3	4	0.5
		Copris sp.		2	2	0.2
		Onthophagus sp.	12	5	17	2.1
		Potosia sp.		1	1	0.1
		Staphylinidae g.sp.	1		1	0.1
		Athous sp.		1	1	0.1
	Lepidoptera	unidentified	2	2	4	0.5
		Noctuidae g.sp.	2	1	3	0.4
		Lymantriidae g.sp.	1		1	0.1
	Hymenoptera	Vespidae g.sp.		1	1	0.1
		Vespula sp.	1		1	0.1
Aves	**Passeriformes**	unidentified	6	2	8	1.0
		Lanius collurio		1	1	0.1
		Peocile palustris		1	1	0.1
		Saxicola rubicola		1	1	0.1
Mammalia	**Rodentia**	unidentified	1	12	13	1.6
		Muscardinus avellanarius	4		4	0.5
		Microtus sp.	3		3	0.4
∑			**523**	**308**	**831**	**100**

Inter-seasonal variation in food

More prey specimens and less taxa were found in food samples from 2008 than from 2009 (523 vs. 308 individuals, on average 47.0 ± 39.0 vs. 20.5 ± 14.2 individuals / locality; 29 vs. 36 taxa). The most marked difference was in the proportion of Tettigoniidae (79.7% in 2008, 41.6% in 2009). Crickets (Gryllidae) were represented in 2008 just by one species (*Gryllus campestris*, 0.2%), whereas in 2009 two species could be identified in the samples (*G. campestris*, *Melanogryllus desertus*) in relative abundance up to 16.2%.

Food composition and habitat patterns in the scops owl territories

T. viridissima was identified in seven territories as a diagnostic prey species together with other unidentified species of this genus and family Tettigoniidae. In most cases a marked difference was not obtained, except in territory no. 16 (Tab. 3). This territory was characterized by higher biodiversity of habitats (density of 6 patches / ha): grasslands (54.7%, with wet patches partly grazed and regularly burnt in spring), alfalfa (22.9%), cereal crops (9.0%), fruit trees and shrubs (6.2%), fallows (3.1%), vineyards (2.2%) and forage crops (0.5%).

In two territories with *T. viridissima* and Tettigoniidae sp. as diagnostic prey taxa, other prey species were also present in the owl's food; in the case of territory no. 18 it was *G. campestris*. This territory comprises an extensively-managed cemetery with grassland (22.6%), trees and shrubs (36.5%), gardens (11.6%), settlements and roads (9.7%) and agricultural land (19.6%). In the second territory (No. 19) *Metrioptera bicolor* was another abundant species. The local grassland is grazed and burnt in spring just sporadically (79.4%) and trees and bushes are scattered over the area (19.4%).

G. campestris was significant in the food from territory no. 12, indicating a high proportion of sporadically-grazed grassland and fallows (>70%).

Food samples from territory no. 7 were characterized by *D. verrucivorus*, *Onthophagus* sp. and other unidentified Coleoptera. Most of the beetles in the samples were coprophagous (73.1%). *T. viridissima* was a diagnostic species, with negative value of marked difference. Habitats in this territory were less fragmented (density 1 patch / ha). The grasslands (62.5%) were intensively grazed and located not far from a sheepfold. Only 12.5% of the whole territory surface was overgrown by trees or shrubs, 8.5% were fallows and the rest consisted of fields of alfalfa and cereal crops.

The great green bush-cricket *T. viridissima* was identified as a diagnostic prey species with negative value in territories no. 2, 15 and 20. Tree and shrub vegetation covered 12.7–33.4% of the surface there.

Discussion

Diet composition of the scops owl in different parts of its range

In all parts of its range, the scops owl preys on markedly more insects than the other European owl species (Herrera & Hiraldo 1976). Insects represented 98% of its prey in the Italian Alps (Marchesi & Sergio 2005), 97.9% in Slovakia (Šotnár et al. 2008), 94.6% in Romania (this study), 92.2% in Switzerland (Arlettaz et al. 1991), 90% in Central France (Bavoux et al. 1993) and 89.6 or 77.6% in Austria (Keller & Parrag 1996, Muraoka 2009).

However, the proportion of Orthoptera in the scops owl's food differs considerably from country to country, depending probably on the localization within different parts of its range, or on the differences between the studied habitats and their structure (Toyama & Saitoh 2011).

The number and abundance of Orthoptera species in Europe is declining increasingly from the Mediterranean regions northwards (Ingrisch & Köhler 1998). Hence lower species diversity and abundance of Orthoptera in the diet should be expected in the northern part of the scops owl's range, but this hypothesis was not confirmed. The lowest abundance of Orthoptera (46.8%) was reported from the nests located in open grassland biotopes and from sparse oak forests in France (Bavoux et al. 1993), while the highest (>90%) was from nests in parks and orchards in Slovakia (northern limit of the range) (Šotnár et al. 2008) (Tab. 2). In Austria, with patchy distribution of the scops owl, Orthoptera represented 40.4% and 61.8% of the prey items (Keller & Parrag 1996, Muraoka 2009 respectively). The abundance of Orthoptera in the traditional mosaic agricultural habitats of central Romania (86.8 %) was similar to that at the northern limit of the range in Slovakia (Šotnár et al. 2008). However, we found relatively high species richness of orthopterans (min. 14 species) in Romania in comparison with Slovakia (6 species), Austria (7 and 9 species) or Switzerland (8 species). In France (in the range centre) 11 species of Orthoptera were found (Bavoux et al. 1993), confirming our hypothesis about

Tab. 2. Diet composition [%] of scops owl in different parts of its range
Tab. 2. Zloženie potravy [%] výrika lesného v jednotlivých častiach jeho areálu rozšírenia

taxa / taxón // country / krajina		**Romania[1]**	**Austria[2]**	**Slovakia[3]**	**Italy[4]**	**France[5]**
Arachnida		1.5	0.5	0.5	0.8	4.6
Insecta	Neuroptera	0.1	0.0	0.0	0.0	0.0
	Dermaptera	0.0	0.2	0.0	0.0	0.0
	Orthoptera	86.8	61.8	91.3	78.6	46.8
	Mantodea	0.3	0.0	0.8	0.0	0.0
	Coleoptera	5.7	0.0	4.0	1.0	1.5
	Lepidoptera	1.0	15.2	1.6	14.7	27.8
	Hemiptera	0.0	0.4	0.2	0.4	0.0
	Hymenoptera	0.2	0.0	0.3	0.2	0.0
	Diptera	0.0	0.0	0.1	0.6	0.0
	Cheleutoptera	0.0	0.0	0.0	0.0	13.1
Vertebrata	Aves, Mammalia	3.8	0.9	1.6	0.6	2.8
assessment method /		food remains & one stomach contents	direct observation 3 IR cameras	direct observation & food remains	direct observation & food remains	direct observation
hodnotiaca metóda		potravné zvyšky & obsah jedného žalúdka	priame pozorovania 3 infračervené kamery	priame pozorovania & potravné zvyšky	priame pozorovania & potravné zvyšky	priame pozorovania
no. of prey items / počet kusov koristi		831	2152	880	504	2365
no. of checked nests / počet sledovaných hniezd		21	1	6	15	6

Legend / vysvetlivky: [1] this study / táto práca, [2] Muraoka 2009, [2] Šotnár et al. 2008, [4] Marchsi & Sergio 2005, [5] Bavoux et al. 1993

more species in the owl's food in the southern part of its range. However, in Italy only 2–3 species were identified (Marchesi & Sergio 2005), probably due to mountain habitats in the Alps, or due to methodological differences in prey identification.

The most preferred prey of the scops owl were large-sized bush-crickets, especially *T. viridissima*. Its proportion in the diet varied from 10.5% (Italian Alps – Marchesi & Sergio 2005) to 87.6% (Slovakia – Šotnár et al. 2008). In Romania, its abundance reached medium values, probably due to higher diversity and abundance of other bush-crickets as available prey (Krištín et al. 2011).

Compared to other countries, the scops owl's diet in Romania is characterised by higher abundance of beetles (5.7%) and vertebrates (3.8%) and by a lower proportion of lepidopterans (1.0%) (Tab. 2). The different prey identification methods used for particular diet studies are probably responsible for these differences (Fattorini et al. 2001).

Apart from small birds and small terrestrial mammals, reptiles, amphibians and bats have also been identified in low abundances in the scops owl's diet throughout its range (Streit & Kalotás 1991, 1997, Bavoux et al. 1993, Berg & Zelz 1995, Keller & Parrag 1996, Muraoka 2009).

Inter-seasonal diet differences within the same area and nests

Year-on-year comparison was done for food samples from the same five scops owls' nests occupied in both study years. In 2008 a total of 286 prey items were found (23 taxa); in 2009 only 107 (21 taxa). The diet composition varied with the particular years. In 2008, *T. viridissima* (79.4%) dominated, while in 2009 it was *Tettigonia* sp. (29.9%) and *G. campestris* (21.5%). In both study years, Orthoptera represented the highest proportion of the owl's food (86.7% in 2008 and 84.1% in 2009).

We expected the prey spectrum in particular years to vary, influenced by various factors. The date of food sampling is crucial in connection with the phenology and abundance of individual prey species. For example, the highest abundance of the cricket species (Gryllidae) in suitable habitats in the temperate zone occurs towards the end of June (Detzel 1998). In our study this fact was reflected in food samples from 2009, when the prey remnants collected in June contained a large proportion of Gryllidae (16.2%). In 2008 the food sampling was shifted to the second half of July, and the proportion of cricket species was found at a considerably lower percentage (0.2%).

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Tab 3. Diet composition similarity in 20 nests of scops owl in central Romania (according to the MDFM method; localities were ordered by their similarity; diagnostic species are presented at the top of the table)

Tab. 3. Podobnosť zloženia potravy výrika lesného v 20 hniezdach v strednom Rumunsku (podľa MDFM metódy; lokality boli zoradené podľa podobnosti, diagnostické druhy sú uvedené na vrchu tabuľky)

no. of locality / číslo lokality taxa / taxón	**5**	**13**	**3**	**8**	**19**	**16**	**18**	**12**	**7**	**2**	**15**	**20**	**1**	**4**	**6**	**9**	**10**	**11**	**14**	**17**	**∑**	**%**
Tettigonia viridissima	**1+ 134**	**1+ 66**	**1+ 50**	**1+ 31**	1.6	3- 0	3- 0	44	1.28	1- 0	1- 0	1- 0	8	20		13	1	24	1	12	438	53.16
Metrioptera bicolor	1.2	4	2		**1+ 6**		2	2	6	1	2		1				2		4		34	4.13
Tettigoniidae	4				**1+ 6**	**2+ 16**															26	3.16
Tettigonia sp.	1.9	1- 0	1- 0			**2+ 21**	**1+ 12**	4	15	3	3	4		2			2				75	9.1
Gryllus campestris	2- 0	1- 0			2		**2+ 16**	**2+ 19**	3			2		2							44	5.34
Onthophagus sp.								2	**1+ 13**			1		1							17	2.6
Decticus verrucivorus	5	2	3	2	2	2	2		**1+ 10**	1		2	1	3		1	1			1	38	4.61
Coleoptera sp.									**1+ 5**									1			6	0.73
Pholidoptera griseoaptera	2	5				1	2	2	2	2	3			1	1	1		1	1		24	2.91
Acrididae sp.		1			3	3		3	3											1	14	1.7
Rodentia sp.					3		1	2	1	4		1								1	13	1.58
Passeriformes sp.				1					1			1		1		1		1		1	7	0.85
Araneus sp.	1	1	1						3									1			7	0.85
Mantis religiosa		1	1				2		1					1					1		7	0.85
Araneidea sp.							2	1	1							1		1			6	0.73
Melanogryllus desertus					1	2		1			1									1	6	0.73
Carabus sp.							1	1	2					1							5	0.61
Mammalia	**3**	**1**	**1**	**2**	**3**	**0**	**1**	**2**	**1**	**4**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**20**	**2.43**
Aves	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**1**	**3**	**0**	**1**	**0**	**1**	**0**	**1**	**0**	**1**	**0**	**1**	**10**	**1.21**
Evertebrata	**162**	**82**	**58**	**34**	**28**	**46**	**41**	**82**	**101**	**1.7**	**9**	**9**	**12**	**35**	**5**	**18**	**9**	**31**	**7**	**18**	**794**	**96.36**
∑	**165**	**83**	**59**	**37**	**31**	**46**	**42**	**84**	**103**	**14**	**9**	**11**	**12**	**36**	**5**	**19**	**9**	**32**	**7**	**20**	**824**	**100**
Diversity index H'	0.88	0.91	0.68	0.66	2.5	1.34	1.81	1.61	2.45	1.91	1.31	1.64	1.1	1.75	1.61	1.19	1.89	0.98	1.15	1.5	2.8	

Less abundant prey taxa (no. of locality-no. of prey items) / Menej početné taxóny koristi (číslo lokality-počet kusov koristi): *Microtus* sp. (13-1, 8-2), *Muscardinus avellanarius* (5-3, 3-1), *Saxicola rubicola* (2-1), *Poecile palustris* (2-1), *Lanius collurio* (2-1), Araneidea sp. (7-1, 12-1, 9-1, 11-1), *Mantispa* sp. (16-1), *Isophya* sp. (8-1, 1-1, 10-1), *Tettigonia caudata* (9-1), *Polysarcus denticauda* (5-1, 7-1), *Metrioptera roeselii* (5-1, 19-2), *Ruspolia niditula* (11-3), *Melanogryllus desertus* (16-2, 12-1, 15-1), *Gryllus* sp. (6-1), *Gryllotalpa gryllotalpa* (7-1, 4-1, 17-1), *Prionus coriarius* (1-1, 4-1, 18-1), *Lucanus cervus* (4-1), Carabidae sp. (13-1, 12-1, 10-1), *Carabus* sp. (7-2, 12-1, 4-1), *Pterostichus* sp. (6-1), Curculionidae sp. (5-1, 12-1), Scarabeidae sp. (7-2, 6-1, 10-1), *Copris* sp. (7-2), Staphylinidae sp. (7-1), *Potosia* sp. (6-1), Cerambicydae sp. (7-1), *Athous* sp. (18-1), Lepidoptera sp. (5-2, 13-1, 9-1), Noctuidae sp. (3-1, 7-1, 17-1), Lymantridae sp. (12-1), Vespidae sp. (17-1), *Vespula* sp. (4-1).

Studied localities (No. of locality) / Sledované lokality (číslo lokality): Bedeni (1), Budiu Mic (2-5, 17), Ivaneşti (6), Vălureni (7-14, 20, 21), Crăciuneşti (15), Gălăţeni (16), Corunca (18, 19).

It has also been recognised that changes in abundance of prey species in the diet can reflect their population cycles and long-term variations. For example, the influence of fluctuations in rodent prey has been observed in the diet composition of several owl species (e.g. Korpimäki 1988 in *Aegolius funereus*, Tome 1994 in *Asio otus*, Obuch 1997 in *Strix aluco*, Draus 2003 in *Tyto alba*, Suchý 2003 in *Bubo bubo*) as well as in their breeding biology (e. g. Korpimäki 1992, Latková 2008). Long-term studies enable the evaluation of which factors cause inter-seasonal differences in the diet composition. Such factors as land-use changes or intensification and modernization of agriculture are frequently involved (Kormipäki 1988, Draus 2003). However, seasonal variations in the diet composition of insectivorous owl species and in the cycles of their insect prey have been studied only rarely (Lee & Severinghaus 2004).

The results of analyses of food remnants in particular years may have been influenced by other factors as well. Several times we observed ants carrying prey remnants out from the nestboxes. Moreover, long-lasting precipitation events do not just affect food availability, but they can accelerate the destruction of food remnants as well (personal observation).

Composition of food and habitats in the owl's territories

The prey composition reflects the habitat type. For example, the ground-dwelling species *G. campestris*, *D. verrucivorus* and coprophagous Coleoptera were diagnostic prey species in the scops owl's diet in territories with dominant grassland and fallows (terr. no. 12) and in pastures with intensive management (terr. no. 7). Similar results have also been published for other bird species such as *Lanius minor* (Krištín 1995) and *Athene noctua* (Fattorini et al. 2001).

The abundance of the tree-dwelling bush-cricket *T. viridissima* in the scops owl diet did not correlate with our expectations concerning the composition of tree and shrub vegetation in the owl's territories. In territories no. 3, 5, 8 and 13 with *T. viridissima* identified as a diagnostic species with positive value, trees and shrubs represented 1.9–24.0% of the whole territory surface (14.3% on average). However, in territories no. 2, 7, 15, 16, 18–20 with *T. viridissima* as diagnostic species with negative value, trees and shrub comprised 6.2–36.5% of the territories (19.4% on average). These differences were not significant (Student *t* test, P = 0,355). The high portion of abandoned vineyards, fallows or overgrown pastures in the studied owl's territories might explain the frequent presence of *T. viridissima* there.

Different methods used in studies of the scops owl's diet

The diet composition of this owl species has been studied mainly using the method of direct observation and video- and photo-recording of the parents' feeding activities (Henninger & Banderet 1990, Arlettaz et al. 1991, Bavoux et al. 1993, Muraoka 2009) or by pellet and prey remnants analyses (Uttendörfer 1952, Sorace 1991, Pereni et al. 1997), or sometimes with a combination of these methods (Streit & Kalotás 1991, Keller & Parrag 1996, Marchesi & Sergio 2005, Šotnár et al. 2008). The method of fecal analysis was used in a study on intersexual diet differences of the elegant scops-owl (*Otus elegans*) (Lee & Severinghaus 2004). Regarding the success of food identification, different methods produce different results. According to the research on the scops owl's food spectrum in Italy and Slovakia (Marchesi & Sergio 2005, Šotnár et al. 2008), on average 15% and 22% of all prey items were identified using the direct observation method; 78% and 84% using the remnant analysis method. Using the method of pellet and remnant analysis, 27.2–96.5% of all prey items could be identified at the species level (Sorace 1991, Keller & Parrag 1995, Šotnár et al. 2008, this study), and 35.2–90.5% in the case of video/photo recording (Arlettaz et al. 1991, Bavoux et al. 1993, Šotnár et al. 2008, Muraoka 2009). Each of the methods used has its advantages and disadvantages. Concerning the diet composition, they can provide more complex results only in combination. Analyses could also be completed with research on prey availability regarding insects in the owl's territories, primarily through the use of sweeping nets (Krištín & Sárossy 2002, Krištín et al. 2011).

Conclusions

Our presumption that the scops owl's diet should be more diverse in the centre than in the northern part of its range has been confirmed. Comparing similar-sized samples it was possible to identify 45 prey taxa in Romania and 29 taxa in Slovakia. In some localities, differences in the prey species composition between habitats were confirmed. We suppose that the presence of the scops owl in certain Romanian localities might indicate the presence of traditionally-managed mosaic biotopes characterised by a high species richness of Orthoptera. Detailed analyses from other parts of the owl's range are needed for more exact evaluation.

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