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Different alternative diets within two subgroups in a winter roost of long-eared owls

Rozdielna alternatívna potrava myšiarok ušatých v rámci dvoch častí zimoviska

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Abstract: In winter 2013/2014 a roost of long-eared owls in Bojnice Spa (central Slovakia) was formed by two subgroups situated 12 meters apart from each other. The diets of both subgroups and the direction of the owls' departure from the roost were studied at monthly intervals. Owls of the *Pinus*-subgroup left the roost in a significantly different direction compared with the owls in the *Picea*-subgroup. The common vole was the most hunted prey in both subgroups. However, comparing the alternative prey of the two subgroups, the wood mouse and other mammals were found significantly more often in pellets of the *Picea*-subgroup, whereas birds were more frequent in pellets of the *Pinus*-subgroup. Our results suggest that the different prey hunted by the two subgroups may be a consequence of diverging hunting areas with different availability of alternative prey species.

Abstrakt: V priebehu zimy 2013/2014 bolo zimovisko myšiarok ušatých na lokalite Bojnice kúpele (stredné Slovensko) rozdelené na dve časti, situované 12 metrov od seba. Potrava z oboch častí zimoviska a smer opúšťania zimovísk boli sledované v mesačných intervaloch. Myšiarky z časti zimoviska *Pinus* opúšťali zimovisko preukazne odlišným smerom ako myšiarky z časti zimoviska *Picea*. Hraboš poľný bol najčastejšie loveným druhom koristi v oboch častiachzimoviska. Každopádne porovnanie alternatívnej koristi medzi jednotlivými časťami zimoviska ukázalo, že ryšavka krovinná a ostatné cicavce boli preukazne viac lovené v časti *Picea*, kým vtáky boli preukazne častejšie zastúpene v potrave z časti *Pinus*. Naše výsledky naznačujú, že rozdielne zloženie koristi medzi dvoma sledovanými časťami zimoviska je prejavom využívania odlišných lovných habitatov s odlišnou dostupnosťou alternatívnych druhov koristi.

Key words: *Asio otus*, winter diet, alternative prey, pellet analysis

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Introduction

The long-eared owl (*Asio otus*) is an opportunistic predator (Tome 1991, Bertolino et al. 2001) which prefers open areas (Lövy & Riegert 2013) with forest edges (Henrioux 2000) and network habitats such as hedges and treelines (Galeotti et al. 1997). Its most frequent prey in Central Europe is the common vole (*Microtus arvalis*), but alternative prey is consumed in varying amounts depending on factors such as time, weather and habitat (Birrer 2009). Despite extensive knowledge about the long-eared owl's diet, there is nearly no information about differences in prey use by subgroups of owls living in one roosting-place at the same time.

We studied the foraging behaviour of two subgroups of owls in a roost in winter 2013/2014. This winter roost consisted of two parts, i.e. two different trees, which we labelled as two subgroups. In this article we present: (i) the departure behaviour of the two subgroups in the evening, (ii) differences between the diets of the two subgroups of long-eared owls during winter.

Material and methods

The study was conducted in the western part of the Prievidzská kotlina basin in central Slovakia during the winter of 2013/2014. The long-eared owls' winter roost was situated in the Bojnice Spa park area (48°46´25.16 N, 18°34´18.51 E, 317 m a.s.l.). This roost has been used regularly since 1992 at least (Tulis et al 2015a). The owls roosted in two trees which were 12 m apart and separated by a walkway. The tree to the east was a Norway spruce (*Picea abies*) and the one to the west was Scots pine (*Pinus sylvestris*). The landscape from northwest to southwest of the winter roost is hilly and dominated by extensively-managed grasslands interrupted with hedges and small forest patches. There is a plain with mainly intensively-managed arable fields, some grassland and wetlands along two rivers to the southeast of the roost. A forest and the town of Bojnice border on the roost to the north. The winter climate is characterized by cold weather with average temperatures of 1.3 °C and precipitation of 40.7 mm/month.

The number of owls was counted once a month during their departure in the evening from November 2013 to March 2014, i.e. 5 times. The direction of the owls' departure from the roost was recorded by two persons with the help of a compass with 10° precision at monthly intervals. Pellets were collected also at monthly intervals, separately from both subgroups at the winter roost on the same day when the owls were counted. The pellets were put into 5% solution of sodium hydroxide (NaOH), which dissolves all the undigested parts of prey except the bones. Mammals were identified by the skull – upper jaw (maxilla) and lower jaw (mandibula) according to Baláž et al. (2013). Bird bones were identified using a reference collection based on bills (rostrum), metatarsal (tarsometatarsus), humeral (humerus) and metacarpal (carpometacarpus) bones.

The differences in direction of the owls' departure from the roost were analysed using the Watson-Williams test in Past 3.11 (Hammer & Harper 2006). For statistical analyses four groups of prey were created: 1. *Microtus arvalis*, 2. *Apodemus sylvaticus* 3. birds and 4. other mammals (group consisting of cumulated remaining, less numerous parts of the diet). The minimum number of individuals of each prey species was multiplied with the mean body mass of this species to calculate the total biomass. Data for small mammal weight were taken from Baláž & Ambros (2006) and Baláž et al. (2013) and for birds from Hudec & Šťastný (2005). Trophic niche overlap was measured with Pianka's index, using the percentage of total biomass of particular prey items ($O_{jk} = \sum p_{ij}\, p_{ik} / \sqrt{\sum p_{ij}^2 \sum p_{ik}^2}$, where p_i is the percentage of prey item "i" in the diet of species "j" and "k") (Pianka 1973).

To study differences in prey use between the two subgroups we built linear mixed models using R-package lme4 (Bates et al. 2015) for each prey group in R (version 3.0.3, R Development Core Team 2011). In these models we used prey-group biomass (arcsinus-squareroot transformed) as dependent variable, subgroup as fixed factor and month as random factor. Bayesian methods were used to assess the significance of the models (Bolker et al. 2008). The function sim from the R-package arm (Gelman & Hill 2007) was used to draw random simulations from the joint posterior distribution of the model parameters. Based on the quantiles of these simulated samples from the posterior distributions, 95% credible intervals (CrI) were obtained for each model parameter. If the difference in proportions between the two subgroups was larger than CrI, a significant effect was assumed.

Results

The number of owls at the winter roost varied minimally (mean ± SD = 5.75 ± 0.50, range 5–6 per month). The *Pinus*-subgroup consisted of two owls at each count, whereas the *Picea*-subgroup contained three owls in November and four individuals in the other months. The mean direction of the owls' departure from the roost was south-west (203.9 ± 10.7°) for the owls of the *Pinus*-subgroup and south-east (116.9 ± 10.5°) for the *Picea*-subgroup (Fig. 1). The difference between the directions

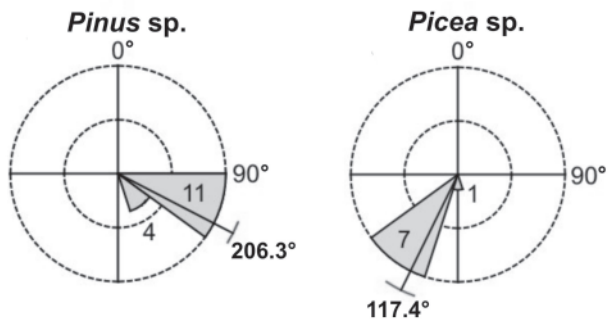

Fig. 1. The direction of long-eared owls' departure from the two parts of the winter roost (grey section = directions of owls' departure with no. of observations, whisker = circular mean of direction).

Obr. 1. Smer odletu myšiarok ušatých z dvoch častí zimoviska (sivá časť = smer odletu myšiarok ušatých zo zimoviska s počtom pozorovaní, línia = kruhový priemer smeru).

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Tab. 1. Number and mass of prey species identified in the pellets of long-eared owls from both subgroups at the Bojnice - Spa winter roost, collected monthly over the winter 2013/2014. Mean body mass is taken from the literature (see Study area and Methods section).

Tab. 1. Početnosť a biomasa druhov koristi determinovaná vo vývržkoch myšiarok ušatých z oboch časti zimoviska na lokalite Bojnice-kúpele, zbieraných v mesačných intervaloch v zime 2013/2014. Priemerná hmotnosť tela bola získaná z literatúry (pozri časť Materiál a metodika).

prey species /	***Pinus*-subgroup / časť**						***Picea*-subgroup / časť**							**prey mass / hmotnosť koristi**	
druh koristi	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**∑**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**∑**	**∑∑**	**mean body mass / priem. telesná hmot.**	**% of total biomass / % z celk. biomasy**
Microtus arvalis	27	33	99	41	112	312	37	58	126	75	131	427	739	26	81.3
Microtus subterraneus	1	0	0	2	0	3	0	0	1	0	0	1	4	19	0.3
Arvicola amphibius	0	0	0	0	0	0	0	0	0	1	1	2	2	150	1.3
Myodes glareolus	0	0	0	0	1	1	0	0	1	0	5	6	7	25	0.7
Apodemus sylvaticus	0	1	3	3	1	8	3	4	11	7	13	38	46	25	4.8
Apodemus flavicollis	0	0	0	0	0	0	0	2	0	0	11	13	13	33	1.8
Mus musculus	1	0	0	1	0	2	2	0	0	1	0	3	5	15	0.3
Micromys minutus	1	2	1	0	0	4	3	2	2	1	1	9	13	8	0.4
Crocidura suaveolens	0	0	0	0	0	0	1	0	0	0	1	2	2	5	<0.1
Sorex minutus	0	0	0	0	0	0	0	0	0	0	1	1	1	4	<0.1
Rhinolophus hipposideros	0	0	0	0	0	0	0	0	1	1	0	1	1	5	<0.1
Muscardinus avellanarius	0	1	0	0	0	1	4	0	0	0	0	4	5	27	0.6
∑ Mammalia	**30**	**37**	**103**	**47**	**114**	**331**	**50**	**66**	**142**	**85**	**164**	**507**	**838**		
Passer domesticus	11	6	4	8	1	30	0	1	1	0	0	2	32	32	4.3
Passer montanus	0	0	0	1	2	3	0	0	0	0	0	0	3	23	0.3
Chloris chloris	0	2	0	0	0	2	0	0	1	0	0	1	3	30	0.4
Parus major	1	7	4	7	2	21	0	0	0	0	0	0	21	19	1.7
Cyanistes caeruleus	0	1	1	0	2	4	0	0	0	1	0	1	5	11	0.2
Erithacus rubecula	1	1	0	0	0	2	0	0	0	0	0	0	2	17	0.1
Galerida cristata	0	0	0	1	0	1	0	0	0	0	0	0	1	43	0.2
Turdus merula	0	1	0	0	0	1	0	0	1	0	1	2	3	107	1.4
∑ Aves	**13**	**18**	**9**	**17**	**7**	**64**	**0**	**1**	**3**	**1**	**1**	**6**	**140**		
∑∑	**43**	**55**	**112**	**64**	**121**	**395**	**50**	**67**	**145**	**86**	**165**	**513**	**908**		

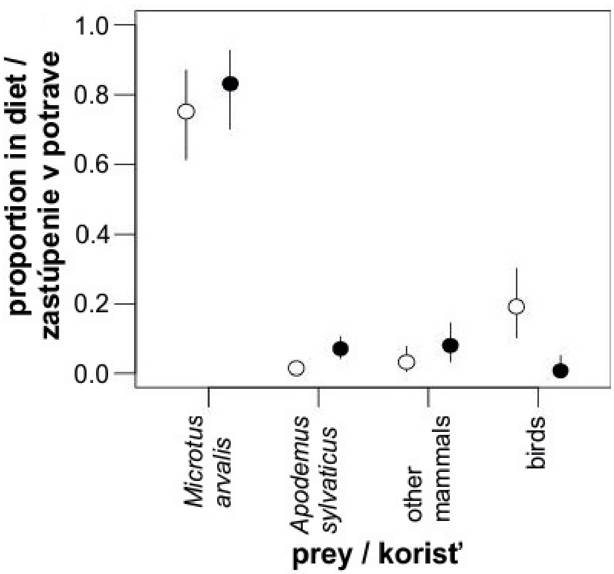
of roost departure was significant (Watson-Williams test, N = 23, F = 25.5, P < 0.001).

In 322 pellets, 908 prey individuals were identified, consisting of twelve mammal and eight bird species (Tab. 1). The common vole was the dominant prey species constituting 81.3% of total biomass (BM) (mean ± SD = 78.4 ± 12.4%, range 59.3–93.9%). Birds were the second most important prey group with 8.6% BM, (11.9 ± 14.6%, range 0–36%) followed by other mammals with 5.5% BM, (5.3 ± 5.11%, range 0.3–14.6%) and wood mouse (*Apodemus sylvaticus*) with 4.8% BM, (4.4 ± 2.9%, range 0–7.6%).

The most hunted prey by the prey number in both subgroups was the common vole, with non-significantly higher proportions in the *Picea*-subgroup (*Pinus* BM mean ± SD = 73.9 ±16.5%; *Picea* BM 82.9 ± 4.5%). Wood mouse (*Pinus* BM 1.9 ± 1.8%; *Picea* BM 6.8 ± 0.8%) and other mammals (*Pinus* BM 2.16 ± 1.5%; Picea BM 8.5 ± 5.6%) were found in significantly lower proportions in the *Pinus*-subgroup diet than in the *Picea*-subgroup. In contrast, birds were found in significantly higher proportions in the *Pinus*-subgroup diet (BM 21.9 ± 15%) than in the *Picea*-subgroup (BM 1.83 ± 1.8%) (Fig. 2). The high proportion of common vole had a strong impact on Pianka's index of trophic niche overlapping (mean ± SD = 0.95 ± 0.03, range 0.86–0.99).

Fig. 2. Proportion of prey groups in diets of long-eared owls in *Pinus*-subgroup (white dots) and *Picea*-subgroup (black dots) (points: fitted value of diet proportion, bars = credible interval (calculated with Bayesian statistic).

Obr. 2. Proporcia skupín koristi v potrave myšiarky ušatej v časti zimoviska na borovici (biele body) a na smreku (čierne body) (body: fitované hodnoty proporcie potravy, čiara = interval spoľahlivosti (vypočítaný pomocou Bayesovskej štatistiky).



Discussion

The prey of the long-eared owls at the Bojnice Spa roost in winter 2013/2014 corresponded to the prey lists of this species found in Central European habitats (Birrer 2009) and at Bojnice in earlier winters (Tulis et al. 2015a), with common vole as the predominant prey species and birds, wood mouse and other mammals as alternative prey.

Individual long-eared owls appear to be very faithful to their sitting spots in the roost over a long period (Bol 2010). But individuals changing their roosting-place during the non-breeding season were observed twice at Bojnice in earlier years (Tulis 2015b). Our data show very small variance in the number of owls in the two subgroups. We assume therefore that membership of the two subgroups stayed constant over time, and that we observed group specific traits.

The main prey of both subgroups of owls was the common vole, whereas alternative prey groups varied significantly between the subgroups. Despite the number of papers dealing with prey differences in time or space, we are aware of only one publication comparing the prey of subgroups in the same place and at the same time: Schnurre (1937) describes a winter roost in Berlin where two long-eared owls sat separated from the rest of the roosting owls. The prey of these two groups of owls was nearly identical. The home ranges of four radio-tracked owls at the Bojnice roost in winter 2010/11 and 2011/12 (Tulis et al. 2015b) were long-shaped with the roost lying acentrically (Tulis 2013). In these years three of the four owls had a home-range directed to the west and one extended to the south. The different directions of roost departure observed in our study combined with the long-shaped home range lead to the assumption that the two subgroups had different hunting areas. In both directions the owls would find open, agricultural landscape. Common voles could be hunted as the main prey there, which was reflected in the high trophic niche overlap in our results Extensively-exploited grassland interspersed with hedges and small woodland patches was found in the southwest, in contrast to the southeast where arable fields were dominant, interrupted with wetlands and grassland. It is probable therefore that the availability of several prey species differed between the two hunting areas, which was reflected in the differing prey the owls of the two subgroups hunted in addition to the common vole. The *Pinus*-subgroup preyed more upon birds, especially on house sparrow (*Passer domesticus*) and great tit (*Parus major*) compared with the *Picea*-subgroup, whereas the latter hunted more on wood mouse and other mammals. Other alternative hypotheses are that the different prey composition was a consequence of different preferences of males and females, of different age classes or of individuals. The probability that the owls of both subgroups were sorted by sex or age is small. In contrast to some other owl species where differences in prey use between sexes are known (Longland 1989, Overskaug et al 1995, Villáran Adanéz 2000, Poulin & Todd 2006, Mikkola et al. 2013, Mikkola & Tornberg 2018), dealing with sex-specific prey use by long-eared owls revealed only minimal differences (Overskaug et al. 2000, Mikkola & Tornberg 2018). Moreover, there is no indication that genetically-related groups or groups from different origins could differ in prey preference, and nothing is known about individual prey use.

However, in accordance with our results we conclude that at the Bojnice roost the two subgroups appeared to use separate hunting areas with different alternative prey availability. This study also indicates that it would be valuable to take a closer look at the structure of long-eared owl roosting groups, to their departure behaviour, and hunting areas.

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