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Comparison of Winter Diet of Long-eared Owls *Asio otus* (L., 1758) and Short-eared Owls *Asio flammeus* (Pontoppidan, 1763) (Aves: Strigidae) in Northern Turkey

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Abstract: This study compares the winter diet of short-eared owls (*Asio flammeus*) and long-eared owls (*Asio otus*) around the Yedikır Dam (Amasya, Northern Turkey). A total of 309 pellets containing remains of 557 individual prey items were found. The diet composition of both owls consisted of only six small mammals dominated by the east European voles (*Microtus levis*) in similar proportions (58.9% by number, 51.0% by biomass in *A. flammeus* and 55.9% by number, 63.3% by biomass in *A. otus*). *Mus macedonicus* was another important prey in the diet of short-eared and long-eared owls (F = 10.0% and F = 18.8%, respectively). Slightly preferred prey were the yellow necked mouse (*Apodemus flavicollis*), Turkish hamster (*Mesocricetus brandti*) and the grey dwarf hamster (*Cricetulus migratorius*). *A. flammeus* and *A. otus* had very similar diets in Northern Turkey. The food-niche breath (FNB) was low in the owl species. The studied owl species showed high level of niche overlap (R_o = 0.886).

Key words: Diet composition, small mammals, Northern Turkey, owls, pellet analysis.

Introduction

Pellet analyses of owls have ecological importance because they may help understand prey distribution, abundance, behaviour or trophic relationships between sympatric species (Torre et al. 2004, Figueroa et al. 2009). The long-eared owl, *Asio otus* (L., 1758), is a medium-sized owl species which is widespread in the open areas of the Holarctic (Mebs & Scherzinger 2000). While almost its entire diet may consist of small mammals (especially rodents of the genus *Microtus*), the diet composition may also show geographical and climatic variations (Romanowski & Zmihorski 2008). The short-eared owl, *Asio flammeus* (Pontoppidan, 1763) is a medium-sized owl of the open habitats, sage flats, grassland and roadsides. Generally, it can hunt at dawn (crepuscular) and at night (nocturnal) in grasslands and open habitats (Swengel & Swengel 2009) and also can be active during the day in breeding period (Reynolds & Gorman 1999). In addition, it may have migratory behaviours when selecting its breeding areas and its preferences are strongly depending on the abundance of small mammals (Poulin et al. 2001). Short-eared owls hunt almost only small mammals and occasionally insects, amphibians and birds (Martinez et al. 1998, Figueroa et al. 2009, Djilali et al.2016).

Recently, we studied for the first time the winter diet composition of the short-eared owl in Turkey. There are only a few studies regarding the feeding of the long-eared owl carried out in Turkey. However, the long-eared owl and short-eared owl diets have not been compared before in Turkey when they occur in sympatry. We analysed the winter diet compositions of the two species in the dominant habitat of steppe and agricultural areas in the Amasya Region (Northern Turkey).

Materials and Methods

The study was conducted in a habitat with partly pinetum and partly steppe and agricultural areas around

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the Yedikır Dam (40°46′ N, 35°33′ E) in the northern region of Turkey. Pellets of long-eared and short-eared owls were collected during the winter months (December-February) of 2015 (three times). The lowest average temperature in Amasya in winter was -1°C and the highest average temperature was 9.3°C. Short-eared owls were observed to roost on the ground in groups in open areas; their pellets were collected from the places they roosted and were identified. The pellets of long-eared owls from the same area were collected from the pinetums where they roosted in groups. Seventy-eight intact short-eared owl pellets and 231 intact long-eared owl pellets were collected in the research area. Minimum number of individuals (MNI) of mammals was estimated mainly on the basis of the remains of skulls and mandibles. Small mammal species identification and their biomass were carried out following KRYSTUFEK & VOHRALIK (2005, 2009). The food niche breadth (FNB) was calculated as follows:

$$FNB: 1/\sum p_i^2,$$

where p_i was the proportion of prey category *i* in the diet of the owls (LEVINS 1968). Shannon-Wiener indices were calculated for trophic diversity at species levels [$H' = -\sum p_i ln(p_i)$, where p_i is the proportion of species *i* in the entire sample, see KREBS 1994]. Evenness index was calculated ($J' = H'/H'max$', where H' is the diversity value calculated from the Shannon's index; $H'max'$ is the maximum possible Shannon measure). Horn index (R_o, see KREBS 1989, 0 = no overlapping, 1 = complete overlapping) was used to estimate the diet-niche overlap between the two species was used.

Results

A total of 557 specimens of six small mammal taxa were found in the pellets of the studied short-eared and long-eared owls (Table 1). The mean number of prey per pellet was 1.32 ± 0.6 for *A. flammeus* and 2.16 ± 1.03 for *A. otus*. The minimum and maximum amount of prey found in a single pellet was 1-3 prey animals for *A. flammeus* and 1-7 prey animals for *A. otus*. Average biomass was 58.00 ± 25.45 g for *A. flammeus* (range 16.85–118.80 g), 72.9 ± 31.15 g for *A. otus* (range 16.85–230.40 g).

Voles (*Microtus* spp.) dominated both diets in similar proportions (64.5%N in *A. flammeus* and 64.9%N in *A. otus*). *Microtus levis* (58.9%N and 51.0%B) and *Meriones tristrami* (16.7%N, 32.3%B) had the highest frequency and biomass proportion in the diet of the short-eared owls while *Microtus levis* (55.9%N, 63.3%B) and *Mus macedonicus* (18.8%N, 9.4%B) had the highest frequency and biomass proportion in the diet of the long-eared owls (Table 1). Mice (*Mus* spp.) were the other important prey for both owl species (11.1%N for *A. flammeus* and 28.4%N for *A. otus*). *Apodemus flavicollis*, *Mesocricetus brandti* and *Cricetulus migratorius* were very occasional prey (Table 1). The food niche breadth (FNB) in the diet was highest in *A. otus*. The values of the evenness Index (J') were low for both owl species and they showed a similar evenness (0.64). Horn index (R_o) showed a high level of niche overlap (Table 1).

The proportions of all mammalian prey were similar in the two studied owl species. Nevertheless,

Table 1. Winter diet of the short-eared owl *Asio flammeus* and long-eared Owl *Asio otus* at Yedikir Dam (Northern Turkey): N – prey number; %N - % by number; %B - % by biomass

Species	**Mean body weight (g)**	**Asio flammeus**			**Asio otus**		
		N	%N	%B	N	%N	%B
Microtus levis	38.40	53	58.9	51.0	261	55.9	63.3
***Microtus* sp.**	38.40	5	5.6	4.8	43	9.0	10.4
Mus macedonicus	16.85	9	10.0	3.8	88	18.8	9.4
***Mus* sp.**	16.85	1	1.1	0.4	45	9.6	4.8
Apodemus flavicollis	27.90	3	3.3	2.1	4	0.9	0.7
Meriones tristrami	85.90	15	16.7	32.3	13	2.8	7.1
Mesocricetus brandti	80.40	2	2.2	4.0	6	1.3	3.0
Cricetulus migratorius	29.70	2	2.2	1.5	7	1.5	1.3
Total prey items		90	100	100	467	100	100
Mean number prey/pellet		1.17 [%95 CI: 1.01-1.33]			2.03 [%95 CI: 1.88-2.17]		
Mean prey biomass/pellet (g)		58.56 [%95CI:52,49-64,63]			72.95 [%95CI:68,77-77,13]		
FNB		0.22			0.25		
Evenness index (J')		0.64			0.64		
Shannon-Wiener index (*H'*)		1.33			1.34		
Horn index (R_o)		0.886					

the analysis of the individual species groups indicated significant variation among A. *flammeus* and *A. otus* for *Meriones tristrami* ($z = 5.52$, $p<0.001$) and *Mus* spp. ($z = 3.45$, $p<0.001$) by frequency. No significant differences occurred in the other prey.

Discussion

The genus *Microtus* is dominant in the diet of the long-eared owl as demonstrated in studies conducted in different parts of Turkey: suburban areas in Central Anatolia (Turan 2005, Bulut et al. 2012); natural habitats in Southern Anatolia (Seçkin & Yüksel 2006), in Central Anatolia (Hizal 2013) and in Northern Anatolia (present study),. As an exception, in a study carried out by Göçer (2016) in the nesting area in a city centre of South-western Anatolia, the diet composition consisted only of birds. Further, unlike our study, in a study conducted by Turan (2005), bird samples were seen in addition to small mammals in the diet composition. Long-eared owl can prey on birds in case of scarcity of main nutritional sources (Cramp 1985). This situation may be very rare or it may constitute a significant part of the diet composition (Sandor & Kiss 2008). Similarly, bats (Chiroptera) can form the main nutritional source of long-eared owl in urban areas (Tian et al. 2015). Since the bat species widespread in the research area (Benda & Horacek 1998) were hibernating, bats were not recorded in the diet composition.

There are no earlier studies conducted in Turkey to determine the diet composition of the short-eared owl. The short-eared owl is a specialised predator and a significant part of its diet in winter consists of small mammals; however, it can feed on insects and birds as well as on small mammals in summer (Roberts & Bowman 1986, Martinez et al. 1998, Williford 2011, Gryz & Gryz 2015, Milchev & Ivanov 2016). In this study, the diet composition of the short-eared owl consisted only of small mammals.

Although owls of the genus *Asio* are generally nocturnal, short-eared owls can show both nocturnal and crepuscular behaviour during winter (Clark 1975, Bosakowski 1989, Figueroa et al. 2009). Similarly, although *Meriones tristrami* (Mammalia: Rodentia) is generally nocturnal and crepuscular (Lewis et al. 1967), it can also show diurnal behaviour (Yiğit et al. 1995). However, a study by Kaya (2005) reported that *M. tristrami* was not caught during the day. It could be speculated that the proportion of *M. tristrami* in the diet of the short-eared owl (F = 16.7%) is higher when compared with the diet of the long-eared owl (F = 2.8%) since both short-eared owl and *M. tristrami* show crepuscular behaviour (*M. tristrami*: $z = 5.52$, $p<0.01$).

According to the Optimal Foraging Theory, the presence of the main prey species in the diet composition is negatively correlated with the diet variability (FNB) (Bertolino et al. 2001). Since *Microtus levis* was the predominant species in the diet composition of the short-eared and long-eared owls, the diet composition had a low variability (FNB = 0.22 and 0.25, respectively). In forestlands, the winter diet of the long-eared owl can have higher variability (Zmihorski 2005).

Due to the territory defence, aggressive behaviour and various adaptations, diet composition of owl species may vary. However, the abundance of the main prey forming the diet may decrease the niche differentiation (Walk 1998, Leveau et al. 2004). Similarly to other studies (Dupal & Chernyshov 2013), we found that the short-eared and long-eared owls had very similar winter diets ($R_o = 0.886$)

Mus macedonicus was another important prey in the diet of short-eared and long-eared owls (F = 10.0% and F = 18.8%, respectively). *Mus macedonicus* and *Microtus* spp. can be seen together in cultivated areas and dense vegetation - grasses, sagebrush, reeds and bushes (Vohralik & Sofianidou 1992, Krystufek & Vohralik 2005, 2009). Since there are dense cultivated and natural vegetation plots in the research area, *Microtus levis* and *Mus macedonicus* constitute an important part of the diet composition of both owl species. If *Microtus* sp. is rare or non-existent in the area, *Mus* sp. can be dominant in the diet composition of the long-eared owl (Bertolino et al. 2001).

The presence of *Cricetulus migratorius*, *Mesocricetus brandti* and *Apodemus flavicollis* in the diet composition of both owls (total F = <10%) can be explained by the presence of woodlands, herbaceous areas and reedbads around the cultivated fields in the research area. These areas are suitable habitats for the three mammal species that we have recorded in the diet (Krystufek & Vohralik 2009).

As a conclusion, our study supports the view that the genus *Microtus* constitutes the main prey of the long-eared owl. In addition, studies should be conducted in different habitats to find out the effects of environmental factors on the short-eared owl and its diet preference.

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